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AN ANALYSIS OF THE EFFECTIVENESS OF WRITTEN DRIVER LICENSE EXAMINATIONS IN EVALUATING APPLICANT DRIVING ABILITIES

Arizona Driver Licensing for the Nineties
Task II

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AN ANALYSIS OF THE EFFECTIVENESS OF WRITTEN DRIVER LICENSE EXAMINATIONS IN EVALUATING APPLICANT DRIVING ABILITIES

Report of Task 2
ARIZONA DRIVER LICENSING FOR THE NINETIES

submitted by
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16. ABSTRACT

A driver licensing system for Arizona in the nineties and beyond has been designed through a comprehensive analysis of the state-of-the-art for driver licensing.

The prominent features of the designed licensing system are listed below:

1) Develop a classified driver's license.
2) Provide for provisional licensing.
3) Ensure testing for license renewal.
4) Improve and expand manuals and tests consistent with a classified system.
5) Provide oral testing using flashcards and audio cassettes where necessary.
6) Administer road tests to applicants for truck and bus and tractor-trailer licenses.
7) Maintain the current motorcycle skill testing procedure.

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TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

TABLE OF CONTENTS (continued)

TASK 2 - ARIZONA DRIVER LICENSING FOR THE NINETIES

This report describes the activities undertaken in, and the results obtained from Task 2, "Arizona Driver Licensing for the Nineties", of a study entitled "An Analysis of the Effectiveness of Written Driver License Examinations in Evaluating Applicant Driving Abilities," Research Project No. HPR-PL-1(25) Item 225.

OBJECTIVES OF THE STUDY

The overall goal of the effort described is to recommend actions that can be taken by the Arizona Department of Transportation to improve the effectiveness of the Arizona written driver license examination as a means of assuring the qualifications of Arizona drivers. In achieving this overall goal, the following objectives must be fulfilled:

1. To analyze the Arizona Driver License Examination to identify needs for improvement--Once the state-of-the-art has been surveyed, the results need to be compared with the present state of the Arizona driver license knowledge examination, and the system of which it is a part. Discrepancies between the two will identify areas in which improvement can be sought.

2. To assess the state-of-the-art in driver license knowledge examination--The first objective will be to undertake a broad survey of driver license knowledge examination technology in order to identify what the state-of-the-art has to offer.

3. To define a set of goals and objectives for the Arizona Department of Transportation--From the needed improvements identified in fulfilling the second objective, those that are appropriate for the Arizona DOT must be identified. These needed improvements must then be fashioned into a set of attainable goals.

4. To identify a plan of action to enable the Arizona DOT to fulfill goals--A step-by-step plan of action needs to be formulated to enable the Arizona DOT to undertake the activities and to procure the goods and services needed to fulfill goals.

BACKGROUND

A little over a decade ago, Nuckols (1972) found the content of state driver license manuals and tests to be woefully deficient with respect to the needs of safe motor vehicle operation. Since that time, enormous strides have been made in improving the quality of driver license manuals and tests.

Factors Leading to Improvement

Among the factors responsible for this improvement are:

- Federal driver licensing standards and the release of 402 funds to support innovative developments, including manuals, written tests, test equipment, etc.
- Increased professionalism within driver licensing agencies leading to development of greater levels of experience and skill in development and use of driver testing methods.
- Development of driver licensing guides, model tests, and other useful products by federal agencies and national private sector organizations.
- Better communication among states and state agencies, leading to the sharing of information and products.
- Research into driver information needs and effective means of fulfilling them.
- Participation by the private sector in dissemination of information and marketing of products.

Study Needs

What was needed to bring the benefit of improvements in the state of the driver licensing art to Arizona was a study that surveys the state of the art and the State of Arizona, compares the two, and recommends improvements along with a plan for achieving them. In order to be of benefit to the Arizona DOT, the proposed study had to:

- Carry out a survey of the driver licensing state-of-the-art that is as comprehensive, thorough, and up-to-date.
- Objectively identify the advantages and disadvantages, benefits and liabilities, successes and failures of driver licensing examination innovations.
- Make a thorough analysis of the Arizona licensing operation, its needs, and the constraints under which it operates.
- Identify, for any contemplated improvement, the specific changes that need to be made, the obstacles to be overcome, the steps that must be taken to overcome them, the cost of instituting the change, the potential benefits to be realized, and the means of assessing those benefits.

Prior to the conduct of a survey and preparation of recommendations for overall improvements in driver licensing, the study was to carry out an analysis of the current Arizona Driver License Manual and Test and recommend specific revisions that would bring those particular items up to date.

THE ROLE OF LICENSE TESTS

People generally view the role of license tests as helping to prevent accidents and make the roads safer. However, their view of the way tests do this differs depending upon the model of the licensing process that they are assuming. The two most commonly assumed models may be termed the "quality assurance" model and the "selection" model.

Quality Assurance Model

According to the American Association of Motor Vehicle Administrators (AAMVA, 1967), the purpose of a license test is "to assure the applicant's ability to drive safely." This implies that the purpose of the test is not one of selection, but one of quality assurance.

Probably the most familiar application of a quality assurance model is the process by which products are inspected as they come off the production line. The function of inspection is not to see which products get "selected" and shipped to market. Unless almost all of them do, the company would quickly go out of business. The primary purpose of the inspection process is to assure the quality of the product by causing the people who produce it to achieve prescribed quality standards. Most of what the inspection process accomplishes is realized before the product ever reaches the inspector.

The same model applies directly to license testing. Drivers recognize they are going to have to exhibit certain abilities in order to pass the test. Accordingly, they practice until those abilities are attained. It is the activities that go on before the applicant ever reaches the licensing station that determine how well drivers perform. Like an inspection, most of what it accomplishes occurs before it is given.

There are other aspects of a quality assurance program that make it the appropriate model for licensing testing.

- The success of a quality assurance program requires that testing be accompanied by materials that help in attaining quality standards. Almost all States provide manuals describing the laws and practices that make up safe driving. Similar manuals are needed for truck driving, although only seven States currently provide them.

- Where the quality assurance process cannot assess all aspects of quality, it is important that those whose quality is being assured not know what will be assessed and what will not be. Otherwise, they will focus their attention upon the former to the sacrifice of the latter.

Selection Model

The selection model assumes that the selected people stay selected and the rejected people stay rejected. Such a model would be appropriate to tests administered to applicants for a driver position with a public carrier

of cargo or passengers, or in a company that operates its own fleet of heavy vehicles. Those who are selected get to operate the company's vehicles while those who are rejected go to work for someone else. If the test employed has validity in predicting accidents, use of the test should improve the company's accident records by employing safe instead of unsafe drivers. This will be true even if the predictive validity was not from the test, but from the correlation of test results with some other accident-correlated factors such as socioeconomic status, educational level, or marital status.

A test that was able to predict accident experience would not be very useful to a company that selected drivers no matter how they scored on the test. Yet, that is precisely what happens in a license test. Dreyer (1976) found that over 95% of people applying for a California driver's license in his study ultimately got one. If one assumes that some portion of the remaining 5% succeeded in getting a license in another State, then practically no one was screened out by the license test.

Summary

The assurance model is an appropriate one for designing a licensing system for Arizona. The purpose of testing Arizona drivers is to assure that only those who are capable of driving Arizona highways safely are legally permitted to do so. The licensing system seeks to achieve this, not by permitting only the best drivers to have licenses, but providing the means by which those who wish to drive can become qualified to do so. To be sure, there will be some small fraction of the population who simply do not have the physical or mental equipment to drive safely. However, this is an extremely small fraction--less than 1%--and certainly not the primary target of licensing activities. This report will attempt to describe means by which the MVD can seek to improve the safety of motor vehicle operation in Arizona through better qualified drivers.

A selection model tends to orient a test toward the inclusion of anything that is predictive of criterion performance. As noted earlier, there are a number of driver characteristics that are related to accidents, including age, prior driving record, marital status, educational level, and measures of socioeconomic status. The danger of application of this approach to licensing is that it can include many characteristics that do not play a causative role in accidents and violations. (For example, marital status is not a cause since divorced drivers don't experience immediate improvement upon remarriage.)

The issue of causation has not generally been of concern in job selection. The personnel manager of a trucking company can select any characteristic having predictive validity, including marital status. However, society has not generally been willing to allow the license to drive to be withheld on the basis of any factor that is not itself a cause. Because of the importance of mobility to economic survival and general well-being, only those factors that play a causative role, such as visual acuity and ability to handle the vehicle, are sanctioned. Of the factors just mentioned, only age serves as a basis for licensing, and that is only to the extent of ruling out the very young.

EFFECTIVENESS OF LICENSE TESTS

A good deal of empirical and theoretical research has gone into the evaluation of license tests. The results of this research have varied, depending largely upon the type of study employed.

Correlational Studies

In employing the selection model, several research studies have attempted to assess the validity of license tests by correlating scores with subsequent accident and violation records. Campbell (1958), McRae (1969), and Harrington (1973) all found significant but very small relationships. Kaestner (1964), as well as Waller and Goo (1968), found both positive and negative relationships depending upon the age and sex of applicants. Finally, Wallace and Crancer (1969), Freeburg and Creech (1972), Dreyer (1976), Conley and Smiley (1976), and Jonah and Dawson (1979) found a total lack of relationship. The results of these studies have generally led to the conclusion that license tests lack sufficient predictive validity to be used as a screening device in determining who gets to drive and who doesn't (Atkins, 1984). Predictive validity is used as a screening device in determining who gets to drive and who doesn't (Atkins, 1984). They support the statement voiced earlier by Uhlaner and Drucker (1964) who pointed out that, if license tests were used to screen out drivers, it would end up barring from the road as many good drivers as it did bad drivers.

There are a number of reasons to question the use of predictive validity in evaluating the effectiveness of license tests.

> Effect of Outside Factors--Several factors known to correlate both with test scores and accidents/violations could obscure the relationship between the two. Chief among these are age, sex, and educational level. Young males, for example, generally score high on any tests of manipulative skills while having poor accident and violation records. This relationship could counter any relationship resulting from direct causative effects upon accidents of variables measured by the test. Some studies have attempted to control for the effects of these variables statistically. However, such control can be exercised only over those outside variables whose relationship with test scores and accidents has been measured.
>
> Change in Performance--In many of the studies cited, accidents were predicted on the basis of initial test scores. However, since the studies dealt with licensed drivers, applicants who failed must have studied and practiced until they were able to pass. How could one expect any correlation between scores and accidents/violations if the scores later changed?
>
> Lack of Variance--A function of a licensing test is to cause applicants to attain the proficiency needed to perform safely. If the test is effective in this regard, applicants will achieve high levels of proficiency before the test is administered and pass. result is to reduce variance in test scores which, in turn,

reduces covariance between test scores and accident measures. In this regard, the more successful a test is, the more homogeneous would be the performance of applicants and the lower would be the correlation of the test with accidents.

Experimental Studies

The problems just described can be overcome if a license test is viewed as a measure of assuring quality (a "treatment") to be evaluated experimentally rather than a predictor to be evaluated correlationally. In an experimental evaluation:

- The effect of all outside factors, including those that are unidentified, can be controlled through randomization.
- Changes in score during the licensing process is not a problem since the scores don't figure in the evaluation.
- For the same reason, lack of variance in the licensing scores is not a problem.

Only recently have efforts been made to evaluate license tests through random experiments. McKnight and Green (1976) evaluated written tests and accompanying manuals designed for teenage novice drivers, adult renewals, and renewals over age 55 in the State of Virginia. The first two showed significant accident reductions when compared with existing tests and manuals.

The California Department of Motor Vehicles evaluated the effect of improved motorcycle licensing tests consisting of a knowledge test and skill measure (Ford and Anderson, 1978). Those administered the improved test had fewer accidents than those administered the regular motorcycle license test. Even greater accident reduction was achieved by giving a three-hour skill test to those failing the skill component of the testing program.

Summary

Evidence indicates that, while license tests have little validity in predicting who will and will not be safe drivers, they are capable of working an improvement in safety of operation by drivers. Tests provide a means of inducing drivers to acquire the skills and knowledges to operate safely. While this has never been specifically assessed in the State of Arizona, there is no reason why the results obtained elsewhere would not generalize here. As will be noted later, tests must be accompanied by means through which drivers can acquire the necessary skills and knowledges. Resources necessary to provide this are available in Arizona.

STUDY APPROACH

NPSRI proposed a 3-phase approach to improving the effectivness of the driver license examination as a means of assuring that Arizona drivers are qualified to operate motor vehicles safely.

> Task 1 - Recommend Revisions of Test and Manual--involved the simultaneous survey of the state of the art in licensing and analysis of the current Arizona Driver License Manual and Examination. Information from these two sources was applied to recommendations for improvements that need to be made to the License Manual and Examination.
>
> Task 2 - Arizona Driver Licensing for the Nineties--involved design of a driver license examination system based upon an analysis of the state of the licensing art.
>
> Task 3 - Plan License Examination Program Implementation--will describe a series of steps by which the MVD can bring into being the system designed in Task 2.

Task 1 "Recommended Revisions of Test and Manual" was completed with submission of a report on March 15, 1985. This report provided the following:

1. Recommendations for changes in the Arizona Driver Manual considered desirable to improve its ability to communicate information needed by drivers to operate vehicles safely in the in the state of Arizona.

2. A revised manual incorporating changes identified in (1) above.

3. A description of activities undertaken to evaluate items making up the current written examination for Arizona drivers and the results of the evaluation.

4. Thirty-four test items designed to assess acquisition of information added to the manual through the revision process.

5. A truck operator manual and written test for use at such time as the state of Arizona revises its licensing system to require a separate license for truck and bus operators.

6. Reproducible copy of the revised Motorcycle Operator Manual and Motorcycle Written Test, developed by National Public Services Research Institute and distributed through the Motorcycle Safety Foundantion.

CONTENTS OF REPORT

This report describes the driver licensing system capable of being implemented within the next five years in order to improve the safety of motor vehicle operation on the Arizona streets and highways throughout the

nineties and beyond. The recommended licensing system is based upon a survey of the driver licensing state of the art and its synthesis into a licensing system. The design of the system is intended to fulfill the study objectives (2) and (3) as enumerated on page 1 of this report.

The design of licensing system was based upon (1) the project staff's extensive experience in development and evaluation of licensing programs, and (2) an exhaustive survey of the driver licensing literature with specific references provided in the body of the report.

The discussion of an Arizona licensing system for the nineties will be organized as follows:

Structure--The kinds of licenses to be issued, and the relationships among them.

Qualifications--The mental and physical qualifications appropriate to each type of license.

Testing--The testing procedures that are most appropriate to assessment of qualifications.

STRUCTURE

The license structure recommended for Arizona is one that is generally called a "classified" licensing system. A classified license system is one which classifies drivers into different categories for licensing purposes. The categories are typically based upon the type of vehicle to be operated. However, some licensing structures also categorize drivers on the basis of conditions underwhich vehicles may be lawfully operated. For purposes of this discussion, both will be considered aspects of a classified license structure.

Arizona has a very limited classified licensing system. It consists of the following three categories:

Driver's License--A license to operate any motor vehicle except those for which a Chauffeurs License or Motorcycle Operators License is required.

Chauffeur's License--A license to operate a vehicle for hire or for purposes of employment.

Motorcycle License--A license to operate a motorcycle or motor driven cycle.

This section of the report will discuss classified license systems in reference to Arizona's needs and will offer some specific recommendations for an Arizona classified license system.

BACKGROUND

Before discussing the purpose of classified licensing for the state of Arizona, it is worth taking a moment to look at how license classification systems are structured.

Purpose of Classified Licensing

Legislatures enact classified licenses for different reasons. However, the major avowed purpose for having a classified license system is that different catagories of vehicle operation require different abilities, the possession of which drivers should be required to demonstrate before being allowed to operate on the public highways. Requiring different licenses for different catagories of vehicles provides a means by which the MVD's can require a demonstration of ability.

Basis of Classification

There are almost as many classified licensing systems as there are states. However, the structure of most systems are based upon the following three dimensions:

- o Level of Ability
- o Level of Responsibility
- o Type of Ability

Level of Ability

A common and logical basis for license classification is the level of ability required to operate a vehicle. The level of ability is generally thought to be closely related to the size of the vehicle being operated. The longer, wider, heavier the vehicle, the harder it is to maneuver within the fixed limits imposed by the highway traffic environment. Certainly, it is harder to keep within the confines of a ten foot travel lane when driving a tractor trailer that is eight and a half feet in width and sixty feet long than it is when driving an automobile that is only six feet wide and twelve feet long.

As of 1984, some thirty states classified licenses on the basis of vehicle size (FHWA 1984). Size has been reckoned in terms of gross vehicle weight, number of axels and articulation. Some use only one of these factors, while others use combinations.

Level of Responsibility

Arizona, like many other states, requires a special license to operate vehicles as a part of one's employment, or as it is more commonly known, "For Hire." The vehicles involved--taxis, buses, and trucks--are no more difficult to operate when being driven for hire than when being used for one's own transportation. However, transporting someone else's goods or person involves a higher level of responsibility.

As a reflection of the added responsibility, most states require operators of vehicles for hire to have a special "Chauffeur's" license. Many states require applicants for Chauffeur's License to be somewhat older and/or have somewhat more driving experience than applicants for regular drivers license. In some states, the visual standards for a Chauffer's License are more stringent than those for a regular license.

Type of Ability

Some license classifications are based upon the fact that the type of driving ability involved is different, in operating various types of vehicles: it doesn't require more ability just different one. Operation of a motorcycle is a good example; the abilities needed for operating it are unique to that vehicle. School buses are another example. They are no harder to drive than any other bus. Picking up, transporting, and discharging children, however, involves a number of unique abilities.

Methods of Classification

States do not issue separate licenses for every category of vehicle for which separate licensing is required. There are three basic methods of classifying drivers for different types of vehicles:

- o License Class
- o License Endorsement
- o Conditional License

License Classes

In a system of license "classes" vehicles are placed in a hierarchy such that a license to operate one vehicle in the hierarchy also includes a license to operate all vehicles that are lower in the hierarchy.

The most common hierarchical classification, used by approximately half the states, involves three classes, corresponding to three vehicle size groups (1) tractor-trailer, (2) straight trucks and buses, (3) cars, van, small panel trucks. A driver holding the first class of license, can drive vehicles in all three classes; those in the second class can drive all vehicles except tractor-trailers; drivers in the third class can drive only vehicles in that class. The use of classes is based on the assumption that drivers who have demonstrated the ability to operate vehicles in the highest class, can also operate vehicles in lower classes and should not have to obtain separate licenses.

The difficulty with license classes rises with vehicles that don't fall in the hierarchy, such as motorcycles or school buses. Separate classes become necessary for each combination, e.g. one class for drivers licensed to operate motorcycles and not cars, another for motorcycles and cars, and yet another for motorcycles and trucks. The classification system then becomes very complicated. The use of license classes is most practical where categories can be ordered with a hierarcy on the basis of some factor such as size.

Endorsements

An endorsement system is extremely simple in that each vehicle a driver is allowed to drive is identified by a separate endorsement. A driver allowed to operate a tractor trailer, straight truck or bus, and automobile would carry three endorsements, one for each vehicle, rather than a single class of license. It isn't necessary that drivers demonstrate their ability to operate every type of vehicle for which they are seeking an endorsement. A driver who demonstrates his ability to drive a tractor trailer can automatically be given endorsements for smaller vehicles.

An endorsement system becomes more practical than license classes where there is not an underlying dimension (such as vehicle size) to form the basis of a hierarchy.

Conditional Licenses

Where license classes and endorsements specify the type of vehicle that drivers may operate, certain licenses specify the conditions under which operation may legally occur.[1] The conditions include the presence of a licensed adult, hours of travel, or travel area. Conditional licenses are issued for most of the vehicles covered by license classes and endorsements.

Recommended Classified License Categories

The Classified License System recommended for Arizona would consist of classes, endorsements and restrictions as follows:

License Classes:

1. Tractor-trailer
2. Trucks and Buses
3. Operator

License Endorsements:

M. Motorcycle

S. School bus

E. Emergency vehicle

C. Chauffeur

Conditional Licenses:

L. Learner

P. Provisional

The remainder of this section on classified licensing will discuss in depth each of the recommended categories of license class, endorsement, and restriction.

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[1] Conditional licenses are not to be confused with the imposition of conditions on other licenses for reasons of medical condition, physical disability, or poor driving record.

LICENSE CLASS

The proposed classification system would distinguish three classes of license: tractor-trailer, trucks and buses, operators.

The use of three classes would allow drivers who have demonstrated the ability to operate a particular class of vehicle to be licensed for all other vehicles that they be considered qualified to operate without burdening themselves or the MVD with separate licensing action for each vehicle. Thus, a driver who is licensed to operate a tractor-trailer does not need to be separately licensed to operate a truck, bus, or automobile.

Trucks and Buses

While the recommended classified licensing system distinguishes between straight trucks (and buses) on the one hand and tractor-trailers on the other, we'll first discuss and justify the separate licensing for the entire truck and bus category before addressing the need for any distinctions within the category.

Accident Involvement of Trucks and Buses

Neither trucks nor buses appear to be overinvolved in accidents generally. According to figures furnished by the National Safety Council (NSC, 1983), trucks were involved in about 18.7% of crashes while constituting 21.1% of vehicle registrations. Combination trucks were somewhat more involved, being responsible for 3.6% of accidents and only 0.9% of registrations. Similarly, commercial buses were involved in .5% of accidents and .1% of registrations.

It is in the more serious accidents that trucks and buses seem to be a greater threat. Because of their heavier weight, any accident in which they are involved is likely to be more serious than would be an accident involving passenger cars. During 1982, trucks were involved in 24.6% of fatal accidents, compared with their 21.1% of total vehicle registrations. Combination vehicles were involved in 9.1% of fatal accidents in comparison with their .9% of registrations. Commercial buses, on the other hand, were involved in only .5% of fatal accidents--the same level of involvement as in non-fatal accidents.

It is difficult to determine to what extent the overinvolvement of trucks and buses in serious accidents is due to hazards inherent in the vehicles themselves--their size--and to what extent it is due to the number of vehicle miles that they travel. Trucks and buses compile far greater mileage on the average than do automobiles. Probably the most accurate compilation of heavy vehicle accidents relative to mileage is that prepared by the American Automobile Association (AAA 1983). Using fatality data from the Fatal Accident Reporting System and mileage from the Federal Highway Administration, AAA found combination trucks to be involved in 5.23 fatal accidents per 100 million vehicle miles traveled (V.M.T.). In contrast, passenger cars were involved in only 2.47 fatalities per 100 million V.M.T. Data on buses and single unit trucks are not available.

Vehicle Miles Traveled is not the only variable other than size to influence the relative accident involvement of trucks and buses. Other variables include the following:

Roadway--Heavy vehicles tend to compile their mileage on different roadways than do cars. For example, intercity trucks and buses tend to make greater use of interstate highways than do cars.

Time of Day--Trucks and buses are more likely to operate throughout the night and are, therefore, on the road during those times when serious accidents are most likely to occur.

Weather--In an effort to maintain schedules, commercial drivers are more likely to brave the elements and, therefore, encounter more hazardous driving conditions, than do car drivers.

Speed--Since an inordinate amount of truck and bus operation takes place on high speed highways, their accidents are likely to occur at higher speeds. The speed factor, along with the size of the vehicle, contributes to the relatively high severity of truck and bus accidents.

It is difficult to believe that these factors could account for more than a two-fold difference in fatal accidents between automobiles and combination trucks. The size of the vehicles--their length and weight--certainly account for much of the difference.

Need for Separate Licensing of Truck and Bus Operators

While the high severity of accidents involving trucks and buses has focused attention upon the operation of these vehicles, it does not by itself justify a separate license. It is the accident involvement, coupled with the special requirements that are imposed upon truck and bus operation, that justifies the need for a separate license. Special requirements arise with respect to each of the three variables upon which classified licensing systems are based: level of ability, type of ability, and responsibility.

Level of Ability--That increased vehicle length demands increased operating ability has been more or less assumed by the general public. As mentioned earlier, this is the primary basis for treating trucks and buses in separate license classes. Direct evidence of the relationship was found by McKnight, Kelsey, and Edwards (1984), who observed that scores on an offstreet skill test were inversely correlated with the vehicle length. The actual correlations were .54 for straight trucks and buses and .31 for articulated vehicles (the differences in correlations were attributed to the greater variation in length for trucks and buses).

Responsibility--operators of trucks and buses have a particularly great responsibility, not only because of the numbers of people and

goods they can carry, but because of the greater ability of heavy vehicles to inflict damage and injury upon the motoring public.

Types of Ability--the length, mass, power train, and visibility restrictions of trucks and buses, along with the regulations under which they operate, demand different sets of abilities than those required in operation of other vehicles. The specific skills and knowledge will be described later on when license tests are discussed.

These issues, and the need for separate licensing for truck and bus operators, have been fully discussed by Waller et all (1976), Waller and Li (1979) and McKnight, Kelsey, and Edwards (1984).

As pointed out earlier, some 30 states require special licenses for operation of trucks and buses. The trend is definitely in the direction of more classified licensing; in 1976, 7 fewer states had classified licensing systems calling for separate licenses for trucks and buses.

Vehicle Size

How long, wide, or heavy must a vehicle be before it falls into the "truck-bus" category? States differ widely in the criteria they use. Weight is the most common defining characteristic. The table below is compiled from data provided by the U.S. Department of Transportation (FHWA 1983).

WEIGHT	NUMBER OF STATES
less than 9,000 lbs.	4
10,000-19,000 lbs.	8
20,000-29,000 lbs.	12
30,000 and over	3
	27 states

These data are just from those states using weight as a criterion. Three states classify trucks as those vehicles having more than two axles without regard to weight. Four states classify buses on the basis of passenger capacity rather than weight.

The modal weight threshold is 24,000 lbs., which serves as the threshold in 7 states. It is also the threshold proposed in the AAMVA vehicle classification plan. Such a weight threshold would permit drivers with automobile licenses to operate almost all vehicles that are used in private, non commercial transportation, including vans, pickup trucks, and small trucks used in moving household goods. We would propose the use of this threshold by the state of Arizona.

Rental Vehicles

Some states allow exceptions to weight thresholds for vehicles that are rented. The rational is unclear. Presumably, if operation of the vehicle requires special abilities or responsibilities, a separate license should be required, whether the vehicle is rented or owned. One possible explanation is that the potential hazard of operating these vehicles is minimized when drivers are operating them infrequently on a rental basis.

The weight threshold recommended by the state of Arizona is sufficiently liberal to allow operation of vehicles that are adequate for noncommercial use without hazard to the public. We therefore see no need to make any exceptions for rental vehicles.

Tractor-Trailers

Of the 30 states requiring special licenses for trucks and buses, 28 distinguish tractor-trailers from straight trucks or buses in their classified license system. One of the remaining states makes a weight factor distinction in requiring different licenses for operators of vehicles under versus over 40,000 lbs. gross vehicle weight. Most tractor-trailers would fall in the former category, and most straight trucks and buses in the latter.

The same three factors that justify separate truck and bus licenses also justify a distinction between single unit vehicles and tractor-trailers.

Ability--a higher level of skill is required to operate a tractor-trailer for two reasons:

- The purpose of articulation is to permit greater length, which in turn leads to the need for greater skill.
- The articulation of tractor-trailer complicates backing manuvers and prevention of skids (i.e. jackknife).

Responsibility--the added vehicle weight, length, and ability to jackknife increases the potential danger to other motorists. The tractor-trailer's greater potential for harm is evident in the higher involvement in fatal accidents.

Types of ability--articulation imposes requirements for additional skills and knowledge, including coupling/uncoupling and vehicle inspection.

These factors form the basis for the recommendation for a separate tractor-trailer operator's license.

Operator's License

The standard operator's license would allow drivers to operate any vehicle under 24,000 pounds GVW except for those requiring a special endorsement as will be discussed in a moment. Basically, an operator's

license would authorize people to drive cars, vans, and mopeds. The only aspect of operator licensing to warrant any discussion concerns the licensing of moped operators. Arizona requires operators of mopeds to possess a valid Arizona Operators License. This Arizona practice is currently followed by some 45 states. One state uses a separate moped operators license. The remaining five states do not require moped operators to be licensed at all.

Licensing Moped Operators

The requirement that moped operators at least hold a valid operator's license can easily be justified on the basis of the vehicles operating requirements. States that do not require moped operators to hold any license treat the moped simply as a bicycle with a motor assist. If bicycle riders don't need a license, why should moped riders?

A task analysis of moped operation by McKnight, et al. (1980) showed clearly that moped riders face hazards and operating requirements not generally encountered by bicycle riders. While the maximum speed of mopeds approximates that of bicycles, the fact that such speeds can be maintained almost indefinitely by almost any moped operator encourages trips of much greater length than those customarily taken on bicycles. Long trips generally leads to travel on major arteries and encounters with much faster moving traffic. In addition to the hazard involved with mixing with other vehicles, these same studies showed that moped drivers tend to operate their vehicles like bicycle riders, frequently violating laws that govern motor vehicle operation.

Because they are motor vehicles, and operate in the traffic stream with other motor vehicles, mopeds can only be safely riden by operators who are familiar with safe motor vehicle operating laws and practices. Assurance that operators are at least aware of laws and practices comes only through a requirement for a valid motor vehicle operators license.

Separate Moped Licenses

The idea of a separate moped operators licenses has been advanced by the U. S. Department of Transportation (NHTSA, 1980) and the National Safety Council (NSC, 1982). The recommendation for a separate license is based upon the belief that the operation of a moped involves abilities that are unique.

However, research has shown that anyone who can ride a bicycle can also operate a moped (McKnight, et al. 1980). What is different is the moped rider's need to know how to cope with traffic. This knowledge can be assured by requiring a moped operator's license.

It has been estimated that a sizeable portion of the moped operator population consists of youth who lack access to automobiles and may not have or want an automobile operator license. Requiring them to obtain an operator's license in order to ride a moped has been considered a burden. Only one state issues a separate moped license to such individuals. However,

until mopeds become a great deal more popular then they are now, creation of a special moped endorsement for those who don't wish to obtain an A, B, OR C class license would complicate the license structure unnecessarily.

ENDORSEMENTS

The proposed classified licensing system calls for separate endorsements to operate motorcycles, school buses, emergency vehicles, or vehicles for hire (chauffeurs). The endorsement would simply be added to whatever class of license the operator holds to allow the operator to operate the endorsed vehicle as well as vehicles included in the license class. The one exception would be a motorcycle endorsement, which could also be issued, without a class designation, to someone who wishes to operate only a motorcycle.

Motorcycles

Arizona currently requires a special license for operators of motorcycles, as do some 45 of the 50 states and the District of Columbia. (MSF 1984). The motorcycle's inherent instability, inconspicious profile, lack of operator protection, and special operating skills make operation of motorcycle unlike operation of any other type of vehicle.

There being no real need to defend the imposition of a special licensing requirement for motorcycles, this discussion will focus upon the following:

- o Use of an endorsement
- o Weight subdivisions
- o Three-wheel vehicles

Use of an Endorsement

Of the 45 states requiring special licenses for operation of a motorcycle, approximately half treat motorcycles as a special class, and half as an endorsement to another license class. However, all of the states treat their licenses the same way: By itself, the motorcycle designation--whether class or endorsement--means the operator is restricted to operating a motorcycle. Used in combination with another class, the designation means that the license holder can operate the motorcycle as well as another vehicle.

In short, the motorcycle license is both a class and an endorsement regardless of the terminology used by the state. However, since the overwhelming majority of motorcycle operators are licensed to operate other vehicles as well, the motorcycle license functions as an endorsement far more often than as a license class. For this reason, we recommend that it be treated as an endorsement, to be added to one of the other three license classes. For those few license holders to wish to operate only a motorcy-

cle, the license would carry no class designation, only a motorcycle endorsement.

Licensing officials in some states have considered eliminating the motorcycle-only designation, either as a class or endorsement and requiring motorcycle operators to obtain operators licenses first. The rationale is the motorcycle's inherently greater hazard--a death rate that is over eight times that of an automobile. To reduce the hazard, some would require that all prospective motorcycle operators first gain experience in dealing with traffic situations within the more protective confines of an automobile. Only after holding an automobile driver's license for some specified period of time would they be permitted to apply for motorcyle operator's license. If such a prerequisite were posed, motorcycle licenses could always be endorsements to automobiledor some other class of license.

While the idea of requiring prior operation of an automobile should reduce the hazard in motorcycle operation, it would also impose a considerable inconvenience upon those who have never been licensed to operate an automobile and do not choose to do so. For this reason, no state has, to our knowledge, instituted such a requirement.

Weight Subdivisions

In many other countries, motorcycle licenses are subdivided according to the weight of the vehicle. (Actually, cylinder displacement is generally employed as a criterion; however, displacement is highly correlated with vehicle weight). The relationship between vehicle weight and the ability required to operate safely is believed to be the same for motorcycles as for vehicles with four or more wheels.

None of the states or provinces of North America distinguish weight classes within motorcycle licenses. nor is there any evidence of a need for weight subcategories. While it may take more ability to operate a heavier vehicle, the differences are small and found primarily in carrying out close quarters maneuvering rather than normal highway operation. In contrast with results on truck and bus tests mentioned earlier, performance on a motorcycle skill test was not found to be correlated with vehicle size (McPherson and McKnight, 1976).

Concern about differential skill demands for motorcycles of varying size has lead to studies of the relationship between vehicle size and rate of accident, injury, or fatility. Difficulties in controlling for possible amount of mileage compiled by different size motorcycles has made it impossible to determine the relationship between size and degree of hazard.

In the United States, the rate at which motorcycle riders move up in weight categories is such that requiring different licenses would impose a considerable burden on licensing operations and create considerable inconvenience for motorcycle operators.

School Buses

Arizona does not currently require operators of school buses to obtain a special license. Anyone who holds a Chauffeurs License is permitted to operate a school bus. The only requirements imposed uniquely upon operators of school buses would be those that are established by the school districts and schools employing the drivers.

At the present time, 13 states require special license for operating school buses. Eleven of the 13 states handle licensing through an endorsement, while in 2 states school bus operator licenses constitute a class.

In states not requiring a special school bus operator's license, authority to operate school buses is given through certificates issued by agencies other than the motor vehicle department. In the great majority of these states it is the State Department of Education, although a few states have the certificate issued by the Department of Public Safety or the County Department of Education.

Need for Special License

Safe operation of a school bus involves procedures which are unique to that vehicle. These procedures, described in more detail later on, include loading and unloading of students, passenger supervision, transporting handicapped students, special activities trips, evacuation procedures, operator maintainence, and reporting procedures. (McKnight and McClellan, 1971). On the other hand, the level of skill or responsibility does not appear to be any greater than that involved in operating ordinary passenger buses of the same size.

The real issue is not whether school bus operators must be required to demonstrate their knowledge of school bus operation--all states require that--but whether the issuance of a permit to operate should be made a part of the license process, or handled through certificates issued by other agencies. Requiring a special license would allow MVD to:

- Exercise its responsibility to protect all users of public highways, including school children
- Assess qualifications of school bus operators free from the pressures of having to provide drivers to fulfill pupil transportation needs
- Provide skilled and experienced examiners to carry out the testing
- Identify school bus operators with a drivers license record in order to take action against those with poor driving records

The requirement for a school bus operator's license could and should be imposed on top of whatever requirements are used by school districts, such as completion of a training program. Any state-level training requirements

can be handled by requiring all applicants for school bus operator license to produce a certificate, just as many states require a Driver Education Cerificate for licensing for applicants under age 18.

Issuance of License

We recommend that Arizona issue separate school bus operator's licenses as an endorsement to one of two license classes as follows:

> Large Vehicle--those seeking to operate full size school buses would be required to have a school bus endorsement to a class 2 Truck-Bus license.
>
> Small Vehicle--those seeking to operate small van-type school buses Would be required to have a school bus endorsement on a basic Class 3 Operator's license.

This way of handling endorsements would require applicants for a school bus operator's license to demonstrate, or have previously demonstrated, their ability to handle a vehicle of the size they wish to operate. Those employed by school districts having the large, standard school bus would be required to obtain a Truck-Bus operator's license which, would also permit them to operate smaller vehicles. However, those who will only be driving small vehicles for daycare centers, camps, special schools, and so on would only have to have demonstrated their ability to operate an automobile.

Emergency Vehicles

An "Emergency Vehicle", as discussed in this report, is a vehicle that is permitted exceptions to certain traffic laws when responding to emergencies. The category would include ambulances, rescue trucks, fire trucks, and police vehicles. The laws for which they are granted exception would involve speed limits, traffic signals, and lane controls.

We know of only one state (California) that requires a special endorsement for operation of emergency vehicles, such as ambulances, rescue trucks, and fire trucks. Some other states may impose certification requirements that do not show up in the licensing system.

Need for Separate License

A separate license for operators of emergency vehicles is justified by both the level and types of abilities required to operate safely:

> Level of Ability--Operating in above legal speeds and weaving through traffic demands perceptual and vehicle handling skills above those required for everyday driving.
>
> Types of Ability--Operation of emergency vehicles involves a number of unique procedures, including use of emergency signals,

negotiating intersections, radio communication, passenger care, and operation of the vehicle at emergency scenes.

Requiring special endorsement on a regular license is one way of assuring that drivers possess the experience, skills, and specific knowledges required to handle emergency vehicles with maximum safety.

Issuance of License

We recommend that an emergency vehicle operator's license be issued as an endorsement to a regular license. It is obviously too specialized to constitute a license class.

The requirement for an emergency vehicle operator's license would be waived for all law enforcement, fire fighting, and rescue service personnel operating under government agencies. Such agencies could have their own procedures for assuring the qualifications of those that drive their vehicles. There is no evidence of any deficiency in this regard. And, as a practical matter, it is very unlikely that any effort to transfer any portion of that control to an outside agency such as MVD would be very successful.

The licensing requirement would be applied primarily to drivers of private ambulances. While there is no evidence that these vehicles pose an unusual hazard, protection of those who use private ambulances, as well as those who share the road with them, demands that the drivers demonstrate their ability to operate safely.

We would recommend that the licensing requirement also be extended to those who drive fire fighting and rescue vehicles for non-governmental "volunteer" organizations. While many of the organizations that operate these vehicles take steps to assure the qualifications of their drivers, protection of the public requires that qualifications also be assured by some official agency. The MVD is in the best position to do that.

All drivers would, of course, be required to hold the class of license that is appropiate to the vehicle they are driving, whether they are employed by public or private organizations. Drivers of patrol cars, ambulances, and vans would be required to hold a Class 3 license; drivers of single unit fire apparatus (e.g. pumpers) would need a Class 2 license; drivers of articulated vehicles (e.g. ladder truck) would be required to hold a Class 1 license.

Chauffeurs License

Arizona requires drivers who operate vehicles as part of their employment to hold a Chauffeurs License. Twenty other states also employ this practice. In the remaining states, those who operate vehicles as part of their employment are incorporated into the classified licensing system through license classes and endorsements. Since few people operate trucks, buses, tractor-trailers, school buses, or ambulances except aspart of their employment, issuance of a chauffeurs license to such drivers would seem

superfluous. We would recommend the chauffeur's license be retained as an endorsement required of all class 3 license holders operating vehicles as part of their employment, including drivers of taxis, limousines, shuttle buses, and so on.

With the chauffeur's license limited to operation of CDass 3 vehicles, a separate license is not demanded by either the level or type of ability required. The sole justification is the level of responsibility involved in transporting passengers and goods. In recognition of the added responsibility a separate license allows different requirements to be imposed upon holders of chauffeur's license, such as the current requirement that holders of this license be at least 18 years of age and have at least one year of driving experience.

CONDITIONAL LICENSES

A conditional license is one that allows operation of any type of vehicle but under certain conditions. Two types of conditional licenses are currently in use:

- o Learner's permit
- o Provisional license

Learner's Permit

A learner's permit, as the name implies, is a permit issued to unlicensed drivers in order to let them learn how to operate a motor vehicle. Like all other states, Arizona issues a learner's permit to drivers who do not possess the skill to operate a motor vehicle and need the practice in order to acquire that skill. The learner's permit authorizes operation of a motor vehicle subject to the condition that the driver be accompanied by a licensed operator.

Recommended changes and additions to the learners permit involve:

- o Age of licensed accompaning driver
- o Motorcycle operator's permit
- o Other vehicle classes

Age of Accompanying Driver

Arizona does not impose any minimum age on the accompanying driver. Therefore, a learner could conceivablu operate a vehicle under the supervision of a 16 year old who was just licensed. It is hard to see how the presence of someone with indiscernably greater experience and maturity than

the learner going to exercise supervision. Indeed, learners might be safer by themselves than in the company of immature passengers.

A minimum age of at least 18, and preferably 21, is recommended for a driver accompanying a learner. Also, if Arizona should enact a provisional licensing law that restricts nighttime operation for young drivers (see below), whatever age limitations are imposed upon accompanying drivers during evening operation should also be applied to drivers operating under a learner's permit.

Motorcycle Operator's Permit

The requirement for accompanying passenger excludes motorcycles, for obvious reasons. Therefore, no conditions are placed upon the learner's permit for motorcycle operators. Some states have imposed a requirement that learners be accompanyed by a licensed operator on another motorcycle. This attempt to extend the idea of supervision from automobiles to motorcycles is without any apparent merit.

Recognizing the potential hazard to motorcycle operators during the learning phase, some states have excluded learners from operating at night or on an interstate. Both of these restrictions would reduce exposure to skill-demanding situations without subjecting the learners to undue inconvenience (motorcycles are used relatively infrequently at nights and on interstates). It is proposed that these restrictions be imposed upon motorcycle operator learners permits.

Other Vehicles

Since Arizona does not currently require separate licenses for operation of the other vehicles making up the classified licensing system--trucks, buses, tractor-trailers, school buses, emergency vehicles--it has not been necessary to consider issuance of a learner's permit. However, if drivers of these vehicles are required to demonstrate their ability to safely operate the vehicle before being issued a license, they must be provided a means of gaining the practice needed to provide that demonstration.

As well as can be determined from available literature, no state currently requires learner's permits for operation of vehicles other than automobiles and motorcycles. So long as drivers hold a valid operator's license, they have demonstrated their knowledge of safe driving rules and practices as well as their ability to handle an automobile. Requiring them to apply for a separate learner's permit would accomplish nothing except to inconvenience the drivers and add to the volume of license stations.

It is recommended, however, that drivers operating trucks, buses, tractor-trailers, school buses, or emergency vehicles on regular operator licenses be accompanied by a driver licensed to operate that particular vehicle. The requirement is necessary not only for the safety of the public, but also to provide some reason for drivers to seek licenses of the appropriate class or endorsement. Thus, with such a requirement, people

could drive on their operator's license indefinitely, claiming to be learners.

Provisional Licenses

A provisional license is a license issued to novice drivers, containing certain "provisions" that must be met before a regular license can be issued. The purpose of the provisions is to reduce the hazards novice drivers face because of their lack of experience. Provisional licensing attempts to reduce such hazards by (1) prohibiting operation under potentially hazardous conditions, (2) providing incentives for drivers to operate safely, and (3) extending the period of learning. A comprehensive discussion of the nature and purpose of provisional licensing is provided by Croke and Wilson (1977) in connection with their development of a model provisional program for the U.S. Department of Transportation.

Currently eight states issue provisional licenses to inexperienced drivers under the age of 18. This total does not include states that issue licenses to certain categories of people under age 18 to engage in specialized travel (e.g. farm workers). We recommend that Arizona seek passage of legislation that would create a provisional license.

Advantages of Provisional Licensing

The rational underlying provisional licensing is that lack of experience makes the first few months of automobile operation the most dangerous, and that new drivers should be protected as much as possible from encountering the hazards of the highway traffic environment while they are learning. Provisional Licensing attempts to accomplish this in three ways:

Reduced Exposure--Restrictions placed upon provisional licenses attempt to reduce the new driver's exposure to traffic hazards. The most common restriction is a curfew that keeps novice drivers off the road in the late night and early morning hours when visibility is poorest, the incidence of drinking/driving is greatest, and novice drivers are most overrepresented in accidents. The state of New York also prohibits travel in New York City. Other exposure reducing restrictions that have been considered include prohibiting passengers and requiring the use of safety belts or helmets.

Safety Incentive--The provisional license often requires a period of violation free driving before drivers can qualify for a regular operator's license and thus escape the restrictions of a provisional license. Coupling removal of restrictions with violation free driving creates an incentive to lawful driving. Many programs also lower the threshold for driver improvement action for drivers on provisional licenses, creating another incentive to lawful driving.

Extended Learning--The role of licensing in fostering participation in driver education has been well established by the increase

in enrollment which has occurred when completion of Driver Education has been made a licensing requirement.

Unfortunately, once a license has been obtained, the learning incentive largely disappears. It has been estimated that less than 2 percent of licensed drivers will voluntarily enroll in a driver education activity (McKnight, McPherson, and Knipper 1980). A provisional license provides an incentive for learning beyond the initial licensing.

Attempts to evaluate provisional license programs has produced equivocal results. Preusser et al (1983) reported reductions in nighttime accidents of 25 percent to 69 percent in four states where curfew laws were a part of the provisional license program. However, in three of the states, the study involved comparing accident rates by age and hour for the curfew states with those of a control state. There is no way of knowing whether the differences found were due to the curfew or just reflective of chance differences across states. In the one state in which a pre-post comparison was made, a separate evaluation by McKnight, Hyle, and Albrecht (1983) found the results to be attributable to long-term trends which began long before and continued long after the program was implemented. However, the curfew covered a period when very few teenagers were driving anyway (1:00 a.m.-6:00 a.m.) and didn't provide a fair test of curfews in general. In the other three states, curfews began at 11:00 p.m.

While the study by McKnight, Hyle, and Albrecht failed to show the effect of a curfew upon nighttime accidents, there was a 5 percent decrease in accidents and a 10 percent decrease in violations among 16-17 year olds during non-curfew hours. Since only half of the drivers in the two age groups were on provisional licenses, the effect of the provisional licensing program upon those holding provisional licenses could be a high as 10 percent and 20 percent for accidents and violations respectively. These reductions were attributed to the incentive affect of a curfew coupled with a requirement for violation free driving. While the program also had a provision for extended learning (parents to provide instruction), this aspect of the program was not fully implemented and was therefore not believed to have contributed to the success of the program.

Recommended Provisional Licensing Program

While evidence as to the effectiveness of provisional licensed is not totally conclusive, it is sufficiently convincing to warrant implementation of a program in the state of Arizona. We recommend the Arizona MVD seek legislation that would permit issuance of a provisional license having the following provisions:

Applicable Drivers--A provisional license would be required of all previously unlicensed drivers under the age of 18.

Conditions Imposed--Drivers operating on a provisional license would be prohibited from operating a motor vehicle between the hours of 11:00 p.m. and 5:00 a.m. unless accompanied by a licensed adult.

Eligibility for Operator's License--To be eligible for an operator's license, driver's holding professional licenses would be required to have at least one year of violation-free driving.

Each of these provisions will be discussed in detail.

Applicable Drivers

Provisional licenses would be required of all previously unlicensed drivers under the age of 18. Drivers 18 years or older would be issued a regular operator's license whenever they qualify for it.

The requirement for provisional licenses should benefit any experienced driver, regardless of age. Limiting the license to driver's under age 18 is a concession to reality. To many of the drivers age 18 and over have work and social obligations that necessitate night travel. Opposition to the license by this segment of the population would almost certainly prevent passage of the legislation. Those under age 18, on the other hand, are predominately high school age, and have little true need to be driving late at night. And, of course, drivers in this age are not eligible to vote.

Provisions should be made to waive the curfew for provisional license holders who have a legitimate reason to drive during the curfew hours. Eligible candidates would be students working in fast food restaurants or other establishments that don't close until after 11 o'clock. Experience suggests that the number of driver's applying for waivers is rather small--less than 5 percent of the provisional license holders.

Hours of Restrictions

The proposed curfew hours, 11:00 p.m.-5:00 a.m., are based upon the following considerations:

Number of Accidents--Approximately 1/3 of injury producing accidents (including fatals) involving 16-17 year olds occurred during the proposed curfew hours. A shorter curfew period would reduce the potential impact by decreasing the accident base line.

Affected Drivers--There is evidence (McKnight, Hyle, and Albrecht, 1983), that drivers on the road during the wee hours (e.g. after 1:00 a.m.) are a "hardcore" subgroup and less likely to be deterred from driving by a curfew than are the rest of the age group. A curfew beginning at 11:00 p.m. is likely to affect a more representative and responsive segment of the 16-17 year age group.

Incentive Value--To provide the incentive to lawful driving that was described earlier, drivers must be strongly motivated to seek a regular license. The earlier the curfew begins, the greater the incentive to get out from under it.

Hazard--If curfews are to reduce the exposure to hazard they should encompass the period in which the hazard per mile driven is the greatest. The proposed hours fulfill this requirement. Extending them in either direction would reduce the hazard, but not proportionately. (FARS 1984)

Interference--The curfew should not interfer with legimate or necessary travel if it is to avoid incurring excessive opposition. The three states that have imposed curfews starting at 11:00 p.m. (Louisiana, Illinois, and Indiana) have at least succeeded in passing necessary legislation. While an 11:00 p.m. curfew is not likely to gather much support from the affected drivers, parents have generally been accepting of it. Ending the curfew at 5:00 a.m. avoids interfering with early morning events such as paper routes or athletic events and doesn't produce appreciable risks.

Operator's License

The proposed program calls for provisional license holders to become eligible for a regular license after 6 months of violation free driving. Making the duration of the provisional license contingent upon driving record provides an incentive for drivers to operate lawfully. Some provisional licenses systems terminate the provisional license at a specified age (e.g.18) regardless of driving record. While such a practice extends the protection of the driving restriction over a longer period of time, it deprives the system of a valuable incentive to safe driving. Moreover, it defies the logic of a provisional license, that is, to protect drivers during the learning phrase.

A longer duration, say one year--would increase the period of protection and still provide the incentive. The problem is that many applicants don't seek a license until late in their 16th year or sometime in their 17th year. With a one year provisional license, they would have little to gain by qualifying for a regular license; by the time their year was up, they would be so close to age 18 that it wouldn't matter if they had a violation on their record or not.

Other Provisions

A number of other provisions have been suggested as part of provisional licensing program. This section will describe the most promising of these and the reasons why they were not included in the provisional licensing program recommended for Arizona.

Safety Restraints--One provision frequently considered has been the requirement that provisional license holders wear safety belts when driving, or helmets when riding motorcycles. The thought behind it is that use of restraints during this period would generate a habit that would result in continued use after the requirement was removed. However, since the value of safety belts is not strongly related to lack of experience, there is no logical reason for selectively applying a requirement to provisional

license holders. Moreover, it could backfire by creating the impression that safety belts and helmets are "kid stuff". The result might be reduced rather than increased use when drivers are released from the requirement.

Extended Education--The provisional license provides a mechanism for requiring driver education beyond initial license and thereby allow in-vehicle instruction be given when students are truly prepared to absorb it. However, such a requirement could only be imposed in a state where driver education is mandatory for licensing under the age of 18. However, since Arizona does not currently require driver education, such a provision could not be made part of a provisional license (recommending changes in educational requirements is beyond the scope of this report).

Parent-Supervised Instruction--One element of the model provisional license program recommended by NHTSA is a requirement that parents provide and certify a certain number of hours of in-vehicle practice. When the program was tested in Maryland, this provision proved impossible to implement completely. Special instructional material was prepared and distributed to parents through license applicants. However, actually requiring parents to give, or applicants to obtain such instruction in order to be licensed was considered to be of questionable legallity. The same legal question would be almost certain to arise in Arizona.

Two-Level Testing--The model provisional license program called for applicants to be tested both for the provisional and regular license. However, such requirement is not really feasible. Applicants must be required to demonstrate through written and performance tests if they are qualified to operate a vehicle before being issued a provisional license. If such qualifications are demonstrated, there is no valid basis for requiring a second test for the regular license.

Driver Improvement Criteria--In some states, holders of provisional licenses are subject to driver improvement action at lower thresholds than are drivers with regular operator's licenses. Provisional license holders may receive a warning with a first violation and be called in for an interview as early as the second violation. Under the proposed Arizona provisional license program, some action automatically occurs with the first violation in that the 6 month period of provisional licensing starts a new period. However, whether any additional action should take place is really a driver improvement rather than a licensing consideration. The lowering of thresholds would greatly increase the number of driver improvement actions and the burden on the driver improvement system, particularly if the cost had to be borne by the MVD. This issue lies outside the scope of this provisional report.

QUALIFICATIONS

This section of the report will discuss qualifications that drivers are believed to need in order to safely operate vehicles under each classification and endorsement. The specific qualifications that will be discussed are:

- o Age
- o Experience
- o Vision
- o Knowledge
- o Skill

Two other important qualifications to safe operation are (1) the motivation to operate safely, and (2) safe driving habits. Indeed, the consensus among safety specialists is that these factors are more important than any of those listed above. The problem is that there is no way of validly assessing them. Attempts have been made to assess motivation through the use of attitude measures. However, it is unreasonable to expect candid responses to attitude measures when a license is at stake.

Some licensing officials believe that a road test provides an assessment of such driving habits as signaling, use of mirror checks, and following distance. However, research by McPherson and McKnight (1981) showed there was no correlation between performance on a road test and a driver's normal behavior, as evidenced after leaving the license station. Therefore, neither motivation nor habit will be discreted by this discussion of qualifications.

AGE

The relation of age to accident involvement is rather well established. On a per-driver basis, accident rate declines rather steadily on the 16-18 year bracket to the 25-30 year age group, where it begins to level off. It remains at its lowest through the 50-55 age bracket, after which it rises somewhat. Some studies have shown a slight increase in accident rate from age 16 through 18 as newly licensed drivers begin to compile more mileage (Waller, House and Stewart, 1977). When accidents are normalized for amount of driving, the trends are magnified: older and younger drivers have relatively more accidents per mile of travel.

We will examine here the age qualifications for operation of vehicles in Arizona. Specifically, we will look at the minimum age for a regular operator's license as well as for operation of other categories of vehicles and examine the prospect of withdrawing licenses from drivers whose advanced age results in excessive risk.

Minimum Age

Arizona issues instruction permits to drivers at age 15 years, 7 months, and licenses at age 16. Sixteen is the minimum age of licensing in all but seven states. Most states issue a learner's permit from two months to one year prior to the minimum licensing age. The differential allows those just at age 16 to have gained some experience before becoming licensed. It also allows high school students who complete driver education before reaching age 16 (it is typically taught in the sophomore year) to begin driving immediately rather than allowing a period of time for skills to deterioriate (Jones, 1973; Croke and Wilson, 1977).

In a study of the optimum minimum age for driver licensing, Cameron (1972) recommended 16 years of age on the following grounds:

- Accident rates for drivers age 16 are not substantially different from those of age 17 or 18.
- Licensing at age 16 allows drivers to gain experience and develop driving skill before they reach the legal drinking age.
- Licensing at age 16 facilitates giving driving instruction as part of the high school curriculum.

The only notable opposition to licensing at age 16 is that presented by the Insurance Institute for Highway Safety (Robertson and Zador, 1977). The objection resulted solely upon the number of accidents involving drivers in the 16-18 year age group. No claim was made that the number of accidents was disproportionate--the objection was simply that accidents occurred. The same objection pertains to any licensing age. There's no greater justification for raising the licensing age to 18 than there is for raising it to 21, 25, 35, 45, etc.

No change in the minimum licensing age of drivers in the State of Arizona seems necessary.

Maximum Age

No state has a maximum age limit. However, the public has become concerned about the increasing number of elderly drivers and the accidents in which they are involved.

Problem of Age

There's no doubt that driving becomes more hazardous as age increases beyond age 55. By age 65, the accident rate per mile begins to exceed that of teenagers (Brainin, et al., 1977). The increased accident rate has been attributed to a number of deficiencies, including losses in:

- Information processing (McFarland, Tune, and Welford, 1964)
- Reaction time

- o Visual acuity, visual field, night vision, and glare recovery (Nahum, 1968; Hills and Burg, 1977; Taylor, 1974; Council and Allen, 1974; Shinar, 1977)

- o Loss of strength, agility, and coordination, e.g., arthritis, stroke, (McKnight, 1978)

- o Alertness, consciousness (medication, syncope, heart attack) (Waller, 1973)

- o Resistance to fatigue (Lourell, 1973; Ginturco, Ramm, and Erwin, 1973)

- o Hearing (Winstanley, et al., 1974)

- o Ability to maintain attention and vigilance (Planek, Schupak, and Fowler, 1972)

- o Retirement with reduction in work related travel, physical problems, making driving increasingly difficult, decrease in social and recreational activities requiring travel

The failure of these problems to result in inordinately high numbers of accidents involving older drivers is attributable to a progressive decrease in the numbers of people who drive, and the mileage of those who do drive, as age increases. Among the factors reported (McKnight, Simone, and Weidman, 1982) as contributing to this decline in drivers and driving are:

Screening Older Drivers

The fact that decreases in driving tend to offset increased risk has not lessened concern for the hazard represented by the older driver population. Over 20 years ago, Baker (1965) called for screening older drivers through psychophysical, written, and road tests. A few states have introduced special license reexamination requirements for drivers of advancing years. Included in the license reexamination have been vision tests, road tests, and medical-physical tests (Brainin, et al., 1977).

Throughout the 1970s, opposition to selective retesting of older drivers increased. Weiner (1973) held that such selective testing was a violation of equal protection under the 14th Amendment and recommended instead that special rapid-screening tests be developed for administration to all drivers.

Such screening tests would be administered both periodically and when drivers compiled records of sufficient violations or culpable accidents to warrant reexamination. The idea of screening the general driver population to identify age-related problems has also been emphasized by Waller and Li, (1979) and the President's Highway Safety Advisory Committee (1984).

Only a screening process that applied to all drivers would likely be acceptable within the present political climate. Such a screening process would not be specifically directed toward older drivers, but would seek to detect physical and mental problems related to safety of driving regardless of the driver's age.

The screening system would not be expected to detect unsafe drivers, old or otherwise, but to identify candidates for more thorough testing through other measures, such as road tests and physical examinations. To be effective, the screening system must be:

Reliable--While the screening system need not be as reliable as the tests upon which decisions are ultimately made, an unreliable system would end up overlooking too many people that need to be tested and testing too many people who did need to be. The result would be an excessive expenditure of time by both drivers and examiners to detect too few unsafe drivers.

Valid--The deficiencies detected in the screening process must relate to driving safety. Research has shown many mental and physical problems that are uncorrelated with accidents, either because they do not directly relate to safety of operation or because drivers are somehow able to compensate for them (e.g., deafness, monocular vision). It is of no value to identify deficiencies that cannot become a basis for some regulatory action.

Economical--If a screening system must be applied to everyone, it must be inexpensive to procure and maintain, add any more than a few minutes to regular license re-examination. This mandates a computerized, self-administered system. No immediate action on screening driver's can be recommended pending the development of a system meeting the above requirements. It is our understanding that a research effort is currently being undertaken by a firm in Tucson, Arizona to study the feasibility of incorporating a screening process into an automated knowledge test program. This approach to screening for physical and mental problems will be discussed more fully in a later section dealing with automated test equipment.

Differential Age Requirements

While 16 is a suitable minimum age for an operator's license, it is not necessarily so for other classes of licenses or certain endorsements.

Arizona currently requires applicants for Chauffeur's Licenses to be at least 18 years of age. We would recommend that under the proposed classified license system, that age 18 be established as a minimum for all drivers to whom the Chauffeur's License currently applies, including the following classes and endorsements:

1. Tractor-trailer

2. Truck and bus

S. School bus

E. Emergency vehicle

C. Chauffeur

The added responsibility of carrying people and goods demands somewhat more maturity than was found in the typical 16 year old. It also requires at least a years experience (a requirement that will be noted in the next section), which, given the average age of initial licensing, would place most applicants at least close to the age of 18.

An 18 year old minimum age for the recommended classes and endorsements since few people under age 18 would be deprived of a livelihood because of their inability to operate the vehicles in question.

Some seven states have established a minimum age for moped operation that is lower than that of a regular operator's license. We do not see how this practice can be justified given the extent to which mopeds operate in the stream of vehicular traffic. Given the mopeds low noticeability and the lack of protection it affords the rider, operation really demands more maturity rather than less.

EXPERIENCE

Because of the correlation between age and experience, it has been difficult to measure the effect of experience alone upon driving safety. However, an early study by Munsch (1966) found that accidents were more frequent during the first few years of driving regardless of the age at which driving begins. The greatest number of accidents occurred in the first year and dropped markedly thereafter.

The results of what little research there is tends to support the current requirement that applicants for Chauffeur's License be required to have at least one year experience.

While continued learning doubtless leads to improvement in safety beyond the first year, those who have one years experience are at least not downright beginners, and are close to being as good as they will ever be. We therefore recommend that requirement for one years experience be applied to all of those applicants operating vehicles as a part of their jobs, namely Class A--tractor-trailer, Class B--truck and bus, endorsement S--school bus, endorsement E--emergency vehicles, endorsement C--chauffeur.

VISION

Arizona currently limits vision testing among license applicants to a test of visual acuity. Drivers must have visual acuity of 20/40 or better for an unrestricted license. Those with a visual acuity of between 20/40 and 20/60 may be licensed for daylight operation only.

Visual Measures

This section will review visual characteristics and their relation to driving. Specific visual characteristics will include:

- o Acuity
- o Field
- o Contrast sensitivity
- o Motion Detection
- o Glare response
- o Color vision

Visual Acuity

Visual acuity refers to the ability of the eye to resolve spatial information--in more commonplace terms, "to make things out clearly." Acuity for things that are not moving is referred to as "static visual acuity," while acuity for things in motion is "dynamic visual acuity." Acuity may also be measured in low levels of illumination "mespoic acuity" or under other degrading conditions such as glare. When the conditions are not specified, it is generally assumed that acuity is measured under optimal illumination with high contrast static targets presented at the center of the visual field.

The relationship between visual acuity and traffic safety has been subject to a long string of studies dating back to 1930. This work has been exhaustively summarized by Shinar (1977). Significant correlations between accidents and degraded visual acuity have been found wherever sample sizes have been sufficiently large to provide reasonable assurance that true relationships will manifest themselves. The fact that some minimal standard of visual acuity has been a requirement for issuance of licenses (typically 20/40, as in Arizona) helps explain the lack of a stronger relationship. The number of drivers with poor acuity (when corrected with glasses) is very small. Indeed, it is the small number of drivers with very poor acuity who are really responsible for what relationship there is. This is probably one reason why the relationship between acuity and accidents is strongest among older drivers, where the proportion of drivers with poor acuity is the greatest.

Dynamic Acuity

Of the two forms of acuity, static and dynamic, the latter has evidenced the stronger relationship to accidents. The fact that driving is a highly dynamic task probably helps account for this result. However, it may also be explained in part by the fact that dynamic visual acuity has not been used as a basis for issuing licenses--indeed, measurement of dynamic visual acuity has been largely confined to the research in the studies by Burg (1964, 66, 67, 68, 74) and by Shinar (1977).

Because dynamic visual acuity has not been used in licensing, there is more variance among drivers in their dynamic visual acuity than in their static acuity and there are more drivers with poor dynamic visual acuity than drivers with poor static visual acuity (Shinar, 1978). Because static acuity is a component of dynamic visual acuity (and therefore a necessary but insufficient requirement for good dynamic visual acuity), the correlation between dynamic acuity and accidents can be used to replace static acuity for licensing purposes, as soon as an acceptable test of dynamic visual acuity is devised. (Some of the practical difficulties is reaching this goal are discussed by Shinar, 1977.)

Low Illumination Acuity

Another dichotomy between types of acuity can be made on the basis of the ambient illumination. Acuity can be measured under optimal and under adverse illumination. Traditional measures of visual acuity either explicitly or implicitly assumed illumination to be optimal and target background contrast to be high. However, acuity, in accordance with the relationships established by Blackwell (1959) deteriorates whenever illumination or contrast is reduced. Both situations prevail in nighttime driving and the argument has been made that licensing for nightime driving should be predicated on visual performance in nightime conditions (Keeney, 1967; Shinar, 1977) especially since acuity under optimal and low illumination do not correlate highly with each other (Shinar, 1977; Ginsburg, 1982). Driving-related measures of acuity have included acuity under reduced levels of illumination (mesopic acuity) (Henderson and Burg, 1974; Shinar, 1977), acuity for low contrast targets (Allen, 1970), Keeney (1967), and acuity in the presence of spot and veiling glare (Keeney, 1967; Shinar, 1977).

It is important to note that Shinar (1977) found a very strong relationship between acuity under low illumination levels and nighttime accident involvement. In light of Jones and Lee's (1981) recent study on the importance of concordant input from the two eyes under dimmed illumination, the criticality of performance in nighttime (mesopic) conditions for the monocular driver becomes obvious. Unfortunately, since there are no standards for the binocular driving population for most of these measures, the relative deficit of the monocular driver in comparison with the binocular driver must be determined in this study.

Recommended Action

No changes are recommended in either the standards of visual acuity now employed by the MVD or in the types of visual acuity measured. While the addition of dynamic visual acuity and acuity under low illumination to the visual screening process might succeed in identifying a few unsafe drivers, the cost would be prohibitive. There is currently no production device capable of measuring dynamic acuity. Experience with the research equipment that has been used indicates that a dynamic visual acuity measure would be expensive to produce and house, as well as time consuming to use. The measure of acuity under low illumination is currently available in the "Night Vision Test" sold by the American Automobile Association. However, the demands upon examiner and applicant time would make its use costly.

Visual Field

Visual field is defined as the entire area that can be seen without shifting the gaze, i.e., without moving the head or eyes (National Society to Prevent Blindness, 1980). Each eye has its own visual field, and the two combine to form the "total" visual field, in which the central portion is an overlap of the two eyes.

Visual Field and Safety

The importance of visual field derives from the fact that much of the visual information needed by drivers to operate safely first appears in the periphery. Most information of value enters along the horizontal or lateral axis, e.g., intersecting vehicles, merging vehicles, and pedestrians entering the street. However, McKnight, Shinar, and Hilburn (1985) have pointed out that such peripherial stimuli come into play only at very extremely low speeds, e.g., pulling away from a traffic light. Peripherial objects are so close to the driver that there would be no way to avoid them at speeds of more than a few miles per hour. Peripheral vision is much more important when the driver's gaze is diverted to one side or the other, as in checking side mirrors or looking for house numbers. In this instance it is objects in the vehicle's path that must be detected peripherally. The study by McKnight, Shinar, an Hulburn disclosed that, in 120 hours of driving, only 7 hazards requiring response on the part of the driver occurred when gaze was directed to one side or the other and the stimuli could only be seen peripherally. Four of these were encountered by drivers whose limited peripheral vision prevented detection of the stimulis. In all 4 cases, the driver looked back in time to be able to respond in a normal manner.

Research conducted by Lauer, et al. (1939), Brody (1941), and Burg (1967, 1968, 1974) found a small relationship between visual field and accidents, with a smaller visual field associated with a larger number of accidents. More recent studies by Shinar (1975, 1977), Hills (1977), and Council and Allen (1974) did not find field-deficient drivers having significantly more accidents. Council and Allen did find that more of the accidents sustained by the field-deficient drivers came from the side. One problem in all of these studies is the very small numbers of drivers having severe restrictions in visual field. This in part was due to the fact that all of these studies only measured the horizontal extent of the visual field.

A recent study by Johnson and Keltner (1983) showed that, while drivers with visual field loss in one eye evidenced no more accidents and convictions than normal drivers, those with field loss in both eyes had twice the number of accidents and three times the number of convictions as normal drivers matched for age and sex. Such a finding is of particular relevance since restrictions in total visual field for drivers with binocular field loss could be as severe as that of monocular drivers. Thus, a monocular driver with a visual field restriction in the remaining eye would, by Johnson & Keltner's definition, have visual field restriction in both eyes. Their study is particularly significant because it involved 10,000 drivers and relied on a diagnostically valid (though automated) perimeter for the evaluation of visual field in all axes rather than just the horizontal plane.

Bioptic Telescopic Lenses

A small number of drivers, about 1 in 100,000, have visual acuity so poor that they must wear special Bioptic Telescopic lenses in order to meet visual acuity standards. Use of the device narrows the field of vision to but a few degrees. The result is a narrowed visual field. Moreover, while the vehicle is in motion, vibration makes it difficult to fixate upon objects. The U.S. Department of Transportation (Latchaw, 1982) has recommended against licensing drivers who can meet visual acuity standards only through the use of Bioptic Telescopic lenses. The California Department of Motor Vehicles compared the accident rates by "Bioptic Drivers" with those of a randomly selected sample of normal drivers (Janke, 1983). "Bioptic Drivers" were found to have a significantly greater number of accidents per driver than the normal drivers. The author recommended continued licensing of Bioptic Drivers, but with close scrutiny of driving records to permit action to be taken with respect to those having accidents.

Recommended Action

It is not recommended that a measure of visual field be included in the testing of driver license applicants. The small relationship between visual field and driving safety fails to justify such testing. Even the small relationships that exist may be mediated by other factors, that is, they may stem from age related or other health factors that also reduce acuity.

Licenses should not be routinely issued to drivers who can pass a vision test only with the aid of bioptic lenses, or any device that significantly reduces visual field. With evidence of significantly worse driving records, protection of the MVD against lawsuits demands that such licenses only be issued where the applicant:

- Has an urgent, demonstrated need to operate a vehicle
- Is certified by a physician as being physically fit in all other respects
- Is seeking only a Class C license without endorsement
- Is restricted to operating only in the daytime, and at specified places and times

Contrast Sensitivity

Contrast sensitivity is the capability of an observer to distinguish a figure from ground. The contrast sensitivity function (CSF) is measure in terms of the minimum target to background contrast in which an observer can detect the object. Invariably, the object in CSF studies is a grating pattern which can be either sinusoidal or uniform wave pattern. In the first case, the brightness level of the bars changes gradually so that the border line is sharp and there is an obvious point where the bar ends and the white space begins.

The importance of CSF for assessment of visual functioning has been realized only recently. Although the ability to resolve a figure from its background is a measure of visual acuity, CSF measures "acuity" for both large details as well as small details. The typical measures of visual acuity (such as Landolt rings or Snellen charts) only measure acuity for small details. It has been argued that in day-to-day functioning, the ability to resolve large objects may even be more critical than small objects (Comerford, 1983). Furthermore, because only the fovea can resolve the performance of the rest of the retina, i.e., the presence of large scotomas in the visual field.

Measurement of Contrast Sensitivity

Contrast sensitivity is particularly relevant to nighttime driving (with and without glare conditions). This is because one of the most important effects of reduced nighttime illumination is a reduction in contrast. Similarly, when driving in the presence of glare from overhead illumination or the headlight of oncoming cars, contrast is also reduced. Finally, contrast sensitivity has also been studied in relationship to moving targets. In principle, contrast sensitivity can be assessed just like acuity in conjunction with many other variables that may affect vision.

The relative novelty as well as the lack of standard measurement techniques can probably account for the paucity of studies relating contrast sensitivity to driving. However, its importance for driving, particularly nighttime driving, has been noted by Schmidt (1966) and recent studies have demonstrated its importance for flying performance (Kruk, Regan, Beverly, and Longridge, 1981) and nighttime pedestrian detection (Shinar, in preparation). Studies by Ginsburg, et al., (1982) found contrast sensitivity a better predictor of skill in target detection and simulator landings than both photopic and scotopic acuity which did not correlate at all with performance on a flight simulator. Important individ- ual differences in contrast sensitivity were noted by Sekular and Hutman (1980) who found that older subjects (averaging 73 years old) who had the same sensitivity for high spatial frequencey (i.e., same as visual acuity) as younger subjects had much poorer sensitivity to low frequencies. In the low frequencies, the differences in sensitivity were threefold.

Recommended Action

There is insufficient evidence of any relationship between contrast sensitivity and accidents to justify inclusion of the contrast sensitivity measure in the licensing test. Therefore, no such measure is recommended.

Motion Detection

Motion detection is the ability to sense a very slow change in the position of an object. While movement can be in an infinite number of axes relative to the viewer, the ability to perceive slow motion is often broken down to the perception of angular movement (in a plane perpendicular to the line of sight) and movement in-depth (along the line of sight).

Because the cues to motion detection differ in the two cases, and empirically the correlation between them has been very low (Henderson and Burg, 1974; Shinar, 1977), they are treated separately.

The relationship of angular movement to safety of vehicle operation has been studied by Henderson and Burg (1974); Shinar, Mayer and Treat (1975); and Shinar (1977). These studies showed drivers with poor angular motion detection to have more accidents than other drivers. However, the differences were considered too small to warrant the use of angular motion detection as a visual screening measure in licensing.

Detection of Motion In-Depth

The ability to detect minute changes in motion in-depth is necessary to detect acceleration and deceleration patterns in vehicles moving in the driver's path. The cues that can provide that information are the change in the brightness of headlights and taillights (which is proportional to the square of the inverse of the distance) and the change in size. In the nighttime driving environment, the size of individual lights is sufficiently small that changes in apparent size are irrelevant. (However, changes in apparent distance between the headlights or taillights are critical and would be detected as a function of sensitivity to angular movement.) In the daytime, however, the changing retinal size of a vehicle as it slows or accelerates is essential for detection of relative movement in-depth.

The empirical support for a relationship between movement in-depth and safety is tenuous at best. Weak relationships have been reported by Henderson and Burg (1974) and Shinar, Mayer and Treat (1975). However, the vision test used by these researchers had poor reliability and a more reliable device failed to yield any consistent relationship (Shinar, 1977).

Recommended Action

The relationship between motion detection and accidents is too small, and is insufficiently well established to justify including such a test in the licensing process. Therefore, no test of motion detection is recommended for use by Arizona.

Glare Response

Glare is defined as a level of brightness in the field of vision that is higher than the level to which the eyes are adapted. Two types of glare are veiling glare, which is spread relatively uniformly across the visual field such as driving into the sun with a dusty windshield, and spot glare, such as that from the headlights of an oncoming vehicle.

A second aspect of the response to glare is the glare recovery time; which is the time it takes to recover from glare once it ceases. Daylight glare at high levels of illumination (e.g., direct sun) may be impossible to completely adjust to (and is therefore also called disability glare). However, nighttime glare from oncoming cars may be at sufficiently low levels and for sufficiently brief duration to cause only brief and partial loss in sensitivity to important cues such as taillights from cars ahead, delineators, and edge lines.

Recommended Action

The lack of any demonstrated relationship between glare recovery and accidents within the general population argues against inclusion of any glare recovery measure in the licensing process. However, since poor glare response is a characteristic of a man's age, and is associated with accidents among older drivers, it would appear appropriate for use in assessing older drivers who have been identified as a potential risk either through their driving records or some visual screening process.

Color Vision

Tests of color vision have long been administered to applicants for a driver's license. In 1977, Shinar identified 42 states that tested for color vision (Shinar 1977). The justification has always been the need to read the traffic lights, a task commonly thought to be degraded by red-green color blindness. However, it has been rather well established that color blind drivers can easily distinguish traffic light merely from their position. Color blindness has not been found to relate to driving safely, either on a logical basis (Henderson and Burg 1974) or empirically (Shinar 1977). Administering a test for color vision for licensing purposes would be a complete waste of time.

Maintaining Qualifications

Vision changes over time. All of the visual functions described show deterioration with age (Shinar, 1977). For this reason, Arizona requires a test of visual acuity everytime a license is renewed. According to the Arizona MVD Policy Manual for Driver Licensing, "this is done because eyesight quality changes within a short period of time, and because eyesight is a critical component of safe driving behavior." According to Tritsch and Kumbar (1980) some 38 states require vision screening of renewal applicants.

Administration of vision test requires applicants to appear in person at a license station. This is the primary reason for bringing renewal applicants to a license station, although the appearance is also used to detect other physical limitations and, in some states, to administer a written examination.

California studied the effects upon safety of allowing renewal applicants with clean driving records to renew their licenses by mail (Kelsey,

and Janke (1983). They found that excusing renewal applicants from vision screening did not adversely affect subsequent driving record. Meanwhile, the state stood to save several million dollars by not having to test the drivers. On the basis of this outcome, the authors recommended that California adopt a renewal by mail system.

Not finding a significant difference between renewals who were and were not visually screened does not prove that screening is ineffective. The purpose of visual screening is to detect those very few drivers who have an uncorrected acuity deficiency. Even with the large sample employed by California (over 700 thousand), it would be very difficult to detect the presence or absence of a few drivers.

There is no way of knowing how many drivers with visual problems are seeking correction of those problems because they know they will have to take a vision screening test. In the absence of such information, protection of the public demands continuing the present visual screening process until better evidence as to the role of visual screening becomes available. Should a renewal-by-mail system be instituted, drivers who don't wish to appear in person should be required to furnish evidence by a licensed optometrist or physician that their vision meets licensing standards.

So long as appearance at the license station is required for license renewal, more advantage should be taken of the situation than merely to administer a measure of visual acuity. This report will also identify other steps that might be taken as a part of the renewal process.

Recommendations

No routine vision test beyond the test of visual acuity currently given by the MVD appears to be warranted. However, it is recommended that tests of visual field, acuity under low illumination, and glare response be administered to (1) drivers identified as potential problems through a visual screening process or (2) drivers whose traffic record justifies re-testing and whose age, physical condition, or history points to the possibility of visual deficiencies.

The current practice of administering visual acuity tests to renewal applicants should be continued. If it becomes necessary to adopt a renewal-by-mail system, drivers electing to use this system should be required to furnish evidence that they meet visual standards from a licensed optometrist or physician.

KNOWLEDGE

All states require drivers to demonstrate that they possess the knowledge necessary to operate a vehicle safely. Knowledge is considered to be a fundamental qualification for licensing. Previous attempts to assess relationships between the knowledge and accidents involved primarily the correlations between results of knowledge tests and subsequent driving records. The results of these attempts, and the weaknesses in the methodology, were discussed in the introduction of this report. Suffice it to say that a correlation between knowledge test scores and accident rates proved to be small. However, correlations between visual acuity and driving record are similarily small, although few would question the fact that one must be able to see clearly in order to drive safely.

The only true test of the role knowledge plays in safety would require licensing drivers without a knowledge test, advertising the fact so that sizeable numbers of applicants would not even bother to learn the rules of the road and observing the effect upon accidents. Thus far, no state has been willing to run such an experiment. However, if differences in the amount of information given to drivers can influence their accident records (McKnight and Edwards, 1982) it is reasonable to assume the presence or absence of it will have an even bigger impact.

This section will describe the types of knowledge required by various categories of driving. The categories will encompass classified license systems described in the previous sections. However, there is not an exact match between license categories and domains of knowledge owing to: (1) two or more license categories sharing the same knowledge requirements, (2) particular license categories that have different knowledge requirements. One of the most comprehensive analyses of knowledge requirements in different categories of drivers is that conducted by McKnight and Simone (1978). This study identified the following categories of drivers encompassed by the classified licensing system proposed for Arizona:

- New drivers
- Renewals
- New residents
- Older drivers
- Truck and bus operators
- Tractor-trailer operators
- Motorcycle operators
- School bus operators
- Emergency vehicle operators

This study also identified other categories of drivers of concern to driver license administrators but outside the scope of this discussion, including (1) traffic violators, was found most appropriately under "driver improvement" rather than licensing, and (2) illiterate and foreign speaking drivers, this discussion needs to relate to methods of assuring that knowledge qualifications are met rather than that knowledge qualifications themselves.

New Drivers

In this discussion, the term "New Drivers" refers to drivers not previously licensed in any other state. The classified licensing system includes learners, provisionally licensed drivers, and holders of a standard operators license. As noted previously, new drivers are the most dangerous on the road, in part because they lack experience, and part because most of them are teenagers. To some extent the hazard represented by this group is an unavoidable consequence of in experience and maturity. However, it may also be partly contributable to lack of information, a deficiency that is not unavoidable. McKnight and Edwards (1982) proved that information given to new drivers led to a significant reduction in serious accidents. The type of information provided included:

Rules of the Road--Traffic controls, proper lane usage, right-of-way regulations.

Seeing--Scanning, proper use of headlights, use of mirrors.

Communication--Signaling presence and intent to change directions or speed.

Speed--Effective speed upon ability to maneuver, hold the road, stop in time to avoid accidents.

Space management--Maintaining an adequate safety margin of public road users, including vehicles ahead, to the side, and behind including bicyclists, and hazardous operators.

Emergencies--Knowing what to do in response to impending blowouts, brake failure, and other emergencies, as well as knowing the value of safety belts in emergencies.

Driver fitness--The effect of driver conditions upon safety, including fatigue, alcohol, and drugs, as well as fatigue which would contain the fitness.

Vehicle--The effect of maintainence upon safety of operation and the ability to cope with emergencies.

The knowledges were incorporated into the revised Arizona Driver Manual and Test prepared and submitted during Task 1. The use of this test and manual will help insure that new drivers are qualified at least with respect to knowledge.

Knowledge qualifications should be fulfilled to the greatest extent possible with the issuance of the first license, be it a learners permit, a provisional license, or operators license. This is the practice currently followed in Arizona and all of the states. In their model provisional license program, Croke and Wilson (1977) proposed a multi-level approach to knowledge qualifications, with tests to be carried out at each step of the process (learners, provisional, operator's).

The purpose of such a graduated approach is difficult to see. The information needed to drive safely is a function of the highway traffic system, not of the age or experience of the driver. Nor are there any obstacles to acquiring all the information at one time. Unlike skill, which requires practice to develop, knowledge can be acquired at one time, just as necessary knowledge, motivation, and resources.

Thus far we have addressed only what knowledges are required of new drivers. The question of how much knowledge is also important. Arizona currently requires a score of 80 percent to pass a license exam, a standard similar to that has been employed by other states. Presently, these somewhat liberal standards are justified by the reading difficulty of many test questions and many sections of the manual as well as the failure of some test questions to be addressed by the manual. These problems would be overcome by the revised manual and test and therefore justify a somewhat more strict exam. The use of the more strict exam, if well publicized, could lead to greater knowledge levels and therefore greater safety. Unfortunately, such hypotheses has never been tested.

More strict standards would lead to a greater initial failure rate. There is no denying that an increase in the failure rate would result in a greater number of test administrations and an increase in the overall cost of testing, assuming that applicants weren't charged for re-test. However, against the increased cost must be weighed the potential failures from accidents and deaths. Moreover, it is likely that, in time, the raised standards would destroy greater initial learning, with the result that the failure rate will drop.

More strict standards could also lead to applicant resistance. However, California's implementation of a more difficult motorcycle knowledge test, with an increase in the failure rate from approximately 12 percent to 38 percent, did not result in a public outcry. The test was per- ceived as being "fair" by the applicants. So long as the information called for is relevant, and answers can be found in the drivers manual, public acceptance should be high. Therefore, we recommend that, once the revised manual and test is implemented, the passing score will be raised from 80 percent to 90 percent.

Renewal

The knowledge required of licensed drivers seeking to renew their license is the same as that required of novice drivers. The difference is that the renewals have already demonstrated their qualifications at the time they were originally licensed. The issue is, therefore, not being the nature of knowledge qualifications but rather the frequency with which they must be assessed.

Current Practice

Arizona is one of 18 states that administers the knowledge test for license renewal. (Tristch, and Kumbar 1980). This requirement is, however, imposed only upon those who had a moving/passing violation. Since all drivers have been previously tested at the time of initial licensing, the justification in retesting lies in changes that have occurred since initial licensing include: license test and manual, changes in procedures and practices employed, and simple forgetting by the driver. However, these changes occur in all drivers, not just those convicted of a moving violation.

Since traffic violaters have not been found to be particularly deficient in state traffic knowledge (McKnight and Green 1976), there is no apparent justification in confining the test to this group. Granted, it is easier to impose requirements upon traffic violators than those with clean records. Also, any requirements imposed on those with traffic violations will, in time, reach most drivers. However, this is a rather devious, and not very effective way of assuring that previously licensed drivers are knowledgable in safe operations.

Currently, a trip to a license station is necessitated by a vision test. The validity of this requirement was discussed thoroughly in connection with the vision requirement. The fact that renewal applicants must make an appearance at the licensing station anyway, lessens the inconvenience of test taking. However, they still must prepare for the test if it is to benefit them.

The Effectiveness of Renewal Testing

Evidence can be of importance in assuring the knowledge qualifications of renewal applicants if somewhat ambiguous. In experimental studies, Stoke (1978) failed to find any benefit from a renewal testing requirement while McKnight and Edwards (1982) found a significant benefit, despite the fact that both studies were performed at approximately the same time using the same general population of Virginia renewal applicants. One explanation for the discrepancy may be the fact that the drivers in the Stoke study took a test based upon the same manual used for original licensing, while the McKnight and Edward study, drivers received a manual and test designed specifically to overcome information deficiencies of licensed drivers.

The results of these two studies suggests that there is benefit in assuring knowledge qualifications of renewal applicants but only to the extent that those qualifications differ from the qualifications of new drivers.

Recommended Action

Requiring written tests of renewal applicants is likely to incur some public resistence. This could be greatly lessened by confining the test to that information that is truly relevant to renewal applicants. The information could be provided in small booklets mailed to license applicants prior to license expiration in order to save them a trip to the license station.

Arizona is one of 14 states that does not send a written renewal notification to drivers whose licenses are about to expire. The 36 states that send such notices both as a service to drivers and to avoid the expense of relicensing drivers whose license has expired.

Sending mail out to Arizona drivers whose licenses were due to expire would cost in the neighborhood of $150,000. However, benefits of notification include the ability (1) to provide computer pre-printed renewal forms to save time on the part of applicants and MVD clerks, (2) to reduce the number of reexaminations for expired licenses, (3) to allow a tailored renewal knowledge testing program. We therefore recommend that MVD institute a renewal notification program as a means of providing information appropriate to already licensed drivers and testing them to assure that they meet knowledge qualifications.

Should Arizona adopt a renewal-by-mail sysem, as discussed in the section on vision, many of the benefits of a renewal testing system could be secured by (1) providing important information along with the renewal application (which would be a necessary part of a mail renewal system), and (2) providing a series of questions that must be correctly answered on the application form (i.e., a "closed book" test).

New Residents

Drivers transfering to Arizona from other states are required to take a written examination in the same manner as previously unlicensed drivers. They are not required to take a driving test. This is the practice followed by almost all states. The reasons for requiring new residents to take the written test are (1) laws and driving conditions in Arizona are different, (2) the test taken in the previous state may not measure up to Arizona's standards, (3) substantial changes in driving have occurred since they were previously tested.

Differences in laws and driving conditions provide only marginal justification for retesting; very few of the questions on the current or revised test deal with information specific to Arizona. Furthermore, much of the test deals with specific information which need not really be learned such as speed limits which are generally posted along the highway. The other two concerns--possible deficiency in original testing and changes since then--are sufficient to justify continued testing of new residents, particularly with improvements to the current Arizona Driver's Manual. The continued testing of new residents can be recommended as a means of helping to assure that all Arizona drivers are given up to date information concerning safe operation of motor vehicle.

Older Drivers

The fact that older drivers have a significantly higher per-mile accident rate than their younger counterparts is evident of problems that the

the result of irreversible conditions and cannot be corrected. However, knowing what these problems are and ways of compensating for them reduce the magnitude of the safety problem.

Knowledge of any problems and ways of circumventing them defines a set of knowledge qualifications for older drivers. These knowledge qualifications can be summarized as follows:

Information about problems:

- o Vision and the need for frequent eye check-ups
- o Physical conditions that may result in sudden lose of consciousness (e.g., high blood pressure)

Information about circumventing problems:

- o Keeping pace with traffic by maintaining highway speeds or using slow-travel highway lanes
- o Using mirrors to compensate for restricted head movement
- o Avoiding places and hours of heavy traffic to minimize exposure to hazardous situations
- o Limiting the amount and conditions of driving to prevent fatigue
- o Using passengers as lookouts
- o Avoiding driving after certain medications
- o Seeking alternatives to driving, such as public transportation and dial-a-ride
- o Making known availabilty of services to help drivers overcome problems

The extent to which safety could be improved by establishing and fulfilling separate requirements for older drivers has never been established. McKnight and Edwards (1982) failed to find contributing effects from the manual and test designed to meet the knowledge qualifications as identified. However, the sample used in the experiment was too small to provide a truly fair test of the manual and test.

Even the feasibilty of establishing a separate knowledge requirement for older drivers has really never been addressed. Imposing a knowledge testing requirement uniquely upon older drivers would be as discriminatory as imposing a vision test requirement. Older drivers could only be tested under requirements for testing other age groups, i.e., as residents or renewals. It is questionable even then whether separate knowledge qualifications could be established for older drivers. This might be done without

experiencing opposition if separate requirements could be fulfilled without appearing to snuff out older drivers.

If an information booklet were supplied to renewal applicants, as described earlier, separate booklets should be addressed to older drivers. So long as demonstrating possession of information as a requirement for renewal were imposed upon all renewal applicants, there should be no objection to tailoring the information to the age of the driver. Examiners would, of course, have to make sure to administer the correct test. All they would have to do is check the age of the renewal applicant before handing out the test. To help prevent slip ups, renewal application forms, test booklets, and answer sheets could be color coded.

True, older drivers would be taking a different test than other renewal applicants. However, the old driving test should be treated simply as an "Alternate Form". So long as it were not more difficult than the other forms of the test, using a separate test would not be discriminatory. In order to avoid a greater burden upon older than upon their younger counterparts, the test for older drivers would be given instead of rather than in addition to that given to regular renewal applicants. After a period of time, most of the older drivers would have been previously given and tested on information provided regular renewals anyway.

Truck and Bus Operators

A special knowledge requirement for operating trucks and buses was described earlier in the discussion of classified licensing. The requirement is one of the reasons why truck and bus operation was recommended for a separate class of license. Knowledge requirements for operation of trucks and buses include the following:

- Preoperative inspection--The size and construction of trucks and buses makes inspection particularly important
- Maneuvering--The length, construction, and handling characteristics make stopping, backing, turning, and other maneuvers a more complicated process
- Clearances--Because of the height and weight, a truck requires greater clearance in front, back, and overhead
- Speed--The greater mass of the truck effects the control of speed particularly on hills and curves
- Rules of the road--There are a number of laws that apply particularly to trucks and buses
- Emergencies--A variety of certain techniques are required in handling emergencies, particularly those resulting from equipment defects (e.g., lose of brakes)
- Driver requirements--Requirements pertaining to its physical and mental conditions of truck and bus drivers are set forth in local, state, and federal regulations

- o Vehicle requirements--State requirements (construction, safety equipment, and documentation of trucks and buses)

- o Passengers and Cargo--Regulations and practices to insure the safety and security of passengers and cargo

Tractor-trailer Operators

The recommended classification systems distinguish between drivers of buses or great trucks on the one hand and tractor-trailer drivers on the other. This distinction is based, in part, on distinct knowledge requirements. These include:

Backing--Articulation between tractor and trailer changes backing procedures

Emergencies--Presence of a trailer creates the possibility of jack knifing

Coupling--Coupling tractor and trailer is a unique operation necessitating use of safety precautions to prevent hazards to the public

Motorcycle Operators

As in the case of most endorsements, the requirement for a separate motorcycle endorsement is based to a great extent upon knowledge qualifications. These include the following:

Vehicle Control--The aspects of control related to safety include controlled speed, direction, and maintaining balance

Preparation--Compensating for the motorcycle operator's greater vulnerability by emphasizing the importance of wearing protective gear, particulary helmets (Arizona law only requires use of helmets for those under 18; the rest must be encouraged to use them).

Noticability--Making the motorcycle more noticeable through the use of lights, selection of clothing, and positioning the vehicle

Observing--Detecting potential hazards by improved visual scanning and the use of mirrors

Separation--Maintaining safe distances from other vehicles through optimum positioning within lanes

Surface Conditions--Detecting and handling various hazardous surface including surfaces that are slippery, uneven, or sloping

Emergencies--Techniques for making quick stops and turns, obstacles, recovering from skids, handling dangerous vehicle conditions (e.g., wobble)

Passengers and Cargo--Special requirements for carrying people and cargo, including need for special equipment, proper loading techniques, operating with loads, and giving instructions to passengers

Group Riding--Special procedures for use when operating with other motorcycles

Vehicle Requirements--The impact upon safety of various vehicle characteristics, including safety equipment, acessaries, and modifications, as well as the importance of frequent servicing and repair

School Bus Operators

Should Arizona follow the recommendation to create a school bus operator endorsement, applicants for the endorsement will have to be assessed for their ability to meet knowledge qualifications. Since driving a school bus involves relatively few unique skills, it is primilarly knowledges that create a need for a separate license. The unique information requirements include:

- o Handling the bus, including steering, turning, backing, maintaining speed
- o Operating regulations, including speed restrictions, railroad crossings, lane restrictions, and following distances
- o Practices for loading and unloading students, including stopping areas, use of warning signals, observing traffic, and supervising students
- o Passenger Management--Including maintaining discipline, evacuation procedures, and working with bus patrols.
- o Special situations, including field trips and transporting physically handicapped students.
- o Pre/post trip inspection and operator arrangements.
- o Driver mental and physical requirements

Emergency Vehicle Operators

The classified licensing system would include an emergency vehicle operator's endorsement for those operating emergency vehicles outside of government agencies, to include drivers of private ambulances and volunteer fire fighting personnel.

While operation of emergency vehicles demands some special skills, they are not sufficiently greater than those required for Class 1, 2, or 3 operators to demand a separate skill test. The only unique qualifications would be those involving the following subject areas:

Rules of the road--Exemptions from traffic laws

Signals--Proper use of sirens and warning lights

Speed--The relationship of speed to emergency needs and driving conditions

Traffic practices--Interacting with traffic during emergency operations

Contingencies--Techniques for handling such contingencies as vehicle problems and road hazards

Route selection--Selection of special routes for responding to emergencies (to reduce response time, minimize hazard, and avoid disturbance)

Emergency service requirements--Vehicle operation as it relates to loading and unloading the patients, patient safety, and comfort in route

Communication--Radio communication procedures

SKILLS

In addition to knowing what to do, operators must have the skill to do it. The term "skill" in this report will refer to that which over and above knowledge, to operate a vehicle and which is maintained through practice. Most of the skills involved in vehicle operation are perceptual-motor, that is, the required development of association between perceptual processes involved in sensing and interpreting traffic and high-way conditions, and the motor processes involved in controlling the speed and direction of the vehicle.

The need for development of skill arises through the fact that the various associations must be performed within narrow limits, rapidly, and simultaneously. Just what these associations consist of is not really known. Nor does it matter; the purposes of licensing can be simply described in terms of the stimuli that must be perceived and the responses that must be made. For example, the skill required in manual shifting involves primilarly perception of engine sound, vehicle motion, and clutch resistance, and relating these to responsible responses of moving the clutch and accelerator pedals. This, of course, occurs simultaneously with movement of the gearshift level by one hand and movement of the steering wheel with the other. In short, all four limbs are in use at the same time.

In addition to perceptual motor skills, there are a number of purely perceptual skills, that is, skills involving the ability to interpret patterns of stimuli. These include the ability to recognize hazards, the ability to judge "distance" and rate of closure and the ability to recognize these in traffic conditions under low illumination levels.

The skills required to operate the array of vehicles for which drivers must be licensed can be divided into four categories corresponding to the following four categories of drivers:

- Class 3--Operator
- Class 2--Trucks and buses
- Class 1--Tractor-trailer
- Endorsement M--Motorcycle

Relation of Skills to Safety

Attempts to assess the relationship between driving skills and driving safety follow the same pattern as those described for assessing the licensing process in general, as described in the introduction, as well as those used to assess knowledge tests, as described earlier in this section. Those studies attempting to correlate test scores with accidents have produced mixed results. Campbell (1958) McKrie (1968), and Harrington (1973) all found significant but very small correlations. Kaestner (1964), Waller and Goo (1968) found both positive and negative correlations, with results dependent upon the age and sex of the applicant. Finally Wallie and Crancer (1969), Dryer (1976) and Jonah and Dawson (1979) found no correlation.

An experimental assessment of the motorcycle operators skill test by the California Department of Motor Vehicles (Ford and Anderson, 1978) showed that those applicants required to take the motorcycle operators skill test (MOST) had 16 to 22 percent fewer accidents than those required to take the regular California motorcycle operators test. What is of particular interest is that the MOST was one of the tests that, in another study (Jonah and Dawson, 1979), showed no correlation with accidents. Additional evidence comes from comparisons of accidents involved drivers, where Green, Shields, and Platt (1964) found basic control errors to be positively correlated with accident involvement. Also, a study of accidents by Shinar, McDonald, and Treat (1978) found inexperienced drivers to be overinvolved in accidents attributable to lack of vehicle control.

These results strongly suggest that the lack of correlation observed in experimental studies is due to the method of evaluation rather than the test. One of the problems of correlation of studies is that young males tend to do best on skill tests and have the highest accident rate.

Thus with the assessment of knowledge, the crucial test would involve permitting the sample of drivers to obtain licenses without any demonstration of their skill in operating a vehicle. The sample for whom the test was waived must be notified sufficiently well in advance so that they do not attempt to prepare for the license test through any instruction or practice undertaken for that specific purpose. No test of this kind has as yet been performed. The unwillingness of states to countenance such a procedure attests to the widespread belief that some assessment of skill is necessary for the protection of the public.

Basic Operator Skills

An exhaustive analysis of the skills required in operating an automobile have been described by McKnight and McPherson (1981). From a list of 1,700 behaviors resulting from an earlier Task analysis (McKnight and Adams, 1970), the investigators identified a set of 51 behaviors that were judged by a panel of researchers and license administrators as capable of being assessed on a license test. Of the 51 behaviors, 18 involved skill. These were:

- o Acceleration
- o Braking
- o Coordination of accelerator, brake, and shift level in up shifting and down shifting
- o Coordination of acceleration and braking
- o Achieving and maintaining a specified speed
- o Adjusting speed to curvature
- o Stopping at a designated point
- o Maintaining a straight path
- o Maintaining a curved path
- o Judging clearance between two objects
- o Judging clearance between an object and a vehicle
- o Selecting appropriate gaps for entering or crossing traffic
- o Applying brakes to the maximum degree without locking wheels
- o Steering sharply around objects to avoid a collision

These are certainly not all the skills involved in making up qualifications for safe driving. The authors identified a great range of behaviors that could not be assessed in licensing. Many of these involved skill. Unfortunately, they did not segregate those skill-related behaviors from those that do not involve authorizing-specific skills.

An example of that cannt be assessed would be the ability to perceive hazards. This skill cannot be assessed in any licenses test owing to (1) the relative infrequency of hazards, (2) the danger involved in exposing drivers to hazards, and (3) the inabiliity to distinguish drivers who can identify hazards from those who have identified them but simply do not choose to respond to them. It would be possible to identify the full range of skill requirements from the information provided in the report. However, it would serve no purpose to do so in this report since there is no way to assess the skills.

Truck and Bus Operator Skills

An analysis of skills required to operate trucks and buses was performed by McKnight, Kelsey, and Edwards (1984). Drawing from an analysis of truck operator tasks performed by Moe, Kelley, and Farlow(1973), as well as tractor-trailer driver curriculum developed by McKnight, Mahan, and Calvin (1981), the list of skills did not differ substantially from that for automobile drivers. Obviously the nature of the skills differ substantially because of vehicle design and size. For example, manually shifting a truck involves a more complicated, double clutching procedure, and it requires greater precision because of the difference in vehicle weight-to-power ratio. However, the stimulus to which drivers are responding and the response of the vehicles are the same.

The one skill which was unique to trucks and buses was that involved in estimating vertical clearance. Because of the height of some trucks and buses, the ability to pass beneath such overhead structures as overpasses, signs, marquees, and overhanging air conditioners may be questionable. Since drivers must be able to estimate the height of the object in relation of that of a vehicle and judge whether the latter can safely pass beneath the former.

Motorcycle Operators Skills

While the motorcycle must perform essentially the same maneuvers as an automobile or truck, the skills involved are substantially different owing to (1) differences in the vehicle control configuration, (2) response characteristics of the vehicle, (3) the fact that the vehicle operates on two wheels and therefore inherrently unstable.

The most comprehensive analysis of motorcycle operators skills is that conducted by McPherson, McKnight (1976). Using results of the motorcycle task analysis (McKnight and Haywood, 1974) the author has identified a set of skills that were critical to safe operation of motorcycles. These skills were screened for their ability to be validly assessed in a license test. The resulting set of skills was as follows:

- Coordinating clutch, throttle, and shift lever to accelerate
- Coordinating throttle and steering to maintain balance in a low speed turn
- Coordinating throttle and steering to control pass and balance while accelerating
- Coordinating steering and throttle to maintain pass and balance while de-accelerating

- o Coordinating steering and brake application to come to a straight line while stopped at a desiginated point
- o Judging the maximum speed at which a turn may be safely negiotated
- o Applying the front brake with maximum degree possible without causing the wheel to lock or bring the motorcycle to stop in a straight line
- o Applying the front brake with maximum degree possible without locking up the front wheel while stopping in a curve
- o Coordinating brake application and steering to maneuver around an obstacle and yet maintain balance at high speed

A number of other important skills were judged inappropriate for license testing, primarily because of hazard to the operator. These included maneuvering on slippery surfaces, skid recovery, and surmounting obstacles in the motorcycles path.

Other Vehicle Skills

The recommended license structure also calls for endorsements to operate school buses and emergency vehicles. Separate knowledge qualifications are specified for each of these vehicles. However, skills involved in operating these vehicles do not appear to be sufficiently different than those required in operating the vehicles already described to justify separate skill requirements, or administering tests to measure attainment of these qualifications. While the specific skills required in handling school buses may differ somewhat from those involved in handling other types of buses, the differences are certainly no greater than the differences between buses and straight trucks or among different types of vehicles within each of these categories. Those who have exhibited the qualifications needed to handle one of these vehicles can be presumed to have the qualifications to handle others.

Operation of emergency vehicles certainly involves a higher level of skill than that required to handle vehicles that are not permitted the exceptions to traffic laws that drivers of emergency vehicles are. However, these specific skills involved would be very difficult to assess through a license test. The experience requirement that has been proposed--at least one year as a licensed driver--should sufice to assure that emergency vehicle operators have a sufficient level of skill to be able to handle highway and traffic situations without great risk to the public.

TESTS

The previous two sections of this report have, respectively, identified categories of drivers making up the licensing structure, and specified the qualifications that those drivers must possess in order to be able to operate safely. This section will describe the methods by which those qualifications can be assessed. The discussion will be organized in terms of the tests rather than the drivers since most of the points that will be raised in the discussion will relate to the former rather than the latter. The purpose of discussion, tests will be divided into:

- o Knowledge tests
- o Skill tests

KNOWLEDGE TESTS

The immediate purpose of a written test is to assess a license applicants knowledge in order to assure that they're qualified. As noted earlier, the purpose in all this is to motivate license applicants to acquire the information needed to fulfill the qualifications. The value of the test lies primarily in the information that people acquire rather than the ability to distinguish those who do and do not qualify.

Separate written tests must be prepared to assess knowledge qualifications for all those categories of drivers having different sets of knowledge reqirements. Those categories have already been identified as:

- o New drivers
- o Renewals
- o New residents
- o Older drivers
- o Truck and bus drivers
- o School bus operators
- o Emergency vehicle operators

General Consideration

Most of the considerations influencing design of written tests apply to tests for all the categories of drivers. These considerations include:

- o License manuals
- o Selection of content

- Format
- Alternatives
- Wording
- Structure

A set of guidelines for development knowledge test items has been prepared by McKnight and Green (1976). The following is a summary of those guidelines.

License Manual

If the primary purpose of a license test is to motivate applicants to acquire the information needed to operate safely, then an important element of any licensing system is a means of providing applicants the information needed. It is recommended that manuals, phamplets, or other form of information giving mechnicism be developed and used to provide information to all categories of drivers for whom license examination are to be given.

The purpose of this section is to summarize brief steps that can be taken to maximize the ability of manuals to communicate the information needed to help drivers fulfill knowledge qualifications.

Content

Given the constraints placed on the size of the driver manuals, the information placed in them must be that which is most critical to safe operation of automobiles. The discussion of knowledge qualifications identified those topic areas that are most critical of operation of various types of vehicles. There are several categories often appear in driver manuals that are less than critical to safety of vehicle operation:

- Giving descriptions of places, things, or organizations that drivers really don't have to know about
- Giving "official" definitions really don't contribute to understanding, e.g., definition of a motorcycle
- Presenting scientific or technical concepts that can't be translated into action, e.g., BAC
- Providing information that is readily available to people when they need it, e.g., speed limits.
- Providing detail that drivers cannot possibly remember, e.g., stopping distances at various speeds

Readability

A decade ago, Nuckols (1972) found most driver manuals to be written at 12th grade level, and many to be written at college level. Approximately half of the population reads at below this level. More recent analysis of driver manuals by Henk, Stahl, and King (1984) found great improvement, although most manuals are still written at the 8th and 9th grade level. The Arizona manual falls in this range. McKnight and Greene (1976) have recommended the 5th and 6th grade level as an optimal in that any higher reading level looses too many applicants, while writing at a lower level becomes so wordy as to frustrate good readers.

Illustrations

Illustrations should be provided where they can help communicate information. Many state driver manuals use illustrations extensively for eye appeal and then are forced to exclude important information from the manual in order to meet cost constraints. Since applicants must read the manual in order to acquire information needed to pass the test, eye appeal is only secondary.

Selection of Test Content

The content of the test should be drawn directly from the corresponding manual. This has the advantages of (1) allowing applicants to better prepare for the exam, (2) allowing the inclusion of questions dealing with practices other than those required by law, (3) serving as a "referee" in disputes of examiners over the right answers to questions.

The content of test items should:

1. Sample representatively from the knowledge domain to be assessed.

2. Include all levels of difficulty within defined content.

3. Accord priority to that content which is most critical to performance.

4. Call for application, rather than recall of concepts and theory, where possible.

5. Require no more accuracy or precision in response than is required for performance.

6. Call for definitions only when knowledge of the definition itself is essential.

7. Avoid testing for information that is readily available when needed during performance.

8. Avoid testing for knowledges whose role is primarily to maintain interest or facilitate learning rather than support performance.

Format

The format of test items should:

1. Avoid use of "true-false" as it is highly susceptible to response bias (what does "true" mean?).

2. In a multiple choice format, use only as many foils as can attract a substantial response.

3. Provide easy sample questions to acquaint the examinee with the format.

4. Avoid any format that allows an examinee to provide an answer that, while not the one sought, is still correct (e.g., sentence completion).

5. Use situational test items only when they it leads to a single, clearcut answer.

Construction of Alternatives

The alternatives in a multiple-choice test should:

1. Require selection of the correct, not the "best" answer.

2. All deal with the same item of information.

3. Avoid use of mutually exclusive alternatives (one is bound to be correct).

4. Avoid use of "all of the above" (where this is the correct answer, all alternatives are correct).

5. Avoid use of negatives wherever possible (e.g., "the following is not..."); the search for an incorrect answer confuses some examinees.

6. Avoid the use of "none of the above" (like the true-false question, it requires an absolute judgment).

Wording

The wording of multiple choice test items should:

1. Use simple words and phraseology.

2. Make sure that the meanings of all words are clear and unambiguous.

3. Keep all alternatives at about the same length.

4. Avoid "buzz" words (e.g., "good", "sound", "safe").

5. Avoid inclusion of justification or explanation to improve the attractiveness of an alternative.

6. Give emphasis to key words (underlines, capitals).

7. Avoid mixing positive and negative forms and alternatives.

8. Avoid wording that provides clues to the correct answer (i.e., in which the correct answer can be logically derived by an examinee lacking the knowledge tested).

9. Keep alternatives as short as possible consistent with clear understanding.

10. Concentrate shared words in the stem in order to shorten the alternatives as much as possible.

Structure

In assembling alternatives and items, the following rules will be observed:

1. The position of the correct alternative in each item will be decided by chance.

2. Alternative responses involving a logical or numerical aggression will be listed in order (after the position of the correct alternative has been determined by chance).

3. Each item will be independent of other items (examinee should not have to know the answer to one question in order to answer another).

4. The answer to one question should not be given in the stem of another question.

Available Test and Manuals

Tests and manuals meeting the general guidelines just discussed have been prepared and are available. These are described in the following paragraphs.

Operators Test

An operators manual, and seven forms of an operators test were developed by McKnight and Greene (1976). Elements of the driver manual and test have been adopted by a number of states. Connecticut has adopted the entire manual and seven test forms in their totality.

The Arizona Driver Manual and the 37 test items submitted in Task 1 were based upon the operator knowledge requirements identified earlier and the guidelines for design of test and manuals just discussed. It is recommended that the revised manual be substituted for the current manual and that current tests be modified by (1) adding the items supplied in Task 1, and (2) revising current test items to conform with the content of the revised manual.

Renewals Test

Because the knowledge requirements for renewals involve changes in state laws and driving conditions, a renewal manual would have to be prepared specifically for the state of Arizona. The literature review disclosed only one instance in which a special manual was used for license testing. The state of Nebraska adopted a renewal manual and test prepared by McKnight and Simone (1978) for use in licensing renewal applicants.

If Arizona adopts the recommendations to extend the testing requirements to all renewal applicants and to mail renewal notices to those whose license is about to expire, it is recommended that a special renewal manual and test be developed and implemented as a means of insuring that license drivers remain qualified to operate safely.

Older Driver test

If a renewal testing requirement is implemented in Arizona, it is recommended that a separate manual and test be used for drivers over age 55. A manual for older drivers appears in a technical report on elderly drivers by McKnight, Simone and Weidman (1982). This manual fulfills the knowledge requirements specified earlier.

The American Automobile Association has recently typeset and illustrated the older driver manual for use in its program of improvement training for older drivers. It is possible a reproducible copy might be obtained from AAA in the same manner in which the copy for the Motorcycle Operator Manual was currently obtained from the Motorcycle Safety Foundation. Further information can be obtained from Doctor Francis Kenel, American Automobile Association, 8111 Gatehouse Road, Falls Church, Virginia 22042. If an older driver manual is adopted, a test would have to be developed. It should not be difficult to prepare a test from the contents of the older driver manual.

Truck and Bus Operator Test

A Truck Operator Manual (TOM) and Truck Operator's Knowledge Examination (TOKE) meeting the knowledge requirements for truck and bus operator's was prepared and submitted to the MVD as a part of Task 1. The TOKE includes 88 items that have been shown through earlier study to distinguish levels of knowledge among applicants for truck operator's licenses. The item pooled may be divided into two 44-item test forms. The availability of these two forms will allow those who have failed an examination to be given different

test forms, thereby preventing applicants from passing the test simply by learning the answers to questions they have missed.

The special requirements of tractor-trailer drivers are dealt with in the TOM. Creating a separate manual for tractor-trailer drivers would incur unnecessary cost and add unnecessary complications to the distribution of materials. An additional eight items were provided in the TOKE, four of which could be added to each test form. Only tractor-trailer operator's would be required to take the form containing tractor-trailer items.

It is recommended, that at such time as different license classes are created for truck and bus operator's and for tractor-trailer operator's, that the truck operator manual and the truck operator knowledge examination be adopted by the Arizona MVD.

Motorcycle Operator Test

All of the information required to fulfill knowledge requirements for motorcycle operator's are provided in the Motorcycle Operator's Manual (MOM) and its accompanying written examination, prepared by McKnight and McPherson, (1976). Arrangements for providing reproducible copy of the revised MOM and test were made with the Motorcycle Safety Foundation as a part of Task 1 activity. It is recommended that the revised MOM and written test replace the original editions of these publications, currently in use by MVD.

School Bus Operator's

A school bus operator's manual encompassing all of the knowledge requirements specified earlier was prepared by McKnight and Simone (1978). This manual is part of a technical report and not currently in reproducible form. MVD would have to assume responsibility for setting type, preparing illustrations, etc. Also, no test has been prepared to accompany this manual. However, with the content of the manual specified, preparation of a test should not be particularly difficult.

Emergency Vehicle Operator Test

The report by McKnight and Simone (1978) just reference, also provides an Emergency Vehicle Operator's Manual. As is the case of the school bus operator manual, the test is not currently available in printed form, nor is it accompanied by a written test. Responsibility for developing these would have to lie with MVD.

Oral Tests

Like almost all of the states, Arizona administers oral tests to English speaking illiterates and foreign speaking applicants for whom a foreign language test is not available. The approach used is one in which the examiners display flashcards by means of which applicants can indicate their selection of an answer to a question given orally. This approach was

pioneered by Waller, Hall, Lowery, and Nathan (1976) producing test scores that were comparable to those achieved by literate applicants taking the regular drivers test. However, since the questions themselves were not the same, it is difficult to tell whether the pictorial format made the items more valid or simply easier. The pictorial test is to be preferred over the practice of simply reading test questions aloud, which penalized illiterate applicants by (1) forcing them to remember all of the alternatives rather than having them displayed simutaneously, (2) relying upon verbal symbols, which are difficult for illiterates to handle whether in written or spoken form.

Even with the use of pictorial tests, oral testing has two serious drawbacks:

1. It is extremely demanding of examiner time. Not only must it be given on a one-to-one basis, but testing time is greatly in excise of that required for normal written exams.

2. Where none of the available examiners speaks the particular language, it is necessary to use an applicant-furnished interpreter. Such a situation, there is no way of knowing if the interpreter is asking the questions or supplying the answers.

To remedy this problem, Jones (1976) used an audiotape rather than an examiner to ask the questions. She found the test to be reliable and equitable. While the particular test has never been adopted, objections to it involve the pictorial and audio components of the particular test and not the test approach. In addition to reducing the cost of oral testing, the use of this approach results in greater uniformity in that the explanitation is recorded on tape and is therefore the same for all applicants.

In the case of foreign language tests, the same pictorials would be used by all applicants. It would not be expensive to call upon interpreter's to translate the questions orally.

It is recommended that Arizona consider preparing audio cassettes to accompany the current flashcards. The cassettes would be prepared not only in Spanish and English, but in other languages in which significant numbers of oral tests are now given.

SKILL TESTS

A set of skills tests must be provided to permit a measurement of skill qualifications identified for various categories of drivers in th "Qualifications" section. Currently, all state administer skill tests for the basic operators license. Most also administer skill tests for applicants for other classes and endorsements.

Skill Test Requirements

The safety of Arizona citizens requires that, should a classified licensing system be enacted, skill tests be administered for all categories of vehicles posing unique skill qualifications.

To meet Arizona's needs, skill tests must be:

- o Valid--They must assess those behaviors that are critical to safe operation of the motor vehicles
- o Reliable--Each sample of behavior must provide a reliable estimate of driver skill regardless of the variation in route or traffic
- o Objective--The scores that applicants receive must depend totally upon their performance and must not vary as function of differences among examiners
- o Practical--The test must be capable of being administered under constraints imposed by limitations and applicants and examiners time, of their local manpower, personnel skill, and available resources
- o Safe--The tests must not expose applicants or examiners to hazards beyond those that prevail in everyday driving
- o Effective--Administration of the test should result in improved safety, as evidenced by reduction in accidents

Types of Skill Tests

Since skills can be defined only in terms of the stimuli which drivers respond and the responses that make the stimuli, a measurement can only take place under conditions which the stimuli can be produced and responses listed. In short, appeals can only be assessed through tests involving actual driving performance. Three types will be discussed:

- o Road tests--Tests administered on streets and highways
- o Off-street tests--Tests to be administered in areas other than streets and highways
- o Stimulation--Tests administered under conditions where streets and highways are

As with the discussion of knowledge testing, general considerations concerning each of these types of tests will be discussed, followed by a description of available tests.

Road Tests

Several studies evaluating road tests for passenger car drivers and motorcycle operators have reported acceptable examiner and route-to-route reliability (Jones, 1978; Vanosdall, et al., 1977; McPherson, McKnight and Knipper, 1978; McKnight and McPherson, 1981). However, the literature reviewed does not reveal any attempt to evaluate the countermeasure value of road tests in preventing accidents.

Scope of Road Test

A road test measures performance in operating a vehicle under the conditions in which driving normally occurs. Normal driving is a function of the following variables:

Knowledge--A driver's application of knowledge, as defined in the description of written tests.

Skills

- Psychomotor--Skill in manipulating controls (e.g., braking, accelerating, steering)
- Perception--Skill in making perceptual judgments (e.g., following distance, hazard perception)

Motivation--Drivers must be motivated to apply what they know and what they're able to do in order for behavior to occur. Driving is a combination of several motives, including motivation to drive safely, effectively, economically, and comfortably.

Habit--More or less automatic response tendencies resulting from frequent occurrence.

One would like to think the behavior evidenced on a road test is representative of a driver's normal behavior, and that only those drivers who normally operated safely and effectively would be granted licenses. However, it is unrealistic to believe that behavior on a license test is representative of normal driving. The desire to pass a license test generally surpasses all other motives and overrides normal driving habits and leads to behavior that is unrepresentative of applicants' normal driving.

There is evidence that drivers in an examinaton can be induced to exhibit representative behavior if (1) the examination is long enough to let drivers adapt to the presence of the examiner, (2) distractions are created to overload drivers and force them to depend on their normal driving habits, or (3) they are tricked into thinking they are not being tested (e.g., that the test is over or hasn't yet begun). Even if these techniques are successful, their application to a licensing examination is questionable. First, it is unlikely that applicants will adapt to the presence of an examiner in the time that is practically available for a license examination. Second, it is unlikely that licensing agencies will allow having their examiners to distract an applicant during a license test or resort to obvious trickery.

Elimination of motivation and habit from the scope of a road test leaves only assessment of knowledge and skill. As far as assessment of knowledge is concerned, a written test is a great deal more economical, and probably more valid and reliable than a road test. Almost all States require applicants to pass a written knowledge test before even being allowed to take a road test. This leaves skill as the primary driver characteristic to be measured by road tests.

The idea that road tests are primarily measures of skill is supported by research in motorcycle testing where the correlation between a road test and an off-street skill test was almost as high as the route-to-route correlation of the road test itself (McPherson, McKnight, Knipper, 1978). Observations made during the research indicated that applicants with low skill became so preoccupied with vehicle handling that they failed to exhibit many of the safe driving behaviors assessed by the road test. Because of this, the safety of the applicant's interaction with the roadway/traffic environment on the road test provided an indirect measure of skill. Further evidence is found in an evaluation of a road test for automobile drivers in which McKnight and McPherson (1981) found that a road test showed a moderate correlation with a skill measure but none with observations of normal driving made surreptitiously after the test was over.

Need for Road Test

States must be provided with a means of permitting those who would operate vehicles on the public highways a way of evidencing their ability to do so without becoming a hazard or hindrance. If only one performance test is to be developed, it would have to be a road test. It is the only one of the three types of performance measures that can be implemented by any State at any licensing station. It requires nothing but examiners; the applicants furnish the vehicles and the roads are already there.

The principal drawback to road testing is the time that it takes. Just getting the vehicle far enough away from the licensing station to provide a reasonable sample of performance can take a long time. Add the time it takes to get under way and to secure the vehicle, along with the paperwork, it is difficult for one examiner to process more than two applicants in an hour. Many States find it difficult to provide this amount of time under increasingly tight budgets and manpower limits.

Despite its limitations, the road test is the most readily implemented of all performance tests. Therefore, its development within the present project was mandated.

Road Test Requirements

The road test employed by most states involves having an applicant drive over a prescribed route observed by an examiner, who makes an apprasial of driving behavior once the test is completed. Generally, points are taken off for errors made by drivers in performing various tasks. Examiners add up the points and fail applicants whose penalty score exceeds a

certain level. This procedure has been criticized for the degree of subject- ivity involved in the appraisal of skill. Ways of achieving greater objectivity have been studied by a number of investigators, including Forbes et.al (1975), Jones (1978), McPherson, McKnight, and Knipper (1978), McKnight and McPherson, (1981), and McKnight et.al (1984). These investigators have independantly arrived at the following set of requirements:

Observations--The recommended tests confine observations of those performances that occur sufficiently often that can be observed accurately enough to contribute to reliable measures. Many of the observations called for on state road tests occur very rarely and cannot be accurately observed when they do occur.

Checkpoints--In all tests developed by each of the investigators mentioned, examiners make observations of behavior at specific, pre-determined points.

No one examiner can possibly observe all activity of an applicant. Many correct performances and many errors pass unnoticed. Efficient testing demand that examiners look for specific behaviors at the points where they are most likely to occur. This practice (1) increases the likelihood that examiners will observe critical behavior, (2) makes the behaviors observed more uniform across different examiners.

Performance Criteria--In most state road tests, examiners reach an overall judgement on how well applicants carry out a particular performance. To overcome the subjectivity inherrent in such a practice, the recommended tests call upon examiners to report merely whether an applicant did or did not meet specified critia in a given instance. A determination of this sort is much more objective and therefore more likely to be accurate and uniform across examiners.

Total Score--Scores that are derived simply by adding up errors tend to penalize applicants who take the test under difficult highway and traffic conditions. The tests developed by the investigators mentioned minimize this problem by scoring applicants in terms of errors in relation to the total number of responses they are called upon to perform. The practice is comparable to evaluating infielders in terms of their fielding average rather than the raw number of errors they make.

Each of these practices tend to result in applicant appraisals that are more objectice, more indicitive of an applicants true over-all performance, and a betters indication of an applicants ability to operate safely. Comparisons of recommended approach with added state road tests were carried out on automobile drivers (McKnight and McPherson, 1981), and to truck drivers (McKnight, et.al, 1984). In both cases, inter-examiner agreement was approximately the same for the two types of tests. However, the test employing the more objective procedures correlated more highly with a separate skill test than did the state road test. In explaining the results, the officers hypothesied that inter-examiner agreement of state

road test derived more from sharing of common stero types then from the actual behavior. This is why they tended to agree with one another, but did not apparently assess skills as measured by a separate test.

No state has fully implemented any of the developed by the referenced investigators. The main obstacle to widespread implementation of these tests has been the difficulty in use of pre-determined checkpoints. The examiners object to having to (1) select and memorize checkpoints, (2) prepare route-specific scoring forms, (3) scoring only the selected behaviors at the selected checkpoints. The authors of this report believe that the benefits of improved objectivity, uniformity, and validity can be obtained without the use of pre-determined checkpoints so long as examiners know what to look for under various highway-traffic conditions. Therefore, in discussing roadtests for various categories of drivers, we will recommend implementing those aspects of the test that deal with the behaviors to be observed, the locations at which the behaviors are most likely to occur, and the criteria for scoring the behaviors, but not necessarily the exact procedure by which the test combines these into a score.

Basic Operator Road Test

The three most heavily researched road tests developed for administration to operator license applicants are the Driver Performance Measure (DPM) developed by Forbes, et.al, (1975), the Safe Performance Test (SPT) developed by Jones (1978) and the Automobile Driver On-Road Performance Test (ADOPT) developed by McPherson, and McKnight (1981).

The DPM involves a scoring system that requires extensive training of test administrators. Moreover, the training can only be conducted by representatives of the developing organization, Michigan State University. This requirement severly limits its implementation. The development of the ADOPT was launched by National Highway Traffic Safety Administration specifically to devise a test that was simpler and could be implemented solely by licensing personnel. The SPT was developed primarily for evaluating the outcomes of training and involves test administration and time exceeding that available to most licensing agencies. We will therefore focus upon the characteristics of the ADOPT.

The following performances were found, in the ADOPT, to permit reliable measurement:

> Vehicle handling--handling the vehicle during forward and backward maneuvering in tight quarters. it can be performed as a parallel parking maneuver, a three-point turn, or some other similar maneuver. Performance is scored in terms of (1) time to complete the maneuver, (2) the number of direction changes, (3) the striking of any boundary, (4) turning to observe directly through the back window while backing, and (5) final position of the vehicle.
>
> Brake application--the ability to regulate brake pressure in order to stop smoothly with a deceleration that does not exceed .3 g.

Rapid stop--bringing the vehicle to a stop as quickly as possible without locking the wheels.

Lane keeping--the ability to operate within the boundaries of a travel lane while traveling straight ahead, negotiating a curve, or making a turn at an intersection.

Gap selection--making the correct decision in response to gaps when traversing cross traffic, turning right or left to enter cross traffic, or making a left turn across traffic. A correct gap judgement is accepting every safe gap and rejecting every unsafe gap.

Maintaining speed--not permitting speed to fall below 5 mph less than the limit in ordinary straight line driving, when negotiating curves, or when making turns at intersections. The purpose of this check is to prevent applicants from concealing their inability to handle the vehicle by operating at very slow speeds.

Selecting speed--not exceeding a safe speed when entering a curve or approaching a turn.

Observing--proper use of mirrors and headchecks to observe (1) vehicles behind, when slowing to turn or leave the road, (2) vehicles in adjacent lanes before initiating a lane change, (3) vehicles to the sides in the direction of cross traffic at intersections.

Communicating--signaling before entering a new lane (signaling turns almost never results in errors and is therefore not worth including in the test).

Travel restrictions--Observing all travel restrictions, including (1) observing lane control signs, (2) entering the correct lane when turning on a multi-lane highway, (3) not entering areas closed to traffic.

Truck and Bus Operator Road Test

Only one test for truck and bus operators has been developed along the guidelines presented earlier. This test is the Truck Operator Road Test (TORT) developed by McKnight, Kelsey, and Edwards (1984). The performances making up the TORT are described on the following page.

Performance	Description

A Accelerating
AF Accelerating: Flat--smoothness of acceleration on a level surface
AI Accelerating: Incline--smoothness of acceleration on an incline

B Brake
BA Brake: Application--braking smoothly to a stop
BD Brake: Distance--stopping the vehicle at the appropriate point

J Distance Judgment--judging the distance of approaching vehicles when entering or crossing traffic

G Gear Shifting
GU Gear Shifting: Up--correct procedure in shifting up through the gears
GD Gear Shifting: Down--correct procedure in shifting down through the gears
GA Gear Shifting: Ascending--using the proper gear on an upgrade

L Lanekeeping
LS Lanekeeping: Straight--staying within the lane while driving straight
LC Lanekeeping: Curve--staying within the lane while in a curve
LT Lanekeeping: Turn--staying within the lane while in a turn

O Observing
OF Observing: Following--checking the mirrors periodically for following traffic
OI Observing: Intersection--checking cross traffic when approaching a blind intersection
OL Observing: Lane Change--checking mirrors prior to lane change
OM Observing: Merge--aligning vehicle and checking mirrors prior to a merge
OT Observing: Turn--checking trailer for clearance during the turn

P Position
PS Position: Single Turn Lane--positioning the vehicle correctly for a turn within a single lane
PM Position: Multiple Turn Lanes--positioning the vehicle correctly for a turn where more than one lane is available
PL Position: Lane Change--pausing during a lane change to permit any unseen vehicle(s) to move
PR Position: Restriction--complying with lane restrictions imposed by signs and markings

S Signaling
SM Signaling: Merge--activating the turn signal prior to a merge
SC Signaling: Cancel--manually cancelling the signal following a turn

V Velocity
VS Velocity: Straight--maintaining speed on a straightaway
VC Velocity: Curve--entering curves at a normal and safe speed
VT Velocity: Turn--entering turns at a normal and safe speed
VM Velocity: Merge--merging at the speed of traffic
VD Velocity: Downgrade--maintaining a safe speed down a grad

If Arizona implements a classified system providing separate license classes for truck and bus operators and tractor-trailer drivers, then it is recommended the procedures used in the TORT be adopted for road testing license applicants. The same test can be used for licensing drivers of trucks, buses, and tractor-trailers. As with road testing for the operator's license, it is not necessary to use predetermined checkpoints so long as examiners are trained in the types of locations at which various performances are best observed, or is it necessary to employ a percentage scoring system. However, observations should be confined to those performances specified by the TORT and evaluated using the specified criteria. A detailed description of the TORT may be found in McPherson, McKnight, and Oates (1984).

Motorcycle Operator Road Test

Only one road test has been developed following the guidelines described earlier and that is the Motorcyclist In-Traffic Test (MIT) developed by McPherson, McKnight and Knipper (1978). The only difference between the MIT and the previous two road tests is that the examiner follows the applicant in a separate vehicle.

The specific behaviors that are observed in the MIT are:

Observation--Head checks and mirror checks when negotiating intersections and making lane changes.

Position--Placing the motorcycle within the correct portion of the lane in response to roadway design characteristics and the presence of other traffic.

Speed--Operating within 5 mph of the legal speed limit, maintaining safe operating speeds when leaving major roadways.

Signals--Using signals to communicate intention to other drivers when turning, entering roads, or leaving roads.

Gap Selection--Accepting only safe gaps when entering or crossing traffic.

Lane Usage--Operating in the correct lane and avoiding encroachment upon other travel lanes when making turns.

Brake Usage--Using both front and rear brakes when stopping.

Legal Stop--Coming to a complete stop where required and stopping where required (e.g., before crosswalks).

The MIT has exhibited examiner reliabilities of .6, correlations with a separate, off-street, measure of .5, and with the ratings of an expert panel of .5 to .6 (Quane).

The behaviors are currently employed in the Motorcycle Operator Skill Test (MOST) for assessing skills of license applicants. The MOST has the advantage over the MIT of (1) measuring skill directly rather than indirectly, (2) having greater examiner reliability, and (3) having proven effectiveness as an accident countermeasure (Ford and Anderson, 1978). In view of the superiority of the MOST, implementation of the MIT is not recommended.

Off-Street Test

There are many aspects of performance that can be assessed without access to the highway traffic environment. Several States use off-street testing as a part of the licensing process.

Effectiveness of Off-Street Tests

While off-street tests of heavy vehicle operators are given both in training and licensing, no published study of their effectiveness could be identified during this contract. In fact, the only rigorous evaluation of an off-street measure that could be found was the evaluation of the Motorcycle Operator Skill Test (McKnight and McPherson, 1976). This measure showed a high degree of examiner reliability (>.9) and acceptable test-retest reliability (.6-.7). This test, when implemented in California, was credited with contributing to a 16%-25% reduction in accidents (Ford and Anderson, 1979). The high degree of reliability experienced in the off-street motorcycle test could probably be achieved in an off-street measure for heavy vehicle operators were similar measuring processes employed. However, whether a similar reduction in accidents could be achieved, given the differences in both vehicle characteristics and applicant population, is anyone's guess.

Scope of Off-Street Testing

Off-street tests have been used primarily to test vehicle handling skills including the following:

- Starting, accelerating, shifting
- Directional control, including lane keeping in a straight line and in curves
- Turning, including normal turns and quick turns
- Stopping, including normal stops and panic stops
- Backing, both in a straight line and turning.

The space limitations of off-street areas typically prevent operation at high speeds. However, most practitioners and researchers agree that skills can be adequately assessed at low speeds. Speeds employed in the Motorcycle

Operator Skill Test did not exceed 20 mph, and were subsequently reduced to 15 mph without affecting the measurement process.

Skills outside those involved in vehicle handling can also be assessed. Some States measure vehicle inspection and trailer coupling/uncoupling in off-street areas.

Role of Off-Street Testing

The primary advantage of an off-street test is its ability to obtain very precise, reliable measurement of skill. In a well-designed set of exercises, every moment can be made to count, and the amount of information gained per unit of time can far exceed that available from a road test. The added information, when coupled with the increased measurement and reliability, permits a potentially valid skill measure to be administered in considerably less time than is required in a road test.

An additional advantage of an off-street test is its ability to protect the public against unskilled applicants. In fact, even where license tests are given on-road, a brief off-street test is often administered to see if the applicant has sufficient vehicle control to be allowed on the highway.

One obvious drawback of the skill test is the real estate it requires. A survey of licensing officials conducted as part of an earlier motorcycle project (Kirkpatrick, Bathurst, and Loughead, 1979) revealed that, where most licensing stations are located, there is rarely more than a small parking lot available. Even when nearby shopping centers are used, testing is usually restricted to a parking aisle.

Another obvious limitation of an off-street test is the restriction of the measurement process to the assessment of skills. This is probably not as much of a limitation as it might appear in view of the extent to which skill assessment seems to dominate road testing as well.

Available Tests

A few states use off-street tests to assess the performance of applicants for basic operator, truck and bus, and tractor-trailer licenses. However, because of the amount of real estate required, and because of the general acceptability of on-road tests, use of off-street tests for this purpose is very infrequent. Many states will, like Arizona, require applicants to perform a simple parking maneuver, on- or off-street, to illustrate fundamental skills before commencing the road test. This practice prevents wasting time on, and protects examiners from, totally unqualified applicants.

Because of the high cost of off-street testing for Operators, Truck and Bus, and Tractor-Trailer licensing, it is not recommended for this purpose in Arizona. Only one off-street test is recommended and that is the Motorcycle Operator Skill Test (MOST).

Motorcycle Operator Skill Test

Arizona is one of 17 states administering the MOST to applicants for motorcycle operator licenses. The reliability and validity of this test has been mentioned previously. The major drawback of the MOST, one that has inhibited widespread implementation, is its cost. Items contributing to cost are:

> Real Estate--The area required for administration of the MOST is often unavailable to licensing stations.
>
> Equipment--The MOST requires speed measuring equipment and signal lights to permit accurate assessment of turning, stopping, and swerving skills.
>
> Preparation Time--Considerable time is required in transporting and setting up the required equipment.

To circumvent these problems, the Motorcycle Safety Foundation has developed the alternate motorcycle operator skill test or ALMOST. Many states have adopted the ALMOST where the complete MOST is difficult to use. However, the validity of the ALMOST has never been established. Nor has any attempt been made to determine its relationship to the MOST. For this reason, its adoption cannot be recommended, despite the obvious cost savings.

At the present time, the National Highway Traffic Safety Administration is about to initiate a project the objective of which is to lower the cost of the MOST by reducing space requirements, the need for equipment, and examiner time. In view of this activity, any change from the current use of the MOST would be continued pending the outcome of the forthcoming NHTSA study. If that study is successful in reducing the cost of the MOST, while maintaining its reliability and validity, it should be implemented.

Simulation

The attractiveness of simulation as a mode of testing has been enhanced in recent years by (1) economic pressurs that have forced States to seek ways of reducing personnel time, and (2) satisfaction with automated testing equipment in reducing, or at least stabilizing, manpower requirements.

Effectiveness of Simulation

Simulation has been tried out as a part of the licensing process in several States. None of these attempts have involved licensing of heavy vehicle operation. Most of the efforts were conducted under the State/Federal highway safety program and were terminated on completion of the project. So far as can be determined, simulation is not used as part of an operational licensing program in any State. The most systematic evaluation of simulation in licensing was that performed by the New York Motor Vehicle Department (O'Brien, 1977). In this study, simulation was found to provide reliable measurement of various safe driving practices, including observa-

tion, signaling, and hazard identification. No attempt has been made to evaluate simulation as a countermeasure in licensing, either by itself or as part of a broad licensing program.

An evaluation of the application of simulation technology to the licensing of heavy vehicle operators was recently completed by Seidle (1980). His analysis revealed that simulation could accommodate at least some elements of all of the most critical truck operating tasks. However, his costs associated with development and day-to-day operation of the necessary simulation equipment clearly exceeded what licensing agencies can afford.

Scope of Simulation

The types of simulators used in the efforts just mentioned fall into two categories: closed loop and open loop simulation.

Closed Loop Simulation

This term refers to simulation in which the display (i.e., driving scene) to which the driver responds will itself respond to the driver, thus making up a continuous or "closed" loop. The two types of displays that are sufficiently practical to warrant consideration for licensing are computer-generated images and point light source. An attempt to apply the latter to simulation in the State of Oklahoma was not considered sufficiently successful to warrant its continued use.

Because of its inability to simulate traffic conditions or even road conditions (beyond the path to be traveled), closed loop simulation is limited primarily to assessment of vehicle handling skills. While the fidelity of simulation may be sufficient for training purposes, it is unlikely that a State would ever award a license to a driver purely on the basis of performance in the simulator.

Open Loop Simulation

In open loop simulation, the driver responds to the display, but the reverse is not true. No matter what the driver does, the display remains the same. The open loop simulators used in licensing have employed a motion picture display. They are basically adaptations of the simulators widely used in driver education. The advantage of motion picture films is the high resolution of the image, allowing the intricacies of the highway traffic environment to be fairly well portrayed. Their use has been primarily to assess the driver's knowledge of, and tendency to employ, safe driving practices.

Role of Simulation

It doesn't appear as if the simulation can be used by itself as a performance measure in licensing. The most successful form of simulation;, motion pictures, is best suited to measurement of safe driving practices,

leaving measurement of vehicle handling skills to be tested in the vehicle itself. Devices designed to simulate vehicle handling tasks do not do so well enough to allow use of the vehicle to be bypassed entirely.

In the various projects that employed simulation, the simulation measure was added to the regular licensing test. This is probably one of the reasons why use of simulation died with the projects. To be attractive to license administrators, simulation must reduce rather than add to the time and cost of testing.

Simulation has not been developed to the point that would allow simulators to replace road tests or off-street tests. The cost of administering a simulation test in addition to a road test or off-street test would be too great to justify its use at the present time. Therefore, use of simulation is not recommended.

AUTOMATED TESTING

The 1970s witnessed a widespread introduction of automatic license testing equipment throughout the United States. While only a small fraction of license tests are currently administered by this equipment, the equipment that is in use is fully operational--it has gone well beyond the experimental stage.

Characteristics of Automated Test Equipment

While there's a great variety of automated test equipment in use, the various types of equipment share the following characteristics:

Automatic Display--The questions are displayed to applicants automatically. Before the applicants start, the display presents instructions on how to use the equipment. The applicant merely presses a button to display each new test question.

Response Recording--Applicants respond to each question by pressing a button, which registers the answer. In some cases, the answer chosen is displayed to the applicant who then confirms that the answer displayed was indeed the one chosen. This gives the applicant a "second chance" to correct the answer.

Immediate Feedback--As soon as the answer is selected, applicants are given the correct answer.

Automated Scoring--Applicants' answers are scored automatically by the equipment and a readout is given to the examiner. The readout may take the form of a printed tape, a display on the examiner console, or some combination. Some readouts give only the total score while others display the questions answered correctly or the questions missed.

Types of Automated Test Equipment

Three basic types of automated test equipment are currently available for license purposes. They are slides, computers, video discs.

Slides

With this equipment, questions are shown on slides which are projected on a screen. Most slides present a picture as well as the written question. Feedback is usually handled by a mechanical device which, when the applicant responds, exposes the correct answer on the lower portion of the slide. The correct answer is generally coded into the slide so that slides may be added, removed, or shuffled around without requiring modification of the response scoring system.

The slides are generally mounted in a carousel to permit continuous testing. For example, four 20-item slides may be placed in an 80-slide carousel. After the four tests have been administered, the cycle repeats. Some equipment uses a continuous film strip rather than a carousel. The slide approach to automated testing is the first and clearly most popular approach employed. It is simple, reliable, easily maintained, and readily modified.

Computers

With the computerized system, questions are displayed on a standard video display terminal. Once the question is answered, the computer displays the correct answer. While some computerized testing devices present a fixed series of questions, others select questions at random to provide an almost infinite number of test "forms." More recent developments include the simulation of motion through a sequence of images on the screen.

Video Discs

With this approach, video images from a video disc are displayed upon the screen. A computer handles the selection of appropriate questions and answers as well as scoring responses. The video discs are able to provide images approximating the quality of slides, vary the sequence of questions in the manner of a computer, and handle motion better than either slides or a computer.

Advantages of Automated Test Equipment

Early purchases of automated license test equipment were probably motivated more by fascination with the equipment than anything else. The purchases were greatly stimulated by the availability of Federal funds under Section 402 of the Highway Safety Act. As these funds have become more difficult to obtain, the purchase of automated test equipment has slowed down noticeably. Licensing agencies are more inclined than ever to assess the equipment in terms of the advantages it brings to the licensing operation. The advantages of automated test equipment include (1) information presentation, (2) automatic scoring, (3) feedback, and (4) adaptive testing.

Information Presentation

Generally speaking, the various displays used in automated test equipment are able to present questions more intelligibly than is possible with written tests. This advantage stems primarily from their ability to present pictorials in detail and color far more ecomically than would be possible with printed tests.

Computer and video discs also add the dimension of motion, something that McKnight and Green (1976) found improved the understanding of test questions. While the improvement was greatest for those with reading problems, it was manifest at all reading levels. Of the two systems capable of displaying motion, video discs offers very high fidelity at relatively little cost. In asking questions about driving situations, it is capable of presenting driving scenes just as they would be seen by the driver.

None of the information presentation features would be of particular benefit in testing of illiterate or foreign-speaking drivers. To do such would require the addition of an audio component. An early study by Chrystal (1971) found the addition of sound to automated test equipment to add considerably to the expense of testing. The use of speakers was disturbing to adjacent applicants, no matter how low the volume.

This problem could only be overcome by separate ear phones, maintaining the hygiene of which entails considerable expense. For the foreseeable future, the use of an audio component is best restricted to use with a limited number of applicants with reading problems, who can be tested in a separate room.

Automated Scoring

The automated scoring feature saves the time required by examiners to score individual items and add up the scores. This feature was one of the early selling points of automated test equipment. However, since most examiners can manually score a written test in a few seconds, the economic value of this advantage was probably somewhat exaggerated.

Much has been made of the ability of automated test equipment to enter scores automatically into a driver record. However, it takes no little programming to take advantage of this feature and very few license agencies ever enter scores into driver records anyway.

Feedback

The uniqueness of the automated feedback feature lies not so much in its ability to provide the answers--that can be done with any test--than it does with the ability of automated equipment to keep applicants from changing their answers once they've seen the correct one. This is what allows feedback.

Use of information feedback has been widely promoted as a means of improving learning. A study by Kelsey, Sherman, and Ratz (1980) showed that

feedback led to significant learning. While learning no doubt takes place, it is of marginal value. The items making up any test are but a sample from a total population of knowledges that define the qualifications for safe driving. Redressing those few information deficiencies that manifest themselves in an automated test is of relatively little benefit. The result of testing should be to induce drivers to seek recourse to the total population of knowledges, i.e., the driver manual.

A more practical benefit of information feedback is the savings in the time required of examiners to explain answers to applicants. Explaining and justifying correct answers takes a significant amount of examiner time, probably more time than that saved by automatic scoring.

Adaptive Testing

The computer and video disc forms of automated test equipment have the advantage of random access to questions. This feature allows sequences of questions to be varied from one applicant to another. Further, it allows the results obtained from initial questions to be applied to the selection of additional questions. This feature permits the use of "adaptive" testing.

It has been shown by Samejima and by Green that an adaptive testing approach can lead to much more precise estimates of knowledge and skill than a fixed, linear approach. This advantage can be applied to the reduction of test items. In some applications, adaptive testing has led to the same accuracy in estimation as linear testing with as few as 25% of the questions. For example, if an applicant failed four easy items, it could confidently be predicted that the applicant would fail the entire test. Conversely, if an applicant passed four difficult items, a passing score could be predicted with equal confidence. Combinations of passing and failing hard and easy items would necessitate asking more questions. Some applicants might have to take the full set of 25 items currently making up the operator's test, or the 34 items making up the motorcycle test. For most applicants, however, an accurate estimate of the applicant's total sphere of knowledge could be obtained with far fewer items.

A reduction in the number of items each applicant is required to take means a reduction in the average time spent by applicants in the license station. This, in turn, means a reduction in the number that must be accommodated in license stations at any one time. Certainly, the ability to reduce the number of applicants being tested by as much as 75% would be an advantage exceeding that to be gained from automated scoring and information feedback. This is reason alone to consider the use of automated test equipment.

Automated Testing for Screening Purposes

The discussion of "Qualifications" dealt at some length with the potential advantage of screening drivers for mental and physical deficiencies. While the discussion took place within the context of age-related deficien-

cies, any screening process would have to be applied to applicants of any age.

Any screening process that applies to the entire applicant population would have to be performed extremely quickly to avoid overburdening license stations. At the present time, as previously noted, Arizona does not reexamine renewal applicants whose driving record is violation-free. Any attempt to implement a screening process for all applicants would virtually dictate the use of automated test equipment.

Identifying driver functions that are related strongly to the safety of motor vehicle operation on the one hand, and capable of being assessed through state-of-the-art automated test equipment, is an undertaking that lies outside the scope of this report. Such an effort would have to start in recognition of the fact that very few studies attempting to relate basic human functions to driving safety have shown significant relationships.

Most of the studies have sought correlations within large representative samples of drivers. Such correlations have been universally low (Miller and Dimling, 1969). Failure to find significant relationships within representative samples of drivers does not mean that drivers who score very poorly on such tests are not safety hazards. Identifying characteristics of truly hazardous drivers would require administering mental and physical tests to extremely large samples of drivers. This has not, as yet, been done. In the absence of such studies, it would be necessary to select the functions to be tested on the basis of analyses based upon logical rather than empirical relationships with safety. Candidate functions include the following:

- Reaction time (Bransford, 1939; Lauer, et al., 1952)
  - Simple reaction time
  - Choice reaction time
- Coordination
  - Two-hand coordination (Goldstein, et al., 1952)
  - Eye-hand coordination (Miller and Dimling, 1969)
- Visual field dependency (Barrett, et al., 1969)
- Visual search (Robinson, et al., 1971)
- Memory and information processing (Alexander, King, and Warskow, 1967)

Unfortunately, two of the most formidable problems--vision and hearing --don't seem to lend themselves well to testing by automated devices. In the case of vision, measures of acuity (static and dynamic), contrast sensitivity, or motion detection require a fixed distance be maintained between the eyes and the source of stimulation, while measurements of visual field require a fixed point of visual fixation. Neither condition could easily be satisfied in an automated system without human monitoring. Similarly, a test of hearing would require being a fixed distance from the source of sound. Moreover, the disturbing effect of sound on others was mentioned earlier.

Recommended Action

It is recommended that Arizona pursue the acquisition of automated test equipment as a means of accommodating the increased burden of a renewal testing aimed at assuring knowledge qualifications and screening for driver defects. To meet Arizona's needs, an automated testing system should have the following characteristics:

- Be computer-driven so as to permit an adaptive testing approach.
- Provide a visual display capable of depicting driving situations clearly and understandably.
- Be easy to operate and maintain.
- Permit easy modification to accommodate a variety of visual displays and applicant responses in order to serve as a screening device.

SUMMARY

A driver licensing system for Arizona in the nineties and beyond has been designed through a comprehensive analysis of the driver licensing state of the art. Implementation of this design would give Arizona a licensing system that will be unsurpassed in its ability to assure the safety of motor vehicle operation on Arizona streets and highways.

The salient features of this design are summarized here.

Classified License

A recommended classified license system would consist of the following classes and endorsements:

License Classes

1. Tractor-trailer
2. Trucks and buses
3. Operator

License Endorsements

M. Motorcycle

S. School bus

E. Emergency vehicle

C. Chauffeur

Each class and endorsement would require a separate license examination. The license classes form a vertical classification in that each license class subsumes the classes beneath it. Holders of class 1 licenses can also operate vehicles with class 2 and 3; holders of class 2 licenses can also operate vehicles with class 3.

Endorsements are a horizontal classification; they are required in addition to a license class and authorize of operation of motorcycles, school buses, or emergency vehicles. Under the recommended classification system a Chauffeur's license would be required only of those holding a Class 3 license alone, who wish to operate a vehicle for employment. Those operating tractor-trailer, trucks, buses, school buses, or emergency vehicles are already authorized to operate a vehicle for employment.

The recommended classified licensing system, along with the tests

administered to applicants, would help assure that drivers are equipped with the unique qualification needed for all types of vehicles.

Provisional License

Part of the classified system is a provisional license for all novice drivers under age 18 during the first six months of operation. The provisional license would help reduce the hazards of inexperience by (1) restricting the hours of operation to prevent late-night driving, (2) create an incentive for lawful driving by requiring six months of violation-free driving for a regular license.

Renewal Testing

It is recommended that all renewal applicants be required to take a written test in addition to the current vision test. The written test would be limited to information in which licensed drivers are known to be deficient, information that would be supplied with renewal notices. Along with the introduction of automatic test equipment, renewal testing could also screen drivers for other deficiencies. Should Arizona be forced to adopt a renewal-by-mail system, alternative measures, described in the report, could be employed.

Manuals and Tests

Efforts recommended to improve the knowledge qualifications of Arizona drivers include (1) providing manuals and tests for all license classes and endorsements, (2) expanding the contents of manuals and tests to include all information critical to safe vehicle operation, (3) maximizing the readability of manuals and tests. Most of the manuals and tests required are currently available.

Oral Testing

An oral test using a combination of flashcards and an audio cassette is recommended as a means of reducing the costs of oral testing, increasing the range of languages that can be accomodated by oral tests, and assuring uniformity of cross test administrations.

Road Tests

It is recommended that road tests be administered to applicants for truck and bus, and tractor-trailer licenses as well as those applying for operators licenses. Further, the road testing process should be made more objective by (1) limiting the performances checked to those that can be reliable observed and measured, (2) observing particular performances at specific locations, (3) evaluating performance against specific criteria. The procedures needed to institute such road testing procedures are currently available.

Motorcycle Skill Testing

It is recommended that no changes be made in the procedures for testing motorcycle operators, pending the outcome of a forthcoming U.S. Department of Transportation study aimed at decreasing the administration cost of the current Motorcycle Operator Skill Test.

Automated Test Equipment

Automated test equipment is capable of improving the quality and the economy of knowledge testing through (1) better ways of presenting questions, (2) automatic response recording and scoring, (3) feedback to applicants, (4) adaptive testing . It is recommended that automated test equipment be considered as a means of reducing both examiner and applicant time, thereby allowing renewal testing and screening (see below) to be accomodated without increasing the overall cost of licensing activity.

Screening

It is recommended that Arizona follow closely independent efforts to develop means of rapidly screening license applicants for mental and physical deficiencies that pose a critical hazard to driving. Since whatever screening procedures are developed must be uniformly applied to all drivers, the screening process must be extremely rapid. Efforts to develop a screening process therefore must be coupled with any procurement of automated test equipment.

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