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EVALUATION OF THE UTILIZATION OF VIDEODISC TECHNOLOGY TO AUTOMATE THE ORAL DRIVER LICENSE EXAM

Final Report

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16. Abstract This report describes the development and evaluation of an audiovisual license system for illiterate drivers. The work was solicited and supported by the Arizona Department of Transportation. The goal of the system is to assure that drivers license applicants who cannot read well enough to use the written driver's manual or to take the written driver's test are still sufficiently knowledgeable of safe driving rules and practices as to pose no greater risk on the highway than do their literate counterparts.

A 34-item audiovisual test was developed in two languages using videodisc technology. Each item presents the question and three alternative answers, with picture and sound, on a visual display terminal and allows applicants to register their choice of answers by touching the video screen. When initial administration of the audiovisual test yielded a low (27%) pass rate, an 80-minute audiovisual version of the driver's manual was prepared and made available to licensed applicants. Use of the audiovisual test and manual in combination resulted in 51% of applicants ultimately passing the test. Substantial and statistically significant age and language differences were encountered.

The authors conclude that use of the audiovisual test would greatly reduce request for oral tests by those who can read and the examiner time required to administer the tests while improving the effectiveness of the licensing process for illiterate applicants. The tests readily accommodate different languages. The audiovisual license system could be further improved by wider dissemination of the audiovisual manual by reducing test administration time and by greater use of computer-generated material.

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PREFACE

This report was prepared by Dr. A. James McKnight and Mr. A. Scott McKnight of the National Public Services Research Institute, and by Mr. Brian K. Bryans of the Arizona Motor Vehicle Division. Mr. Robert A. Pike, of the Arizona Transportation Research Center, exercised technical monitorship of the project. The work was carried out for the Arizona Department of Transportation in cooperation with the U.S. Department of Transportation, Federal Highway Administration.

All motion sequences for the audiovisual test were shot by Media Design Associates Inc. (MDA) of Boulder, Colorado, which also handled video editing and preparation of the videodisc. The MDA effort was directed by Mr. Burt Kempers, who was assisted by Mr. Mark Schwiesow and Mr. Ronald J. Ladd.

Poseidon, Inc. of Boulder, Colorado assembled the videodisc playback equipment system, including monitor, computer, and videodisc player, as well as devising all of the initial computer programs. The Poseidon effort was carried out by Mr. Michael G. Franklin and Mr. Edward D. Dawson. Reprogramming of the videodisc to accommodate later changes was handled by Mr. Steven Dozier of Spectrum, Inc., Tucson, Arizona. Ms. Marcia L. Williams of NPSRI prepared and edited the manuscript of this report.

The authors are greatly indebted to Mr. Paul Colell of the NPSRI Arizona field office, for coordinating development of the audiovisual manual and test, to Mr. Roy Cirincione of the Arizona Motor Vehicle Division, for coordinating filming in Phoenix, and to Dr. George Woods of TestCorp, Inc. for supplying some of the footage for use in the videodisc test.

TABLE OF CONTENTS

Page

ABSTRACT i
PREFACE ii

I. INTRODUCTION 1
PROBLEM 1
Limitations of Oral Testing 1
Pictorial Tests 2
Automated Testing 3
Videodisc Testing 4
Presenting Information 4
OBJECTIVE OF THE STUDY 5

II. AUDIOVISUAL TEST DESIGN 6
TEST APPROACH 6
TEST CONTENT 7
ITEM FORMAT 8
Displaying Alternatives 9
Reviewing Alternatives 9
Feedback 10
VISUALS 10
Medium 10
Preparation of Visuals 11
AUDIO 11
Audio Source 12
Use of Dual Audio Tracks 12
Narration 12
EQUIPMENT 13
TEST PROCEDURE 14
PILOT TEST 15
Sample 15
Procedure 15
Results 16
Implications of Pilot Test Results 17

III. AUDIOVISUAL MANUAL DESIGN 18
Content of Audiovisual Manual 18
Audiovisual Medium 19
Development of Audiovisual Manual 20
Narrative 20
Visuals 21

Page

IV. EVALUATION OF AUDIOVISUAL LICENSE SYSTEM 23
EVALUATION METHODS 23
Audiovisual Tests 23
Test Procedure 23
Sample 24
RESULTS 24
Total Pass Rate 24
Applicant Characteristics and Pass Rate 26
Age Differences 27
Language Differences 27
Applicant Reaction 28
Individual Items 29
Internal Consistency 30
Test Administration 30

V. DISCUSSION 31
SUMMARY OF EVALUATION RESULTS 31
RECOMMENDED IMPROVEMENTS 32
Greater Use of Audiovisual Manual 32
Reducing Test Administration Time 32
Stopping Those Who Have Failed 32
Stopping Those Who Have Passed 33
Stopping Those Who Will Pass 33
Adaptive Testing 34
Computer Generated Stimuli 34

VI. CONCLUSIONS 35

FIGURES:

1: Proportion of Applicants Passing the Audiovisual Test Prior To and Following the Availability of The Audiovisual Manual 25
2: Pass Rate by Number of Attempts 25
3: Pass Rates by Age and Language Spoken 26
4: Proportion of Applicants Favoring Audiovisual Manual and Test Classified by Outcome (Pass vs Fail) 28

TABLES:

1: Content of the Audiovisual Driver Manual 20

INTRODUCTION

PROBLEM

Like most States, Arizona administers oral license examinations to drivers who are unable to cope with written examinations, either because they cannot read the written word or because a written test in the language they speak is unavailable.

Limitations of Oral Testing

The Arizona Motor Vehicle Division administers over 600 oral examinations each month. At about 15 minutes per examination, this adds up to almost one examiner person-year each year. In addition to the expense in examiner time, oral testing presents the following problems:

> *Inconvenience*—Examiners may not always be available at the time an applicant requests an oral examination. Either the examiner must shift from some other activity to oral testing, creating inconvenience for the licensing operation, or the applicant must be inconvenienced by having to wait. The problem is particularly acute in the case of foreign-speaking applicants since the examiners able to give an oral examination in a foreign language are in short supply and are, therefore, less likely to be available.
>
> *Reluctance to Use*—Applicants who can read to some extent are often reluctant to request an oral exam. Such applicants may be at a greater disadvantage than totally illiterate drivers in that they attempt to take the written examination. They may miss enough questions to fail, not because they do not know the answers, but because they do not understand the questions.
>
> *Difficulty Level*—Many language-limited people have difficulty fully comprehending the spoken word as well as the written word. Even pictorial presentations may not be fully understood, particularly if the information being presented involves motion and the pictorial is static.
>
> *Lack of Uniformity*—While a written test is the same for all applicants, an oral test inevitably varies from one examiner to another. Some examiners can communicate more clearly than others. An even greater source of variance involves the inadvertent or deliberate coaching that often occurs among sympathetic examiners.

Complicating the problems of testing itself is the lack of any certain method of communicating information to illiterate drivers in the first place. Like most States, Arizona provides a written manual that literate drivers may read in preparation for the written test. But how do illiterate applicants acquire the information needed to pass the test? Getting others to read the manual to them is likely to be a formidable task, particularly since many

sections of the manual would have to be read more than once to achieve the level of learning and retention needed to pass the license examination.

The result of the problems that have been enumerated is, in all probability, that large numbers of illiterate drivers are being licensed even though they lack the information that the State believes is necessary for lawful and safe driving, even after being tested through an expensive, labor intensive process. Fairness to the public that both foots the bill for the testing process and shares the road with those unqualified drivers that slip through, requires a more effective and efficient system for testing illiterate drivers.

Pictorial Tests

Until the last decade, an oral test consisted primarily of an examiner reading written test questions to applicants. In a multiple-choice test, an oral presentation clearly puts applicants at a disadvantage. Whereas, a driver taking a written exam can contemplate the various alternatives more or less simultaneously when selecting the correct answer, oral test applicants have to remember the alternatives as they are spoken by the examiner. To overcome this disadvantage, Waller et al. (1976) developed a pictorial examination. In this test, the stem of the question is presented orally by the examiner, but the alternative responses are displayed in pictorial form. Applicants can look over the various alternatives and then point to the correct response.

In Waller's study, applicants taking the pictorial test scored higher than those taking an orally-administered written test. Since the knowledge levels of the two groups of applicants were rendered equal through randomization, the difference was attributed to the ability of the pictorial test to communicate questions more clearly.

While a pictorial test improves the communication of questions to applicants, it requires as much examiner time as does a test involving oral administration entirely. To overcome this problem, Jones (1976) combined a pictorial test with an audio recording. Applicants listened to a question being read on the recording and then stopped the recorder while they selected and marked their answer in an accompanying picture book. While the approach showed promise, many applicants had difficulty understanding the questions, the pictures, or the way in which they were to indicate their answers. Because of the amount of time examiners had to spend coping with questions, the approach was never implemented.

One of the problems in the picture/recording approach was the difficulty applicants had understanding questions that involved motion. For example, in a question with three alternative answers involving different speeds, the same picture was displayed three times, the only indication of differing speeds being a small inset of the speedometer with the indicator at different positions. This may have failed to communicate speed differences to many applicants.

Automated Testing

While automated testing does not address the problem of illiteracy per se, it offers a way of reducing one of the greatest problems of testing illiterate drivers, examiner time.

Almost all of the early automated tests used in actual license testing employed slides projected on a screen in front of applicants. The slides presented a question, often accompanied by a picture, and alternative responses. Applicants pushed a button corresponding to the selected response and then usually another lever to register their answer. Once their answer was recorded, an aperture opened revealing the correct answer. Applicants pushed another button to go on to the next item.

The projected slide type of automated test, still in widespread use, offered the advantages of reduced examiner time through (1) informational feedback, which eliminated time-consuming explanations by examiners after the test was completed, and (2) automated scoring to ease the examiner's task. However, since this type of test equipment had no audio component, it could not be applied to oral testing. An audiovisual test employing videotape was tested by the State of Iowa in 1970 and found great acceptance among license applicants (Chrystal, 1971). However, its cost and a requirement for group testing prevented its general adoption.

In the mid '70s, computer-generated test questions were introduced. Except for the fact that the questions were generated electronically on a video display terminal rather than being projected on a screen, they operated in the same manner as their predecessors, providing informational feedback and automated scoring. They had the additional advantage of being able to select questions at random from a large pool, thereby providing an almost infinite number of test forms. However, questions were presented in purely textual rather than pictorial form.

In the early 1980's, a second generation of computer-generated test questions improved upon earlier forms by introducing pictorial displays, some of which even involved primitive simulation of motion, such as a turn signal flashing on and off. It was at this point that adaptive testing was introduced to exploit the computer's ability to adapt the sequence of test questions to applicant responses. Adaptive testing, which will be discussed in greater detail later, was intended to permit a reduction in the number of questions that must be asked of applicants, thereby leading to reduction in the average duration of testing, and increasing applicant flow.

In an activity as dynamic as driving an automobile, the inability to deal with questions involving motion is certainly a handicap. McKnight and Green (1976) found that the use of motion pictures to present questions involving motion led to a 15-40% reduction in the number of incorrect answers. The fact that there was no reduction in incorrect answers on those questions that didn't involve motion indicates that the benefits of the motion picture format lie in the ability to depict motion and not some other feature of motion picture presentation. So far as we know, no attempt has been made to use dynamic pictorials in the testing of language-deficient applicants.

Videodisc Testing

Application of videodisc technology to driver license testing was initiated by TestCorp in 1983. It combined the realistic and readily understood pictorials of projected slides with the random access capability of computer generated test questions. However, it went the slides one better by accommodating the dynamic aspects of driving. Also, in addition to improving upon the quality of the computer generated dynamic displays, it also greatly simplified the generation of the displays, replacing complex programming with simple photography.

Finally, videodisc offered the easy introduction of sound, something missing from both projected slides and computer-generated questions. In 1985, Media Design Associates undertook the development of an audiovisual videodisc system as part of a Small Business Innovative Research Grant. An 18-item videodisc was generated and pilot tested on 25 license applicants in Denver, Colorado. All rated it favorably as a means of license testing.

Presenting Information

Drivers who cannot read well enough to take a written test are likely to be under a handicap in obtaining the information needed to pass a knowledge test on the same subject matter, regardless of the form in which the test is given. Many illiterate drivers may have access to indulgent friends or relatives who will read the State driver's manual to them and review it until they have a good chance of passing an oral examination. However, it is unlikely that most illiterate applicants have sufficient access as to the information needed to pass a license test. McKnight and Green (1976) analyzed the problem presented illiterate drivers and suggested making audiovisual materials available during preparation for the license test. However, the literature discloses no documented attempt to do this by any licensing or educational agency.

The fact that no one has, as yet, come forth with an operational audiovisual system for helping illiterates prepare for their license examinations doesn't mean it is not a good idea. The ultimate objective of the licensing process is to see that drivers are sufficiently knowledgeable and skilled in safe driving as to pose no threat to the safety and progress of other motorists. Because of the importance of automobile transportation to the welfare of the citizenry, this responsibility cannot be fulfilled simply by testing drivers and withholding licenses from those that are not qualified. Most States go one step further in providing license applicants with a printed manual containing the information believed essential to safe vehicle operation. Furnishing such information is more than just a convenience to drivers; it helps provide additional assurance that those who become licensed know what they are supposed to know. The lack of any audiovisual counterpart to the written drivers manual, therefore, represents a shortcoming in the driver licensing system that is every bit as serious as the lack of a suitable means for testing knowledge.

OBJECTIVE OF THE STUDY

The objective of the effort described in this report was to assess the feasibility of employing an audiovisual system for assuring acquisition of critical driving knowledges by license applicants who are unable to read sufficiently well to pass a written test. The scope of the study included both the means by which driver knowledge was assessed and the means by which the requisite information was presented in the first place.

The body of this report is divided into the following sections:

Audiovisual Test Design—The design of an audiovisual system for assessing the driving knowledge of illiterate license applicants.

Audiovisual Manual Design—The design of an audiovisual system for presenting information to illiterate driver license applicants.

Evaluation of Audiovisual License Testing System—An assessment of the feasibility of license testing illiterates through an audiovisual system.

In the chronology of licensing activities, presentation of information precedes testing. However, in the development of the Arizona Audiovisual License Testing System, the test came first. Indeed, it was an initial assessment of the audiovisual test through which the need for an audiovisual version of the drivers manual was recognized.

AUDIOVISUAL TEST DESIGN

This section of the report will describe the design characteristics of an audiovisual license test system for testing language-limited applicants for driver's licenses. For purposes of discussion, design characteristics will be structured as follows:

1.	**Test Approach**	5.	**Visuals**
2.	**Test Content**	6.	**Equipment**
3.	**Item Format**	7.	**Test Procedure**
4.	**Audio**	8.	**Pilot Test**

TEST APPROACH

An audiovisual approach to the testing of illiterates was dictated by the population being served. The audio component is obviously necessitated by the inability of illiterates to read. Except for an experimental video test employed briefly by the State of Iowa, the need for audio presentation has been met through the use of a live examiner. Use of visuals is dictated by two other characteristics of the illiterate population. First, because many illiterates have difficulty manipulating verbal symbols, regardless of whether they are written or spoken, some pictorial representation can help greatly in communicating questions. Second, illiterate applicants, like their literate counterparts, must have a means of viewing simultaneously the alternative answers in any multiple-choice test. In oral testing by examiners, this vehicle is met through the pictorial test developed by Waller (1976).

The medium chosen for an audiovisual license test was videodisc. While use of videodisc was mandated by the contract under which the study took place, it represented the only reasonable choice. First, video represents the most efficient available approach to individual audiovisual presentation. However, cassette-driven slide or film-strip presentations cannot display the motion that is so important to questions about driving, while motion picture film is very costly to reproduce, inconvenient to project and requires frequent replacement. This left video cassette and videodisc.

In the choice between video cassette and videodisc, only the latter allows the interaction between viewer and presentation needed to let applicants review questions and to allow feedback as to the correct alternatives after the questions have been answered. Also, for reasons to be discussed later, the ability to alter the number and pattern of questions based upon earlier responses was imperative to efficient testing. Finally, only videodisc lends itself to computer administration of tests.

TEST CONTENT

The content of the videodisc driver license examination was drawn from the existing Arizona Driver's Manual. Limiting test items to the content of the manual was necessary in order that license applicants would have had an opportunity to prepare for it.

The length of the videodisc license test was made equal to that of the written test. The inability to read was not considered justification for a shorter test. The Arizona Written License Test included 34 items, of which 25 were multiple choice items dealing with rules of the road and the remainder were sign recognition items. For the oral test, 34 test questions were drawn from the content of the driver's manual.

The subject matter of the items can be summarized as follows:

Signals and Signs

- Flashing red light
- Flashing yellow light
- Double yellow line lanes
- Dashed yellow line
- Meaning of "No U-Turn" sign
- Meaning of "Two-Way Traffic" sign

Practices

- Meaning of "Do Not Enter" sign
- Meaning of "Divided Highway" sign
- Shape of "Yield' sign
- Shape of "Stop" sign

Rules of the Road

- Dimming lights
- Hand signals roads
- Right turn on red vehicles
- Left turn on red
- Right of way at intersections
- No passing in school zones limits
- Response to stop school bus limits
- Wheel position when parked

Lane Use

- Lanes to turn from
- Lanes to turn into
- Continuous left turn
- Lane control signs

Safe Driving

- Checking the blind spot
- Following a school bus

Emergency Procedures

- Blowout
- Skid recovery
- Quick on slippery
- Response to emergency

Speed Limits

- Residential speed
- School zone speed

Driver Fitness

- Time needed to sober up
- Amount of alcohol in beer
- Penalty for breath test refusal

ITEM FORMAT

An audiovisual license test intended for oral examination of driver license applicants must be capable of assessing the knowledge of language-limited applicants as reliably as a written test does for fully-literate applicants. This requirement guided design of the item format. Briefly summarized, the format is as follows:

1. *Stem*—The stem of each item is presented visually in full screen with simultaneous oral presentation. Those questions that involve motion employ dynamic visuals.

2. *Serial Alternatives*—Three alternatives are presented in series. Each alternative is presented visually in full screen, accompanied by an oral presentation. Those alternatives involving motion are presented dynamically.

3. *Simultaneous Alternatives*—Still frames from the stem and three alternatives are then presented simultaneously in four quadrants on the screen. The narrative for each alternative is repeated while the corresponding still frame is highlighted.

4. *Review*—Before selecting an answer, the applicant is invited to touch a red arrow then superimposed on the stem if a review of the three alternatives is desired. Touching the arrow recycles the program back to the simultaneous presentation of alternatives. The narrative, inviting the applicant to review the question, is repeated every 10 seconds until the applicant touches one of the frames.

5. *Selection*—Following presentation of the three alternatives, the narrative asks the applicant to select the correct answer by touching the appropriate frame. An early version of the test also required applicants to next touch a green arrow in order to proceed, thus allowing a period for reconsideration before the response was registered. However, this just added delay without obvious benefit. Now, the response is registered when it is selected.

6. *Feedback*—Applicants who answer correctly are simply informed that their answer is correct. When the answer is not correct, the correct frame is highlighted and an oral explanation of the correct answer is provided. Originally, the latter procedure was used in all cases. However, it was obviously unnecessary for those answering correctly and unduly lengthened the testing time.

7. *Program Advance*—Once the feedback is given, the program then proceeds immediately to the stem of the next question. This also occurs if the question recycles twice without any response on the part of the applicant. (Non-responses are scored as incorrect answers.)

Displaying Alternatives

Probably the most complex design issue to be resolved was that concerning the means by which alternatives are displayed simultaneously in order to allow the applicant to select an answer. In the selected format, the three still frames are displayed simultaneously, and each is successively highlighted as each alternative is repeated orally. Initially, the thought was that making the still frames highly distinctive would allow them to be presented simultaneously without the highlighting and oral repetitions. This would save on videodisc capacity, which is consumed by either an oral presentation or dynamic visuals and is limited to 30 minutes per videodisc. A still frame can be displayed indefinitely without using videodisc capacity. However, most of the still frames were but static elements of a motion sequence and were unable to stimulate recall of the entire sequence without the aid of the accompanying narrative.

Another approach considered in the simultaneous display of alternatives was to repeat the entire motion sequence as used in the serial presentations rather than just still frames. Use of the complete dynamic visual would assure the ability of the applicant to recall each alternative. Arguments against repeating the full dynamic sequence were:

> *Cost*—Dynamic split frames are extremely expensive to produce and would raise the cost of the videodisc oral examination by an order of magnitude.
>
> *Comprehension*—The loss of detail in reducing the image by three-quarters would be much more debilitating to a moving image than a static one.
>
> *Videodisc Capacity*—The three dynamic sequences would require greater disc space than just the three narratives.
>
> *Applicant Limitations*—Trying to watch three simultaneous motion picture sequence simultaneously could have been more difficult than were the questions.

As it turned out, key still frames from each motion sequence could be selected in such a way as to represent simply the entire sequence. The pairing of a still frame with an oral explanation helped applicants make the necessary connection.

Reviewing Alternatives

One important feature of the approach employed is the provision that allows applicants to review three alternatives as often as desired. This feature takes a lot of pressure off the presentation of alternatives. An applicant who can't remember what a particular still frame is supposed to represent can review the alternatives and listen again to the oral presentation that accompanies each. Probably the most valuable element of the review provision is its ability to minimize consumption of videodisc space. It is much less expensive of videodisc space to repeat an audiovisual presentation over and over than it is to use a longer presentation in order to ensure understanding the first time.

One issue relative to the review feature was how much of the question to review: stem, dynamic alternatives, and still frame alternatives. It is no more expensive of equipment, programming, visuals, or videodisc space to repeat all three than it is to repeat merely the simultaneous split frame presentation of alternatives. What was of primary concern was the effect of the choice upon total examination time. Recycling applicants through an entire sequence (Steps 1-3) when they need only to review the alternatives (Step 3) would be wasteful of time and possibly frustrating to the applicants themselves. Therefore the review only recycles back to the still frame sequence.

Feedback

As explained earlier, those who answered correctly are given the oral message "That is correct." This oral message, along with a blank (blue) video frame, is contained on a small portion of the videodisc which is accessed after each correct answer. For those who answer incorrectly, the feedback employed simply highlights the correct answer frame and provides an oral explanation of the correct answer. To save on videodisc space, the narrative is synthesized from that accompanying the stem of the question and that for the correct alternative.

One alternative approach considered was the "answer-till-correct" approach in which applicants who answer incorrectly the first time are invited to select another alternative, continuing until the correct alternative is selected. The rationale for such an approach is the belief that applicants are more likely to retain the correct answer if they select it themselves since the "response" of selecting the correct answer has been "reinforced."

This extrapolation of reinforcement theory is tenuous at best. The applicant has already made an incorrect response and, given the opportunity, may well make another one. Whether these incorrect responses will be "extinguished" because a later response is correct is a matter for conjecture. Meanwhile, the process takes valuable time. Simply presenting the correct response takes less time and, by avoiding more mistakes, may have a more beneficial effect upon retention than allowing applicants to "discover" the correct answer.

VISUALS

The discussion of visuals will consider the *medium* in which visuals were recorded, and the *procedures* employed in the *preparation* of materials.

Medium

Ultimately, all visual stimuli were recorded on, and retrieved from, a videodisc. However, the medium in which the stimuli were originally recorded varied somewhat from question to question. Questions that involved static information were originally photographed in the format of 35mm still pictures. These visuals included close-ups of signs, alcoholic beverages, money, someone in jail, etc.

For questions involving dynamic information, either motion picture film or video are appropriate media. Each has its advantages and disadvantages. Motion pictures were used as the primary medium because of the experience of staff personnel in its use. After editing, the motion picture sequences were then transferred to video format. However, video material sequences for three of the questions were kindly supplied by TestCorp. Later in the project, when it became necessary to replace faulty items, improvements in video cameras and changes it staff composition made the use of video a more appropriate medium.

Preparation of Visuals

The preparation of visuals was guided by the following specifications:

- "Questions involving responses to highway-traffic situations use the driver's perspective as much as possible.
- "When the question involves the physical movements of the driver, the driver appears in the visual. For example, in showing mirror checks, we see the driver look at the mirror rather than panning the camera.
- "Questions involving the relationship of the vehicle to outside objects or another vehicle are taken from outside rather than inside the vehicle.
- "Where questions involve the direction of motion, the oral and visual presentations are consistent. For example, a visual dealing with a "left turn" is taken from behind so the motion of the vehicle is toward the left side of the screen.
- "Dynamic scenes are shot at speeds roughly 30% below speeds to be pictured, to allow for the tendency of a vehicle to appear to be traveling faster than it really is.
- "All scenes are filmed from full-sized vehicles operating over smooth road surfaces with tires inflated to about 20% below minimum specified PSI.
- "Where necessary, the cooperation of law enforcement agencies is obtained in filming scenes that required traffic control.
- "Filming is scheduled so as to avoid heavy traffic, traffic restrictions (e.g., no left turn 4-6pm) or sun glare.

AUDIO

Since the illiterate applicants cannot read, questions must be given to them orally. It is the audio component, therefore, that actually presents the questions. The visuals help to clarify the questions and serve as reminders while alternative answers are being considered.

Audio Source

Two alternative ways of providing the audio were considered. The most straightforward system was simply to integrate the audio component into the videodisc as is usually done in a video presentation. This approach requires that the videodisc move at its normal 30 frames per second any time an audio presentation is required, even if the audio accompanies a still frame. Any audio presentation, therefore, will use up what is limited videodisc capacity.

To conserve on videodisc space, the audio component could have been provided on a separate overlay card controlled by the computer so as to select the appropriate audio segment for each video segment. This approach could be used at all times, although it would only save on videodisc space in those cases where the audio accompanied a still frame. Use of an audio overlay also has the advantage of allowing changes in the audio presentation, or insertion of purely local information, without having to re-master the videodisc. Finally, it allows instant access to the audio message from any point on the videodisc, without changing the visual presentation. The primary disadvantage was the expense of the overlay card, which added approximately 5% to the cost of the videodisc system.

The approach selected was to integrate the audio into the videodisc and to attempt to economize on the audio presentation to the extent necessary to accommodate the 34 test questions on a single videodisc. However, should it later become advantageous to add an audio overlay, this could always be done. The simplicity of an integrated system was believed to be worth the effort to economize on space.

Use of Dual Audio Tracks

The videodisc contains two audio tracks. The two tracks could have been put to use in either of two ways. One approach would have provided different English and Spanish narrations on the same videodisc allowing examiners to switch languages without swapping discs. The alternative was to use a separate disc for each language reserving the second audio track to allow two different narrators to share the same video.

Because of the large number of Spanish-speaking applicants, it was desirable to be able to switch languages without having to substitute videodiscs. Therefore, the approach taken was to be sufficiently sparing of narrative to be able to confine the basic English narration to a single audio track, reserving the second track for a Spanish version. Having both languages on the same videodisc meant that the examiner need only touch the screen to switch from one language to another, rather than having to change videodiscs.

Narration

The initial pilot test versions of both English and Spanish audio tracks were narrated by non-professionals with good quality voices. These were replaced by professional narrations in the final version.

In the English version, both male and female narrators were used, each narrating approximately half of the items. While this helped reduce the monotony inherent in the presentation of many questions and achieved a gender balance, it would also facilitate the introduction of new voices at a later date if it became necessary to replace items. An additional voice where there were already two would be less noticeable than if all the questions were narrated by a single voice. This was not done for the Spanish version simply due to the lack of enough suitable Spanish-speaking professional narrators.

EQUIPMENT

A videodisc oral license test console was assembled from off-the-shelf, state-of-the-art equipment. The following components were employed:

> *Monitor*—A Sony 1271 high resolution Elographics color touch screen monitor was used to permit items to be displayed in the format described and to allow answers to be registered by touching the screen.
>
> *Computer*—An IBM compatible PC having 256K of memory and an 8088 microprocessor was used to (1) control the videodisc player and select appropriate videodisc frames, (2) score responses and grade the test, and (3) collect, maintain, and process data for valuative purposes (e.g., testing time).
>
> *Videodisc Player*—A Pioneer LD-V4000 videodisc player, designed for industrial/educational applications, was the source of visual (moving and still) and audio information displayed on the monitor.
>
> *Interface*—The interconnections among monitor, computer, and videodisc player were handled through an interface designed specially for the system by Poseidon Systems Inc.
>
> *Speakers*—While the video monitor has built-in speakers, a telephone handset was connected to the audio output to keep the sound from disturbing others within reach of the test unit.

The use of a telephone handset was a bigger step than it might appear. One of the obstacles to large scale use of audiovisual license testing has been a means of presenting audio information. The use of a single headphone or earpiece was discouraged by public perception of them as being unsanitary, while replacing the item after each use would be prohibitively expensive. One early audiovisual testing device used low volume speakers and sound-insulated carrels to avoid the problem. However, this is costly when a lot of test stations are involved and often leads to sound interference.

Fortunately, the public manifests little or no reluctance at all to placing against the ear the plastic earpiece of a public telephone handset. Since only one hand was needed to register responses on the touch screen monitor, the use of a handset created no problem and became the means of delivering audio information.

TEST PROCEDURE

Applicants to be administered the audiovisual license test were seated in front of the touch screen monitor and received a brief introduction by the examiner. On the left and right sides of the monitor were, respectively, the words "English" and "Español." The examiner touched that portion of the screen corresponding to the applicant's language in order to select the appropriate audio track. Beyond this point, the examiner was no longer required. However, during the pilot testing and later evaluation of the audiovisual system, the examiner remained nearby in order to monitor testing.

Prior to the first question, the videodisc presented applicants with a brief introduction to the test and the equipment to be used. After the test was described, applicants were given a practice question. Those that answered correctly went on to start the test, while those who answered incorrectly were given the correct answer and told to touch the corresponding frame on the screen.

The test then began with the items given in a fixed sequence but from a random start. The recommended procedure in operational licensing would be to continue testing until an applicant had either passed 80% of the items on the test or failed 20%. The purpose of stopping the test the instant a pass/fail decision can be made is both to save time and avoid exposing applicants to any more of the items than is necessary. In both cases, concern was primarily with those who would fail the test. It was possible for those failing the test is to spend as much as 80% of the testing time answering questions after they had already failed. Moreover, they would be provided an opportunity to preview the items they would be given when they were re-tested. To avoid this, it would be necessary to prepare at least one alternate form. Stopping the test after an applicant has failed limits the number of items that can be observed. Just how much time and how many test items could be saved is something that could be answered only through administration of the entire test to representative samples of all applicants. This issue will be discussed again in connection with "Recommended Improvements".

Upon completion of the test, applicants were orally instructed to summon the examiner. By touching the monitor screen, the examiner could read the results of the test. The computer also maintained a record of individual results for research purposes.

PILOT TEST

The Audiovisual Test was pilot tested through administration to driver license applicants at the Tucson Main station in Tucson, Arizona. The purpose in conducting a test of the audiovisual test was to (1) obtain an overall appraisal of its suitability for oral testing, and (2) to identify specific strengths and weaknesses of the system. No attempt was made to assess the psychometric characteristics of the test in its prototype form. Such an evaluation would have required large numbers of applicants and would have been appropriate only after the development of the test had been completed.

Sample

Two samples were employed in the evaluation:

> *Illiterates*—Twenty-seven applicants who requested an oral test were invited to take the prototype test. While some could read to a limited extent, they may be classed as functional illiterates with respect to the written license test.
>
> *Literates*—A group of 10 drivers who had passed the written test were invited to take the test on a voluntary basis.

The purpose in administering the test to illiterates requesting the oral test was to obtain reaction from a group representative of those who would be administered the test in actual practice. However, recognizing that this group was likely to be somewhat deficient in the knowledges being tested and, therefore, not very helpful in identifying deficiencies within the test itself, the test was also administered to a group known to possess the knowledges being tested.

Procedure

The following procedure was used in administering the test:

Solicitation—Illiterate applicants requesting an oral exam were asked to volunteer for the test, being told that if they failed, they would be given the regular oral test. In addition to the oral examinees, a group of applicants passing the regular written test was asked to take the test while their paperwork was being processed. They were assured their results would have no impact upon issuance of a license.

Instruction—An examiner escorted applicants to the test, showed them how to use it, and started the system. Examiners then monitored the applicants for a while to see if they were having difficulties. If the applicant appeared to be handling the system appropriately, the examiner left, offering to return if difficulties were encountered.

Administration – Applicants were left to complete the test by themselves. For purposes of pilot testing all 34 items were given to each applicant. Their responses were automatically recorded on a disk within the computer. When applicants announced that they had finished, the examiner returned and, by pushing a key on the computer, read their score on the monitor.

Questionnaire – When the illiterate applicants had finished, examiners asked them to complete a survey asking whether or not they liked the automated oral test.

Results

Literate applicants did very well on the test while the illiterate applicants did not. Literate applicants averaged scores of 30.2 out of a possible 34 test items. A "passing" score was 80% correct or 27 items. Only one of the literate applicants failed the test and that applicant missed by only one item (i.e., 26 correct). Since all of the literate applicants had previously passed the written test, the result provides evidence as to the equality of the two measures.

In contrast, the illiterate applicants did rather poorly, with a mean score of 20.5 and only 5 of the 27 applicants passing the test. It is worth noting that 21 of the illiterate applicants had attempted to take the written test and all failed. To what extent the failure is due to reading limitations and to what extent it is due to lack of knowledge cannot be determined. (Recall that the term "illiterate" here is just a shorthand for drivers whose lack of confidence in their reading skill led them to *request* an oral exam.)

The literate applicants averaged approximately 20 minutes per test. The illiterate applicants measured over 10 minutes longer. The difference in testing times probably has less to do with literacy than knowledge of correct answers. Those within the illiterate group who passed the test took relatively little time. Across the two test groups, the correlation between score and time was -.54, with the highest scores involving the shortest times. These results suggest that, where illiterate applicants really prepared to take the test, their average testing time might be more like that of the literate applicants.

The applicants we have been classifying as "illiterate", that is those taking the audiovisual in lieu of the written exam, were surveyed as to their opinions concerning the test. The majority of applicants liked the videodisc license test. That included 83% of those passing it and 76% of those failing it. The universal complaint registered by those who didn't like it was that they could not understand the questions. Since six out of the seven applicants objecting to the test failed it, it is entirely possible that their inability to understand the question resulted from their lack of knowledge concerning the subject.

Implications of Pilot Test Results

While the pilot test was not intended to provide a true evaluation of the audiovisual test, the results were certainly informative. The fact that the majority of applicants were favorably disposed toward the test (including those who failed) was certainly encouraging. So too is the fact that those literate applicants who demonstrated their knowledge on the written test all did well on its audiovisual counterpart.

What is disconcerting is the high failure rate. While no records of failure rates for oral examinees are kept, it has been estimated by licensing officials to be no higher than 5%. Assuming the pilot test participants were a representative cross section of those requesting oral examinations, it would seem that either the audiovisual test or the regular oral examination is failing to give a valid appraisal of applicant knowledge. As far as the audiovisual test is concerned, many of the illiterate applicants who failed the test complained that they did not understand the questions. A few questions were indeed difficult to comprehend, even by those passing the test. However, inability to understand the test question is a common defense of people who fail tests of any kind. All of those who had already demonstrated their knowledge of the general subject matter in a written test did well (and all passed, if those items that were clearly misworded were eliminated).

The estimated 95% pass rate for oral exams is in stark contrast with data reported by Harrington (1973) for California where only 49% passed oral tests and 85% passed written tests. Either Arizona illiterates are far more knowledgeable than those in California, or the Arizona test is far easier.

Monitoring the oral examination process by licensing administrators revealed that the examiner's oral delivery was not always confined to the content of test questions as written. While deliberate coaching was not in evidence, questions were often "clarified" in a manner that helped make correct answers somewhat more obvious. The guidance given seems to reflect an assumption on the part of many examiners that applicants certainly must know the correct answer and simply do not understand the question.

At the very least, the oral examination process is inequitable in that it extends to the illiterate a form of assistance that is not available to those taking the written test. At its worst, it leads to licensing of drivers who may lack knowledge of critical safe driving laws and practices. When people are unable to answer questions, the most tenable hypothesis is that they don't know the answer. It is not only the safest assumption, but the one that is most logical when the people in question cannot read and, therefore, lack direct access to the source of the answers.

AUDIOVISUAL MANUAL DESIGN

The poor performance of illiterate license applicants on the audiovisual test is not surprising given their inability to read the driver's manual by which those taking the written test acquired the information needed to pass it. The potential value of some means for delivering the contents of the driver's manual to illiterate applicants has not been unrecognized.

In the study by McKnight and Green (1976) alluded to earlier, applicants were allowed to prepare for the examination by viewing films containing all of the information included in the manual relating to safe driving. None of the subjects in the study was capable of reading and many were classified as "mentally retarded". Nevertheless, the majority were able to pass a license examination given in the same audiovisual format as the information presentations. The test was also similar to the VDLT in that questions were presented through a combination of pictures and spoken words and, hence, did not require the ability to read. However, like a written driver's manual, material had to be reviewed two or more times before applicants could pass the test; one time through was not enough.

Once the extent of knowledge deficit represented by illiterate license applicants had been revealed through the pilot test the potential role of an audiovisual driver's manual was elevated from a "benefit" to a "necessity." Accordingly, the scope of the project was enlarged to incorporate an audiovisual version of the Arizona Driver's License Manual into the license testing system under development and evaluation.

Content of Audiovisual Manual

The fact that a licensed applicant cannot read is not in itself reason for altering what they should be expected to know before being allowed to operate an automobile. Therefore, the content of the audiovisual manual was extracted duplicate that of the written version. As noted previously in connection to the audiovisual test, the Arizona Driver's Manual was undergoing revision at the time this study was taken place. However, a change of content was obviously a greater problem when it had to be duplicated completely in a manual than when it was only sampled in 34 test questions.

Not all of that which resides in a State driver's manual can be considered critical to the safety of the motoring public. Some of the manual's content is provided as a service and has nothing to do with safety, while some of the safety information is conceptual or persuasive and does not involve information for which anyone could be held responsible. From the existing and proposed written manuals, the project staff prepared a list of information items, the possession of which might be expected to enhance the safety of the motoring public. The items included not only the rules of the road and other actions dictated by law, but also a wide array of safety *practices* not specifically prescribed by the motor vehicle code. Examples of safety practices included visual search, maintaining space, adjusting speed to a variety of conditions, use of alcohol and other drugs, fatigue, condition of the vehicle, and others. This list of information items was reviewed with representatives of the Arizona Department of Transportation and a final list agreed upon. This list defined the content of the audiovisual manual.

Audiovisual Medium

The most suitable format for an audiovisual manual would be video cassette recording (VCR). In comparison with competing media (videodisc, film, slide cassette) it enjoys the following advantages:

1. The ready availability of playback equipment in libraries, schools and homes

2. Low reproduction costs – about $10 for a one hour presentation

3. Proven durability; a video copy can be played a hundred or more times without serious degradation, and

4. Widespread public familiarity with operation of VCR equipment.

While videodisc is also suitable, it is more costly and much less readily available at the present time. The inability to exploit the videodisc's interactive capability renders it a cost ineffective way of meeting the need for an audiovisual manual.

A number of alternative approaches to information dissemination are available including the following:

Loan – Copies of the video cassette could be made available through MVD, local libraries, or other agencies with a returnable deposit equal to the reproduction cost of the cassette.

Rental – Copies could be made available to video stores for rental along with entertainment and other educational videos.

Individual showing – Libraries, schools, MVD stations, or other organizations could make both the video cassette and playback equipment available for on-premises use to individual applicants. This service is currently provided by many libraries.

Group showing – Where the demand justified it, presentations could be offered on a group basis either at regularly scheduled times or on a continuous basis. In a continuous presentation, applicants could start watching whenever they arrived and leave when they'd seen it in its entirety.

Development of Audiovisual Manual

The first step in developing an audiovisual manual was to prepare a script for the narrative. Once the script was finalized, the appropriate visuals were decided upon and the script annotated in the form of a shooting script.

Narrative

A narrative was prepared to present orally all of the information making up the agreed upon list of information items. Since the content of the audiovisual test came from the same basic source, the script included all of the information needed to pass the test. More than that, it employed largely the same language as is used in the test.

While the *content* of the audiovisual manual parallels that of the written manual, the language was not the same. Whereas much of the verbiage in the driver's manual was taken almost directly from the Arizona Motor Vehicle Code, the script employed the simplest possible language. Ordinarily, a group of licensed applicants distinguished by difficulty in handling verbal symbols is no one to be confronted with complex language, whether in written or spoken form.

The *structure* of the narrative also differed from that employed in the printed manual. The latter consisted of 40 independent sections, bearing no particular logical relation to one another. It followed the form of a catalogue, in which readers look up specific items of interest, rather than that of a text book which is read in a more or less fixed sequence. Obviously, the catalogue format is inappropriate to a video, which is of necessity viewed and listened to in one sequence. That sequence is shown in the Table 1.

TABLE 1
CONTENT OF THE AUDIOVISUAL DRIVER MANUAL

INTRODUCTION

THE DRIVER'S LICENSE

RULES OF THE ROAD
- Prohibited Parking
- Required Stops
- Passing
- Right of Way
- Signal Lights
- Traffic Signs
- Roadway Markings
- Parking

DRIVING EMERGENCIES
- Off-Road Recovery
- Skid Recovery
- Avoiding Collisions
- Head-On Collisions
- Car Emergencies
- Accident Procedures

SAFE DRIVING PRACTICES
- Speed
- Maintaining a Cushion of Space
- Lane Selection
- Communication
- Seeing

BEING IN SHAPE TO DRIVE
- Drinking and Driving
- Other Drugs and Driving
- Driving and Fatigue
- Driving and Emotions
- Safety Restraints

REVIEW QUESTIONS

The body of the audiovisual manual consists of four major sections, preceded by an introduction to the manual and information on obtaining a driver's license, and followed by review questions and a preview of the audiovisual test. The hierarchial organization presented a more logical pattern, and one that was presumably easier to follow, than the "laundry list" of topics making up the printed manual. The "Introduction", simply introduces the audiovisual manual and provides an overview of its contents.

The section on "The Driver's License" acquaints applicants with what requirements they must fulfill in order to obtain a driver's license and enables them to prepare before arriving at the station. "Rules of the Road" groups together those laws that are enacted to keep drivers out of one another's way while "Safe Driving Practices" deals with those practices that are needed in order to cope with the laws of nature. "Driving Emergencies" groups together procedures that are followed when breakdowns in rules and practices lead to emergencies. "Being in Shape to Drive" deals with those safety practices that do not occur behind the wheel, but influence safety on the road. A series of "Review Questions" are intended to help viewers assess how much they have learned and encourage repeated review. Finally, the demonstration of the "Audiovisual Test" is intended to help applicants better prepare for the audiovisual test and reduce the amount of in-station time required to complete it.

A final script was reviewed by the Arizona Department of Transportation, and, once necessary revisions were made, became the narrative for the audiovisual manual. An audio track was developed with the same professional narrators as prepared the final version of the audiovisual test. Male and female narrators dubbed the English soundtrack and a male narrated the Spanish soundtrack. Again, the lack of a professional female Spanish-speaking narrator is due to inability to find someone who was qualified, dialect, narrating skill, and quality of voice was on a par with the male narrator, at least within the time and money constraints placed on the project.

Visuals

The purpose of the visual component of the audiovisual manual was to help communicate to applicants the information contained in the narrative. The importance of the visual component was demonstrated in research mentioned earlier showing that the use of visuals facilitates the acquisition of driving-related information, most of which involves what people are supposed to do in response to what they see. The visuals were not simply to give applicants something to look at while they listened to the narrative.

For most of the information making up the audiovisual manual, the visuals followed very clearly from the information itself. Information about signs required showing the signs; information about various safe driving practices involved demonstrating the practices. On the whole, the same guidelines as that during the development of visuals for the audiovisual test were applied to the audiovisual manual.

For a number of scenes involving situations that would be difficult and costly to stage, available film and video footage were obtained from existing audiovisual presentations, without cost to the project. The organizations supplying materials included the American Automobile Association, the Insurance Institute for Highway Safety, and the Ford Motor Company. The majority of the footage – over 90% – was shot by project personnel using a Betacam in order to obtain the quality and resolution needed for relatively complex highway-traffic scenes. Much of the footage representing the driver's point-of-view was taken using the same procedures as described earlier in connection with the audiovisual test. All footage was edited to a 3/4" master from which the 1/2" VHS videocasettes were ultimately dubbed.

EVALUATION OF AUDIOVISUAL LICENSE SYSTEM

Following completion of the audiovisual manual, an evaluation was carried out with assistance from the Arizona Motor Vehicle Division. The purpose of the evaluation was to assess the feasibility of using an audiovisual manual and audiovisual test to help assure that illiterate drivers are sufficiently knowledgeable of safety rules and practices before being granted a license. Of particular interest was whether addition of the audiovisual manual would lead to a substantial increase in the proportion of applicants passing the audiovisual tests. This section will describe the methods used in the evaluation and the results obtained.

EVALUATION METHODS

Evaluation of the audiovisual manual and test was confined to one license station in Tucson, Arizona. During a five-month period, all applicants seeking an oral examination in the Tucson area were referred to that station and required to take the audiovisual test.

Audiovisual Tests

A few changes were made to the audiovisual test following its pilot evaluation; the most important being the reduction in the number of items from 34 to 29 items. It had been the desire of the Motor Vehicle Division to reduce the number of items in an operational audiovisual test to 25 items, the number to which the written test had been reduced to earlier. A shorter test is neither easier nor harder than the longer test; it is simply a less reliable measure of what the applicant knows. The Motor Vehicle Division agreed to permit a longer test during the evaluation so that all items could be studied. However, during the pilot phase, five items were identified as having problems in wording that made the questions somewhat difficult to comprehend. While they seemed clear enough during the many rounds of review, illiterate applicants found them troubling. One of the five items was used as a demonstration item in the audiovisual manual and during the introduction of the audiovisual test. The remainder were simply side-lined during the evaluation, to be revised at the end of the project, along with any other items found wanting during the evaluation itself.

Test Procedure

Upon request for an oral test, applicants were told about the audiovisual test and informed that they would have to watch the audiovisual manual before they would be allowed to take it. The high failure rate experienced with the audiovisual test during the initial pilot evaluation made it clear that taking the test without viewing the manual was a waste of time. Applicants were given the option of watching the audiovisual manual at the license station and taking the test immediately afterward, or, checking out a copy of the manual and watching it at home with the aide of a VCR (a $10 deposit was required). The majority watched it at the license station.

A test administrator introduced applicants to the equipment and got them started, and helped deal with any problems involving use of the equipment. However, the administrator did not attempt to clarify questions, or give any assistance that would aid in identifying the correct answer. During the evaluation, the administrative responsibility was assigned to one individual rather than being distributed to all the regular oral examiners; the practice used in the pilot test. First, the oral examiners were not highly receptive to the automated test and were certainly not good choices to represent the test to applicants. Second, investing the responsibility for test administration in one person led to more effective and efficient administration, as well as more conscientious and constructive monitoring of the testing process. Problems were more likely to be seen by the testing specialist as opportunities to improve the test, rather than shortcomings in the whole approach.

Applicants who failed the test the first time were invited to review the audiovisual manual, either in the station or at home, and to return for a retest. They were not permitted an immediate retest.

Sample

The sample employed in the evaluation consisted of all applicants for a drivers license in Tucson during the period March – July, 1990. The number of applicants processed during this period totaled 158, of which 115 were English speaking while 43 spoke only Spanish. As will be noted later, retesting of the same individual led to more test administrations than applicants – 218 administrations in all.

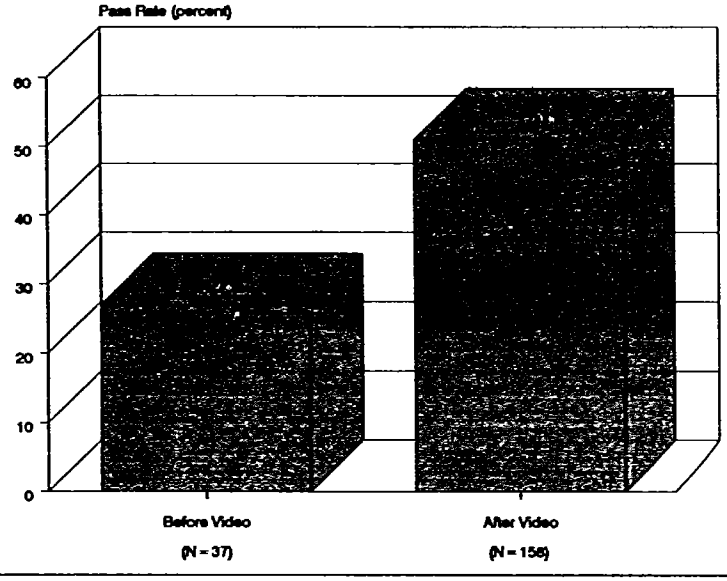
RESULTS

Results obtained in administering the audiovisual test to the sample of illiterate applicants were analyzed to assess overall applicant performance as well as to identify specific aspects of the test procedure causing difficulties and the types of applicants experiencing difficulties.

Total Pass Rate

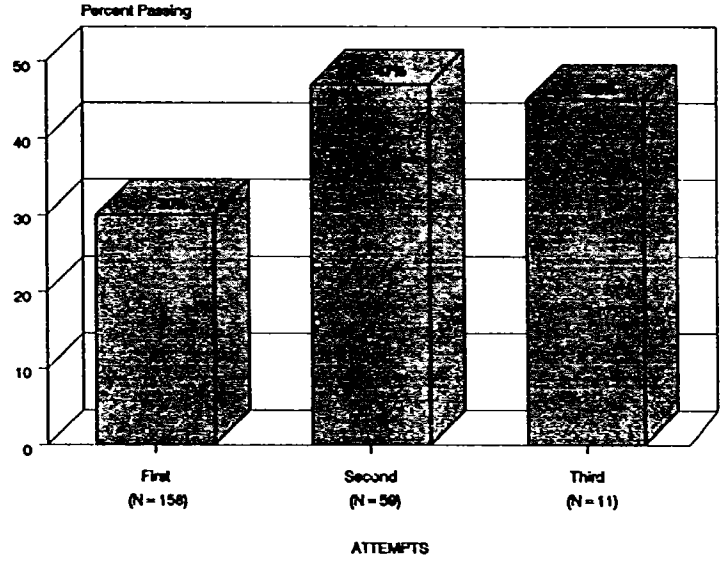
Of the 158 applicants taking the audiovisual test, 80 (50.6%) ultimately passed (three or fewer attempts). This is well below the approximately 80% pass rate obtained by literate applicants. As shown in Figure 1, this is a marked improvement over the pass rate prior to availability of the audiovisual manual. The difference is statistically significant (Chi-square = 6.72, P = .01). It should be pointed out, that at the pass rate, the first time around was only 30%, a result not greatly different from that found during initial pilot testing. However, those who failed during the pilot test had no resource available to enable them to pass on reexamination. Since all had subsequently been given the regular oral reexamination, there was no way of knowing how well they would have fared on the audiovisual test the second time.

FIGURE 1
Proportion of Applicants Passing the Audiovisual Test Prior to and Following Availability of the Audiovisual Manual



The breakdown of pass rates by number of attempts is shown in Figure 2. Of those failing the first time, 59 came back for a second try and 47% of them passed. Of those who did not pass on thier second try, 11 came back the third time and 45% of those passed. Between each attempt, they had been required to view the audiovisual manual at least once.

FIGURE 2
Pass Rate By Number of Attempts



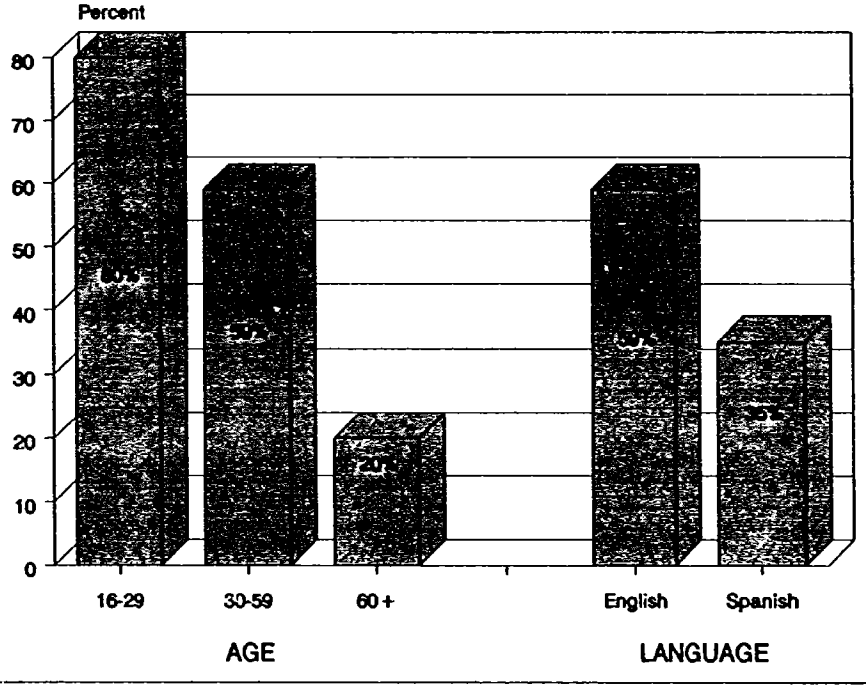
Had the applicants who dropped out along the way stuck with the audiovisual test, and had they experienced the same pass rates as those who came back to take the second or third time, an additional 33 applicants would have ultimately passed the test. This would have raised the percent of applicants ultimately passing from 51 to 72%.

Applicants who passed the test averaged 33 minutes per test, versus 39 minutes per test for those who failed. That these test administrations took longer than those occurring during the pilot test is probably due to the fact that they were a basis for issuance of a license (applicants during the pilot test could fail and still get a license).

Applicant Characteristics and Pass Rate

The overall pass rate conceals marked differences among applicants of different ages and applicants speaking different languages. Figure 3 provides a breakdown of pass rates by these two factors.

FIGURE 3
PASS RATES BY AGE AND LANGUAGE SPOKEN



Age Differences

The age differences are enormous, with 80% of those under age 30 passing the test as compared to only 20% of those age 60 and over. Since the 60-plus age group made up 30% of the total sample, the results cannot be viewed as a fluke (chi square = 25.81, P.01). That the elderly do poorly is no surprise; testing, stress, and new equipment are all associated with performance decrements among the elderly. An abundance of research shows deficiencies in almost every human function occurring in more and more drivers as age levels advance.

It would be a mistake to explain away the difficulties of older drivers by general factors unrelated to the specific content of the tests. It is quite possible that elderly applicants, lacking the mobility of their juniors, do not have as ready access to the information for which they are held responsible. It is also likely that the deficits for recent memory that characterize older drivers prevent them from retaining much of what they have learned. Therefore, the low scores of older drivers on the audiovisual tests probably represent true knowledge gaps as well as difficulties with the testing process. Making the testing process easier for older drivers would not necessarily help solve the problem.

Language Differences

Figure 3 shows clear and statistically significant differences in the pass rate of English- and Spanish-speaking applicants (chi square = 7.40; P.10). The language difference is particularly troubling in view of the relatively large number of illiterate applicants among the Spanish-speaking population, which made up 27% of the sample taking the audiovisual test and only 10% of the population taking the written test. Some small portion of the language difference can be explained by age. Spanish-speaking applicants were an average of three years older than their English-speaking counterparts.

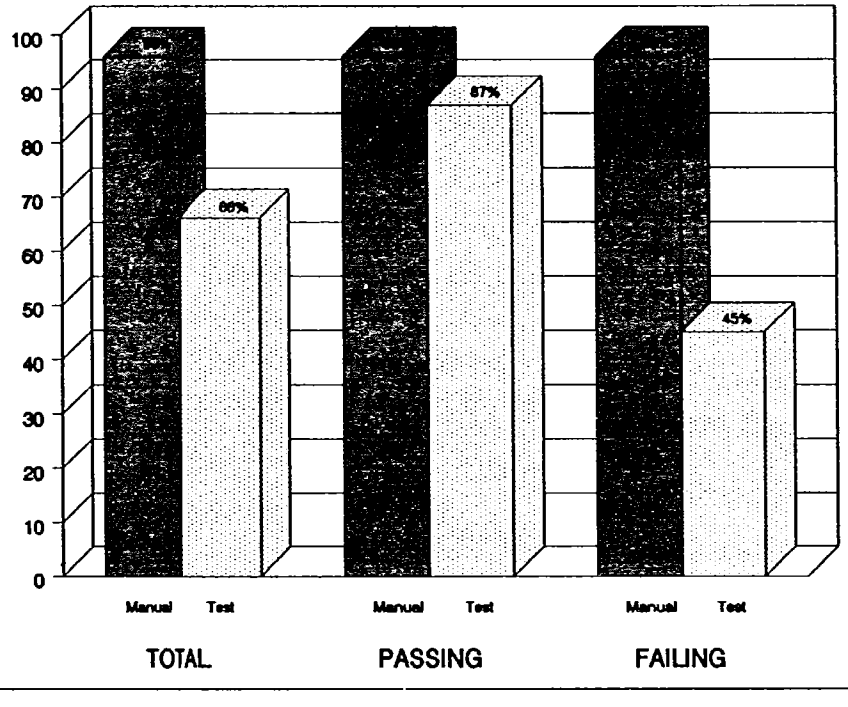
It must also be acknowledged that preparation of the final Spanish soundtrack for the audiovisual test was delayed by legal questions associated with passage of a referendum making English the official language of Arizona. The soundtrack employed during the evaluation not only lacked professional narration, but employed a number of phrases that were later changed by the linguist preparing the final script. (This problem did not arise with the audiovisual manual, which was developed in only one final version). However, neither the small age difference, nor the minor problems with the soundtrack can account for the large difference in pass rate.

Actually, the language difference found in the audiovisual exam parallels that of the written exam, where the pass rate for English- and Spanish-speaking applicants is 82% and 47% respectively. While use of the audiovisual manual and test did not overcome the language difficulty encountered by Spanish-speaking applicants, neither did it amplify the problem.

Applicant Reaction

Each time the test was administered, applicants were asked whether they liked or disliked the audiovisual manual and the audiovisual test. Those who retook the test were queried each time they took it. Figure 4 presents the results obtained across all 218 administrations of the test to the 158 applicants.

Figure 4
Proportion of Applicants Favoring Audiovisual Manual and Test



Almost everyone was favorably disposed to the manual, with favorable reactions obtained from 96% of both those passing and failing the test. The audiovisual test was, however, a different story. Among those who passed the test, 87% reacted favorably. However, among those failing it, less than half (45%) liked it. It is quite possible that the dissatisfaction of those failing is attributable in some measure of disappointment in not encountering a human examiner. Perhaps more impressive than the number of failures who didn't like the audiovisual test is the number who did like it. Fortunately, a significant number of those failing the test retook it and ultimately passed.

From a public relations viewpoint, the audiovisual manual is definitely a "hit." Indeed, high schools in the Tucson area obtained copies of the audiovisual manual for use in local driver education classes. A video intended for a literate audience would be made more useful with the addition of captions and other textual material. However, neither driver education teachers nor other literate viewers of the audiovisual manual have complained about the lack of the written word.

Of the 78 applicants who failed to pass the audiovisual test, 30 ultimately obtained licenses, either by taking the regular written test, or by going outside of the area to obtain an examiner-administered oral test. Unfortunately, license files do not record the form in which a license exam was given. However, it is likely many read well enough to take a written test. Over the eight months after the audiovisual test was introduced, the monthly average of requests for an oral examination was about 40% below the monthly average for the 14 preceding months. This change strongly suggests that a sizeable proportion of applicants requesting an oral examination are able to read well enough to take and pass a written examination.

Individual Items

The individual items making up the audiovisual test were examined to see if any needed improvement. For each item, the mean total score obtained by applicants selecting each of the alternative responses was calculated. One point was subtracted from the mean for the correct answer to remove the effect of that item from the mean total score. It was then possible to see how applicants selecting a given alternative answer fared upon the rest of the test.

One would expect those applicants who selected the correct answer to a particular item would be the ones who scored highest on the rest of the items. Where they didn't, that is, where some foil (incorrect answer) registered the highest mean test score, there may have been something about the wording of the item that led the most knowledgeable applicants away from the correct answer. There was no certainty of it; an item isn't necessarily bad just because the most knowledgeable applicants get it wrong. In practice, however, close examination usually reveals something to be confusing or misleading in the wording of the item.

On four items making up the audiovisual test, the correct answer was not selected by the most knowledgeable applicants. For one item, the correct answer was "All of the above." This is unacceptable for any item since it means that all of the alternatives are correct. The best scoring applicants tended to pick the first alternative without reading further. Another "bad" item dealt with locations at which school buses were required to stop. While the only correct answer was supposed to be railroad crossings, one of the foils was "school zones," also correct. The two remaining items, dealing with Right of Way at intersections and left-turns onto a one-way street, were not misleading but simply too confusing to be easily understood.

In all four cases, over half of the applicants selected the wrong answers. Improvement of these items should have, therefore, increased the pass rate somewhat. These were not the only items failed by more than half of the applicants. However, in the other cases the highest scoring applicants did select the correct answer and the low pass rate was attributed simply to the failure of many applicants to pay sufficient attention to the corresponding section of the audiovisual manual.

Following the evaluation, items were revised to correct the problems described. At the same time, four additional items were also revised in order to correct inconsistencies in the visuals that had been obvious at the outset.

Internal Consistency

The split half reliability of the audiovisual test, as administered to the 158 illiterate applicants was .78, with the Spearman-Brown correction. This means we would expect scores on this test to correlate very highly with another test of equal length of similar constitution. Cronbach's Alpha was .60 for the first half and .61 for the second half, meaning that internal consistency was the same for both halves; collectively. These statistics mean that the audiovisual test affords about as reliable measurement of applicant knowledge as does its written counterparts.

Test Administration

Once administrative procedures had become routine, administration of the audiovisual licensing process went off without great difficulty. Applicants were capable of watching the video by themselves and completing the audiovisual test largely without help. The only truly disruptive problems were those resulting from occasional equipment malfunctions. These appear to have been the result of failure to provide sufficient ventilation to the computer when enclosing it in a wooden cabinet. While installing blowers prevented any further overheating, some permanent damage appears to have occurred and resulted in brief, transient, but annoying difficulties in equipment operation.

DISCUSSION

SUMMARY OF EVALUATION RESULTS

The audiovisual manual and test, in combination, appear capable of improving both the effectiveness and the efficiency of driver licensing in assuring that illiterate drivers are knowledgeable as to safe driving rules and practices before being issued a license. Over half of the applicants requesting oral examinations were able to pass the knowledge test by means of the audiovisual manual and the test. An additional 19% passed the knowledge test in some other way, most probably by taking the written examination. The per-applicant examiner time was but a fraction of that necessitated by an oral test. Moreover, the fact that requests for oral examinations dropped by 40% means further savings in examiner time. The audiovisual manual won almost universal acceptance from all quarters; the audiovisual test was accepted by almost all of those passing it, and close to half of those failing it.

Approximately 50% of literate applicants ultimately passing the audiovisual examination is far below the estimated 95% pass rate reported by oral examiners. The question is which figure better represents the proportion of illiterate applicants who are truly qualified to receive licenses. Several considerations suggest that it is not the 95% figure. First, the finding that applicants who cannot read the driver license manual have had a higher pass rate than those who can read it, (78% pass rate for applicants taking the written test) is grounds for suspicion. The suspicion is amplified by the fact that administration of oral examinations in California under controlled conditions yielded a pass rate of only 45%. Finally, the observations of license administrators monitoring the oral testing process support the belief that oral examinees receive help that is not available to those taking the written test.

Some oral examiners defend coaching on the grounds that it doesn't matter how applicants learn the answers to questions on the test as long as they learn them. The fallacy in this reasoning is, of courses, that the questions on the test are but a small sample of what applicants are supposed to know. Passing 80% of the items on the test is supposed to mean knowing 80% of all the questions that could be asked. Coaching applicants through the test does not provide them with the rest of the information they are expected to possess. Extending the same coaching service to literate applicants would certainly raise scores and at the same time discourage reading the manual.

It seems very likely that, in addition to reducing the total examiner time involved in testing illiterates, use of the audiovisual manual and test should also reduce the number of unqualified applicants who are issued licenses.

RECOMMENDED IMPROVEMENTS

Though the results of the evaluation are certainly favorable, they also reveal ways in which audiovisual licensing manual and test could be improved. Routes to improvement include (1) encouraging greater use of the audiovisual manual, (2) reducing testing time, and (3) use of computer-generated stimuli.

Greater Use of Audiovisual Manual

While slightly over half of the applicants ultimately pass the audiovisual test, only 30% did the first time they took it. The first-time pass rate is not appreciably better than that achieved in the absence of the audiovisual manual. Considering that all applicants were required to review the manual before taking the test, the low initial pass rate does not speak well for the manual. Yet, how many licensed applicants would pass the written manual with but a single read-through? The typical pattern of preparation involves several stages of review in order to commit to memory that which was not well-known in advance.

The initial failure rate might be greatly reduced by affording applicants an opportunity to view the audiovisual manual several times before ever appearing at the license station. This might be accomplished by administering all oral examinations—automated or examiner-given—by appointment only. The advance contact would provide an opportunity to explain to applicants the low probability of their passing without extensive preparation and to encourage them to check out copies of the audiovisual manual for home viewing. Applicants would then have an opportunity to play the video several times and to review those sections they find difficult to commit to memory.

Reducing Test Administration Time

The most direct way of reducing the time needed to take the test is simply to cut back on the number of test items. Had the audiovisual test been limited to the 25 items that make up the current written examination, total testing time would have been reduced from an average of 37.5 minutes to slightly over 32 minutes.

Stopping Those Who Have Failed

An additional means of shortening the test would be to terminate it whenever an applicant has already passed enough items to pass the whole test, or has failed enough items to fail the test. Terminating the test for those who failed would save the most time since many of the applicants had actually failed after taking less than half the test. On a 25-item test, anyone who has answered six questions incorrectly has already failed. Among those who ultimately failed the test, this happened after an average of 16.5 items. Terminating the test at this point would have reduced the mean testing time for those who failed from an average of 39.0 minutes to an average of 22.3 minutes.

Perhaps an even more important reason for terminating the test when an applicant fails is its effect upon validity of a retest. Because of the feedback provision, applicants completing the entire test are given answers to each question on the test itself. As previously noted, readministration of the same test no longer gives a valid measure of the extent to which applicants possess all of the information they are supposed to posses. This is one of the reasons why alternate forms are provided for written tests. While the costs of producing a video test will probably prevent preparation of an alternate form in the near future, limiting the number of items to which failing applicants are exposed will allow the remaining items on the test to comprise an alternate form. With 33 items available on the videodisc (the original 34 minus one practice question), terminating the test after an average of 16 items would leave 17 items that the average applicant has not seen. This would greatly reduce repetition of items on retest. Entering the applicant's name or social security number into the computer at the time of first administration would allow any retest to begin with the first item following the last one taken on the original test.

There being no value gained from requiring applicants to continue taking a test that they've already failed, the most appropriate course would seem to be terminating the test when an applicant fails the sixth item. Those who fail need not know that the test is being abbreviated. They would simply be told that the test was over and asked to summon the examiner, who would inform them that they had failed. Anyone who asked to see all the questions could be told that they will have an opportunity to do so when they come back for retesting and that, in the mean time, they can see all the questions and answers by viewing the audiovisual manual.

Stopping Those Who Have Passed

Some small additional saving and overall test time would be realized by stopping those who passed the test at the point that a *passing* score is assured, that is, when they have answered the 20 out of 25 items correct. Obviously, the potential reduction in the test of time to be gained from those who passed is quite limited. The most that can be deleted is five items, and typically it would amount to no more than one or two items. Yet, there is no point in continuing to give the test after the applicant has already passed. Moreover, if the audiovisual manual were successful in leading to higher and higher pass rates, the savings as aggregated across all applicants who pass could be significant.

Stopping Those Who Will Pass

The greatest time savings could be gained from those passing the test if the test were terminated as soon as the odds became great enough that they would pass, much as the returns declare a winner before all of the votes are tallied. For example, the chances of an applicant answering the first 19 questions correctly and still failing the test (i.e., answering the last six incorrectly) are about as great as their being struck by lighting in the license station. Indeed, the odds of someone failing after answering the first 15 items correctly, though somewhat greater, are still small. The continued administration of the audiovisual tests to many hundreds of applicants will provide statistics that will allow the odds of passing the entire test to be estimated for various patterns of correct and incorrect answers. When the odds of passing exceeded 99%, the test would stop. While one could never be absolutely certain they would

pass the entire test, 99% certainty is probably acceptable (after all, among those who take the entire test and pass it there is probably less than 99% certainty that they would pass it the next time around.)

Tests could be terminated for those predicted to fail as well as those predicted to pass. However, if for no other reason than public relations, it would be undesirable to fail applicants until they have actually failed more than 20% of the items.

Adaptive Testing

The number of test items needed to reach a 99% of passing might be even further reduced if the *sequence* in which items are given beyond any point could be adapted to the pattern of answers given up to that point. For example, those who answer the first few items correctly might be given the most difficult items next (assuming that passing the most difficult items yields greater odds of passing the whole test than does passing the easier items). It is likely that this "adaptive" test sequence would permit applicants to be passed with 99% certainty with the fewest number of items.

Computer Generated Stimuli

Videodisc technology is far better suited to the audiovisual test with its scenes from the highway traffic environment and its extensive soundtrack than would stimuli generated entirely from a computer. However, a combination of the two might be more advantageous than either alone.

Overlay cards, would allow computer-generated graphics to be superimposed upon the videodisc output, and audio information to be added to that coming from the sound track. Their use with the audiovisual test offers several potential benefits. One is in handling *recurring information*, which now must either be positioned at several points along the disk, using up disk space, or cycled back to each time it is used, disrupting the continuity of the test. An obvious example would be the feedback that an item has been passed or failed, which currently involves accessing an audio message at one place on the disc. The use of overlays would not only speed up access to the audio message but would allow addition of a visual component distinguishing between an item answered correctly (e.g., smiley-face) and one answered incorrectly (e.g., frowny-face).

Another use of overlays would be to add material on an *experimental basis* without having to remaster the disk. For example, one licensing official has suggested adding a number to each alternative answer frame, as in a written multiple-choice test, to help applicants identify each response. The fact that they are illiterate does not mean that they are unable to identify numbers. This could be tried out experimentally, and if successful, either kept as a computer-generated image or added to the videodisc at the next opportunity.

Finally, computer-generated video stimuli provide a means for *localizing* sections of the test. Economy forbids pressing a separate disk for each licensed station within a State. However, purely local information, such as how to summon an examiner, could be provided in written and oral form on the overlays at individual license stations quite simply.

The addition of computer-generated stimuli does not come without cost. Audio and video overlays add approximately 10% to the cost of the audiovisual license test system. However, it greatly adds to both the capability and the flexibility of the automated system. It is worth noting that overlays would allow the audiovisuals and test equipment to be used for an automated written exam or for the psychophysical test battery currently being studied by the Arizona Motor Vehicle Department:

CONCLUSIONS

Based upon the study described in this report, the following conclusions can be reached as to an audiovisual licensing system:

1. An audiovisual license test employing video disk technology is capable of assessing knowledge among illiterate license applicants without requiring significant involvement on the part of license examiners. Because of its greater objectivity, an audiovisual test should reduce the likelihood of unqualified drivers being licensed.

2. Continued use of an audiovisual test will discourage requests for oral exams by fully literate applicants.

3. An audiovisual license manual is a valuable aid in helping illiterate applicants to acquire the information needed to pass the license test and to operate vehicles safely.

4. The initial and final pass rate for illiterate applicants would be greatly improved by encouraging and passing repeated viewing of the audiovisual manual prior to testing.

5. Testing time would be reduced and knowledge levels increased by terminating the audiovisual test at the moment the maximum number of incorrect answers has been exceeded.

6. Modifications of the audiovisual test might improve its effectiveness in economy would include adaptive test sequences, and integration of computer-generated of audio and video information.

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