"New, Improved, Comprehensive, and Automated Driver's License Test and Vision Screening System"
by Sandy H. Straus, ESRA Consulting Corporation.
http://www.esracorp.com
Published May 2005, Arizona Department of Transportation

RECOMMENDATIONS

Vision Screening System

The literature, surveys, and data analyses confirm the need for a comprehensive and automated system of vision screening. According to Ball (2003), full and comprehensive computerized and automated vision testing systems at driver's license bureaus may significantly reduce dishonorable test-taking practices (through memorization), personnel time, and transcription errors, among other limitations. Based on our review, we suggest that Arizona take the following steps:

- We recommend the following such tests, as part of the ESRA DVAT™ system:

Product Name	Useful Features
B1Max™ VACS test for vision function	• Fully automated and fast. • high- and low- contrast visual acuity screen. • ready for implementation. • widespread usage.
Systems Technology, Inc. Driving Simulators STISIM Drive™ Model E-01 (1-screen model with cab) STISIM Drive™ Model E-02 (1-screen desktop model) STISIM Drive™ Model E-03 (3-screen model with cab) STISIM Drive™ Model E-04 (3-screen desktop model) test for vision status	• pilot study test for eye status and/ or strategy through ambient light and weather conditions and to screen novice drivers, older drivers, and at-risk drivers.
Modified 3-D Amsler Grid Test test for vision condition	• pilot study test for possible visual diseases, injuries, and tumors that may impair driving abilities.

In addition to some refinements needed prior to emplacement for a pilot study, it is necessary to also ensure that the ESRA DVAT™ products provide instant scoring, short and effective on-site testing, and computer automation score reports linked by network to the driver's license bureau. These changes are needed in order to ensure a smooth

transition for the driver's license bureau officials and to reduce the amount of paperwork and costs that may be associated with this unusual pilot study. Long queues account for many complaints at driver's license offices (Man, 2005). The testing should be done as effectively and as swiftly as possible, without compromising thoroughness. This will reduce the issue of simulator sickness and aftereffects that some perceive as an impediment to driving simulators.

However, the issue of aftereffects, especially of the flashback effect, is of concern. The flashback effect, when flash images or flashbacks appear, following driving simulator usage, need to be explored due to safety concerns, among others, of drivers prior to implementation in any driver's license bureau, transportation agency, or medical facility setting. These flashback effects may be delayed and occur while driving. No independent testings of the ESRA DVAT ™ System and ESRA DAT™, such as the products we identify were conducted to study for safety concerns. To the best of our knowledge, no driving simulators exist in any driver's license bureaus we reviewed. These systems developed by ESRA are new and revolutionary. The potential benefits may be great if carefully instituted. We therefore highlight the following:

- A driving simulator, particularly one equipped with tests of ambient light and / or weather conditions, may also assist in identification and evaluation of possible dementia drivers and drivers with varying forms of AD who, typically, would not be detected using conventional vision testing methods. Such screening methods are imperative when the number of dementia cases is expected to increase 400% over he next twenty years (Whitmer *et al.,* 2005).
- Driving simulators may either be used as a supplementary vision screening device or an educational tool to expose novice drivers to weather conditions for which they lack experience and put themselves at risk.
- ADOT may select from the 1-screen cab, 3-screen cab, 1-screen desktop, and/ or 3-screen desktop models of simulators depending on cost, space considerations, and risk. (As discussed, the 3-screen models require additional expense and space. Although they may also account for a greater susceptibility to simulator sickness and possible aftereffects, they also provide a more realistic view of driving.)
- According to our RAIR analyses, both Arizona and Florida, drivers age 16 to 19 years, ages 80 to 89 years, and age 90 years and older are most likely at fault in angle, backing, head-on, left-turn, rear-end, and sideswipe manners of collision, in clear weather, cloudy weather, rain, fog, daylight, dawn or dusk, and darkness conditions, and due to restrictions based on visual defects. These trends tend to follow bathtub-shaped curves. On average, we find that the older age groups (ages 80 years and older) are about twice as likely as the teenage drivers to be at-fault in these collisions.
- Our RAIR results support the findings of Stamatiadis and Deacon (1995): Older drivers are more unsafe than younger drivers who, in turn, are more unsafe than middle-aged drivers.

Cognition Test

We recommend the Useful Field of View (UFOV®), a cognitive test of visual attention performed and scored on a computer. As a fully automated test, it has the potential to assist licensing authorities in the recertification process of impaired drivers. It may be used as a pre-recovery assessment of patients with head injuries to predict their driving ability. The UFOV is shown to adequately predict driving performance on the low fidelity simulation task. The UFOV is widely distributed through the AAA Roadwise Review™, where it provides a rapid and effective measure of visual information processing speed in approximately five minutes. According to Staplin (2005), the UFOV also classifies performance according to the level of functional deficit, if any, and identifies examinees whose performance is associated with a significant increase in collision risk. Following thousands of test administrations, the UFOV reliably identifies mild and serious deficits in visual attention and visual information processing speed. Therefore, the UFOV may also serve as a useful method of identifying at-risk drivers that may not be easily screened through other techniques, especially in the absence of driving simulators.

- We recommend the following such test as part of the ESRA DAT™ system:

Product Name	Useful Features
Useful Field of View (UFOV®)	• Fully automated and fast. • Measures visual information processing speed and visual attention. • Ready for implementation. • Demonstrated usage in MVD settings. • Widely distributed through AAA Roadwise Review™ as part of DRIVING HEALTH INVENTORY ®.

Knowledge Test

The knowledge test is commonly referred to as the written test. While it is now automated in many states, the knowledge test varies according to state and classifications of drivers' licenses. It often tests the examinee's understanding of accident prevention, pavement marking identification, safety rules, signal identification, traffic laws, traffic signage identification, and vehicle equipment.

Automated knowledge tests may allow for local and remote accessibility, multilingual features, adequate storage and record capabilities, biometrics, accommodation of

individuals with various impairments, and significant reductions in dishonorable test-taking practices, among other benefits.

Ideally, these types of tests and/ or their components should be developed and based on research and published studies. For example, the ReFb-06 ™ exists as a stand-alone and fully automated sign road sign knowledge test. It is based on research sponsored by federal and state DOTs. According to Staplin (2005), this research includes identification of the most frequent and serious collision types, the problem driving behaviors associated with these collisions, and the extent to which these driving errors could reasonably be linked to a specific knowledge deficiency. The ReFb-06 ™ is a significant improvement over traditional road sign knowledge tests that most states utilize to test examinees according to the literal meaning of signs. Questions on the ReFb-06 ™ address the driving behavior that should or must be performed to safely respond to the road or traffic conditions that would lead a highway authority to install the sign in the first place.

Driving Test

The driving test allows examinees to actually drive a motor vehicle in order to demonstrate the ability to safely operate a motor vehicle. Driving tests vary for different classifications of drivers' licenses. Since these types of tests may also differ between states, it may be necessary to eventually federalize such procedures if a federal driver's license is adopted.

Any standardization of driving tests may incorporate elements of simulation to test the different terrain, pavement conditions, weather conditions, and sinage that drivers may encounter during intrastate and interstate travel.

While there are many good driving simulators in use and numerous simulation projects underway, we are now unable to identify any automated driving tests that can replace the actual driving tests. Safety, simulator sickness, and aftereffects associated with driving simulators require further research to explore this possibility as gas prices increase and driver's license bureaus are burdened with staffing matters and motor vehicle maintenance costs.

Long queues at driver's license bureaus are also an issue. Also, some driver's license bureau officials express concerns about their safety and the safety of the examinee when conducting on-road driving tests.

In the future, automated driving simulators, as illustrated in Figure 8, may therefore provide cost-effective, quick, and "environmentally friendly" methods of conducting and/ or supplementing traditional on-road driver's license tests, with little or no staff intervention, once all important safety concerns are adequately researched and addressed.

Driver's License Renewal

The existing vision testing methodology at the Arizona Motor Vehicle Division should be augmented to include driver's license renewal policy modifications and Internet-based technology to allow for testing at remote and expanded locations.

The Wearout Period of a bathtub curve, a period of increased decline, tends to initiate within the Arizona and Florida driver cohorts ages 50 to 59 years. The RAIR results, in conjunction with other preceding visual impairment studies conducted on various populations, suggest that driver's license renewal policies also need to be modified in order to screen drivers as soon as they reach the age of 50 years. Compulsory vision testing in increments of two-year renewal periods between ages 50 to 59 years and annual vision testing for drivers age 70 years and older are now needed. Since novice drivers from ages 15 to 19 years are also susceptible to at-fault automobile collisions, they, too, require frequent vision testing, perhaps in two-year intervals. A driving simulator equipped with ambient light and weather conditions to assess the vision status of drivers, as illustrated in the ESRA DVAT™, may prove beneficial to novice drivers since many collisions among younger drivers occur in poor weather when visibility decreases and driving risk increases. These drivers tend to lack the driver vision experience that older and more seasoned drivers seem to develop.

We also suggest the following provisions for the pilot test:

- The implementation phase should proceed for a period of five years to maximize cost-effectiveness of the ESRA DVAT™.
- A pilot test study should commence for a period of at least two years in order to maximize the number of licensees.
- Results should be compared to risk analyses, RAIR values, and rates of collisions, injuries, and fatalities as illustrated in this study.
- To facilitate future studies, it is necessary to suggest a national and international database where various forms of collision data can easily and readily be accessed for analysis and review for all government agencies and industries. These would encourage further studies and contribute to areas where there is now very little.
- The development of a new and comprehensive vision standard is now needed since the Snellen visual acuity standard is inadequate. This may be accomplished with the assistance of a panelist or representative of the International Council of Ophthalmology.
- We suggest the driver's license bureau decide on a maximum time allocation per test, a management and database setup for each test, and a comprehensive method of scoring and assessment to accurately screen at-risk drivers.
- A pilot test will be necessary to validate the results of our system. Driver collision, injury, and fatality data will need to be monitored. Validation of results will not only demonstrate possible effects on safety, but also gauge the effectiveness of our innovative system as an alternative to current driver's license testing methods within the State of Arizona and elsewhere.

Baggett (2003) recommended the use of on-road tests tailored to the needs of older drivers, at-risk drivers, or drivers of any age, especially at the time of driver's license renewal. However, these on-road tests may involve additional motor vehicle purchases, maintenance and fuel costs, and extra staffing issues. Nevertheless, driving simulator products, such as those available through Systems Technology, Inc., with a history of independent studies on older drivers, novice drivers, and at-risk drivers, may suit the dual purpose of vision status assessment through the driver's responses to environmental and lighting conditions, as well as, per Baggett's recommendation, motor vehicle navigation and movement. This may prove to be a cost-effective strategy that can be used as parts of the vision and driving test methodologies once all safety concerns are addressed. However, the subject of driving simulator safety issues, as these relate to tests, such as the on-road test, is beyond the scope of this study. We, nevertheless, call for research and safety testing into these areas, among others, prior to installation and implementation in any agency.

Additional Recommendations

Vision testing research, policies, practices, and systems are in dire need of improvement in the State of Arizona and elsewhere. We therefore recommend the following:

- The formation of a task force, led by both the Arizona Motor Vehicle Division and other ADOT officials to include representatives of various agencies: American Association for Retired Persons (AARP), AAMVA, American Automobile Association (AAA), Arizona Department of Economic Security Aging and Adult Administration, Alzheimer's Association (Desert Southwest Chapter), Arizona Department of Health Services, Arizona Governor's Advisory Council on Aging, Parkinson's Association, NHTSA, United States Administration on Aging, the American Medical Association, and a member of a major Ophthalomologic Organization (e.g., International Council of Ophthalmology).
- A possible partnering with the Florida At-Risk Driving Council, a group formed in response to recent modifications in Florida driver's license policy procedures, may also prove useful, especially through video-conferencing capabilities. The results and findings of our study may also support initiatives of the Florida At-Risk Driver Council, especially as these relate to possible vision pilot tests, policies, and procedures.
- A possible partnering with the Florida At-Risk Driving Council may also assist ADOT in the development of further studies to explore and implement alternative forms of transportation to accommodate at-risk and older drivers who are unable to drive.
- Due to differences in categorization of data between states, a uniform system, such as the State Data System underway at NHTSA, for comprehensively reporting collision data as well as an open database for retrieving this data, is now recommended. Ultimately, it may prove beneficial to link this data with other countries to improve collision analyses.

- We recommend new and uniform federal visual standards and vision tests in all U.S. states. This way, a completely automated system can be used to identify all drivers, irrespective of their residency. This would simplify the licensure process and ultimately reduce a lot of paperwork and bureaucracy. Federal visual standards would also eliminate the number of drivers who may not visually qualify for a driver's license in one state from obtaining a license in another state. Federal visual standards support similar recommendations as these relate to driver's licenses and other documents introduced through The 9/11 Commission Report (2004) (by The 9/11 Commission Report Implementation Act of 2004, S.2774) and The Intelligence Reform Bill. Arizona Senator John McCain and his cosponsors introduced this bill in the United States Senate on September 16, 2004. The Intelligence Reform Bill, signed into law by President Bush, December 17, 2004, requires federal agencies to implement uniform driver's license issuance standards for the U.S. States. H.R. 418 (February 8, 2005) allows for the bill "…. to establish and rapidly implement regulations for State driver's license and identification document security standards…"
- The Congress should ensure privacy and protection of personal data associated with federal driver's licenses. This may be accomplished through sufficient backup copies, encryption, and automation techniques, among other methodologies.
- The ESRA DAT™, ESRA DVAT™, ESRA VAPT™, and vision testing standards may also aid in the implementation of the new national identity card scheme underway in the UK, and, ultimately, may promote compatible standards across the European Union, Australia, and New Zealand. The incorporation of biometrics, such as facial recognition, fingerprints, or iris scans as planned in the UK card scheme (United Kingdom Home Office, November 2003) may actually facilitate the use of web-based automated vision testing at private homes and in other public locations other than a driver's license bureau office or other transportation facility where licenses are issued. Other countries as well as the United States should explore these types of vision testing opportunities.
- We recommend the automation of data and information between other transportation agencies. These measures may ultimately result in significant cost-savings, especially through the avoidance of repeatability of certain vision and cognition tests. Such assessments allow for extensive transportation applications.
- The ESRA VAPT™ , ESRA DVAT™, and ESRA DAT™, can be optimized to incorporate other features, such as biometrics. However, these tests need to be solicited separately rather than as part of the automated vision test process to ensure compatibility with our ESRA patents-pending systems and methodologies.
- The ESRA VAPT™, ESRA DVAT™, and ESRA DAT™, can also be optimized to incorporate multilingual capabilities.
- Networking capabilities are essential for any products incorporated in the ESRA DAVT™, ESRA VAPT™, and ESRA DAT™, to ensure automation and ease for agencies.
- Automation and networking of personal information between driver's license bureaus, as recommended, will promote the use of encryption and reduce the possibility of identity theft, such the recent robbery of private data of 8,737

people at the Department of Motor Vehicles office in Las Vegas, Nevada (MSNBC, 2005). The stolen data included Social Security numbers, signatures and pictures of residents, in addition to blank licenses and license-making equipment.

- This study also demonstrates support for more stringent federal standards for vision testing for commercial driver's licenses. The potential for disaster is particularly greatest among drivers of hazardous materials cargoes. There are more than 800,000 of these shipments on our nation's roads each day.
- The Federal Motor Carrier Safety Improvement Act now requires a new written federal test on rider management, railroad crossing safety, and emergency evacuations for school bus drivers. By Oct. 1, 2005, all school bus drivers must have a new "S" endorsement, for school children transportation, on their commercial driver's license (CDL). Yet, there are no comprehensive vision testing requirements in place. This issue needs to be addressed for safety purposes.
- We therefore also recommend a pilot program to address the screening mechanisms of dementia drivers. It is possible that the ESRA DVAT™ we identify may assist in screening many different kinds of at-risk drivers, including dementia drivers. It may also allow for screening in other areas of transportation, including but not limited to aviation, rail, maritime, agriculture, and commercial driver's license applications.
- It would also be very useful if the State of Arizona conducted a comprehensive study on estimating the number of residents affected with dementia and, in particular, Alzheimer's disease. An estimation of this population would assist the Motor Vehicle Division in gauging the need for certain driver's license screening methods, tests, and policies. Other agencies would also benefit from this information through research and support services.
- The common denominator is safety. The need for a new comprehensive and automated visual system in the State of Arizona is fundamental to reducing the high collision, injury, and fatality rates. This system should include the B1Max™ VACS and both the modified 3-D Amsler Grid Test and the driving simulator. In the unlikely event that there are technical, financial, or managerial problems hosting the simulator, then the State of Arizona should reconcile usage through the B1Max™ to quickly and easily provide automated visual acuity testing. Ultimately, the State of Arizona should also consider the modified 3DAGT product since, this not only has the potential to screen many at-risk drivers for visual impairments, but also for numerous diseases and conditions that traditional vision tests in driver's license bureau settings fail to detect.
- "Florida License On Wheels (FLOW) mobiles", mobile driver's license bureaus, are also a great concept to alleviate the long queues and heavy traffic at some driver's license bureaus. While these are generally used for administrative tasks, such as identification card issuance and license renewals (FHSMV, 2004; Man, 2005), they may prove to be especially effective in providing driver's license tests in remote areas, particularly those with limited Internet access and/ or staff shortages.

- In the event that the State of Arizona can neither fund nor support the addition of ESRA DVAT™, in whole or in part, in their driver assessment Motor Vehicle Division curricula, then these instruments, once successfully and adequately tested for safety concerns, as discussed, including the flashback effect in driving simulators, should be included in hospitals and/ or other medical settings where physicians and/ or other licensed medical professionals can adequately assess driver's license applicants. The ESRA DVAT™ and ESRA VAPT™, in whole or in part, may prove particularly useful, as this study demonstrates, in the assessment of at-risk drivers and others with vision diseases, vision injuries, and neurological disorders, including but not limited to dementia, Alzheimer's disease, and Parkinson's disease.
- Several nationwide committees exist that address simulator sickness and aftereffects. As long as ADOT incorporates the driving simulator component of the ESRA VDAT™ into its driver's license testing program, then they should follow authoritative guidelines or team up with such committees to ensure safety and comfort of examinees.
  ADOT may consider participating in the Simulator Users Group (SUG) whose members include first-rate international scholars with expertise in driving simulator usage and research. The Simulator Users Group (SUG) address topics as diverse as simulator validation, simulator standards, and Simulator Adaptation Syndrome. For example, they recommend pre- and post-driving simulator session questionnaires, which may be extremely valuable during a pilot test program involving driving simulators. The SUG intends to share detection, measurement, and mitigation Simulator Adaptation Syndrome techniques (University of Iowa, 2005).
- The ESRA VAPT™ and ESRA DVAT™, can, at the discretion of the agency, incorporate other features, such as a written test, knowledge test, and/ or cognition skills test. These tests should also be automated and linked by a network. Discussions and illustrations of these ESRA designs are beyond the scope of this paper.
- Although driving simulator usage poses a safety concern, it is suggested that transportation agencies and medical facilities have examinees sign waivers, indemnification, and release of liability waivers and not drive, fly, and/ or perform roof repair, and/ or operate any machinery until at least 72 hours have elapsed following a simulator test session to reduce the possibility of potential liability for any possible aftereffects, flashbacks, and/ or simulator sicknesses that some subjects may experience.
- It is important to urge these agencies to implement driving simulators, such as the STISIM models we identify, with long histories of success, implementation, safety testing, and usage as these relate to both novice *and* older drivers. These should be documented through numerous independent and peer-reviewed publications over the last ten years in several different subject areas.
- We strongly recommend that transportation agencies and medical facilities have examinees sign waivers, indemnification, and release of liability waivers and not drive, fly, and/ or perform roof repair, and/ or operate any machinery following all other automated forms of testing. Since these may not incorporate simulation,

and the effects, if any, may be very short, a team of independent physicians and scientists should determine the appropriate amount of time to refrain from such activities.

- Transportation may need to be arranged for driving simulator and/ or other automated testing testees due to possible simulator sickness and aftereffects.
- During the pilot test, the Simulator Sickness Questionnaire (SSQ), as developed by Kennedy *et al.* should be administered to testees to gauge the incidence and impacts of possible simulator sickness and aftereffects.
- Future studies need to consider the implications of vision testing on racial groups, in particular, Asians, and Native Americans. Most scientific studies reviewed in this study focused primarily on Caucasians, African-Americans, and Hispanics. In the United States, there now exists a burgeoning population of Asians that may constitute the fastest-growing major population over the next 50 years. By 2010, this population may increase to 14 million and by 2050, this population may top 33 million (Associated Press, 2004). Many of these Asians may comprise a significant population of large U.S. cities, including Phoenix. Native Americans, per contra, may live on pueblos and reservations in rural areas where advanced vision testing facilities are scarce. In order to meet the demand of our ever-growing states and nation, driver's license bureaus now need to consider research and testing improvements in order to adequately screen a cross-section of the U.S. society.

This study shows that safety issues associated with any new driver's license testing system must be addressed prior to any implementation in any driver's license bureau, transportation agency, or medical facility setting. Driving simulator studies, in particular, must cover investigations into simulator sickness, flashbacks, and successful testing techniques of the products we identify. Space constraints in a driver's license bureau setting must also be considered due to excess heat concerns, electrical needs, lighting requirements, and crowded conditions, especially in warmer climates. Specially designed cooling systems or larger space areas may be also needed before any driving simulators are emplaced in a driver's license bureau location. Most Florida Department of Highway Safety and Motor Vehicle driver's license testing centers are, for example, located in small and leased storefront areas. New and specially designed buildings or equipped locations may therefore be needed to accommodate the use of driving simulators and the special needs of the testees.

Once adequate safety issues are addressed and technical modifications are made, as determined by an independent panel of physicians and scientists, as prescribed in this report, then driving simulators may offer the potential for more comprehensive and automated vision testing of older, and, possibly, novice drivers. Although a driving simulator study is beyond the scope of the original visual acuity report, our identification of driving simulator products necessitate a pilot study to explore these safety concerns and others prior to any implementation, especially as these relate to applications within the ESRA DAT™ and/ or ESRA DVAT™. (The original title of this report was "SPR 559: Comprehensive Automated Driver's License Testing System: The Visual Acuity Test (Phase 1: Pre-Pilot Test)". Since ESRA was unable to identify a visual acuity test

that was comprehensive for driver's license testing, we found it was advisable for ESRA to independently and entirely develop completely new and automated systems and procedures capable of thorough screening for transportation licenses and applications.) However, in the event that a driving simulator cannot be emplaced in a driver's license agency setting due to safety, management, and/ or ergonomic issues, then the ESRA DVAT ™ System will be considered adequate with only the B1Max ™ VACS, a high- and low- contrast visual acuity screen, and ultimately, the Modified 3DAGT according to modifications outlined by and developed with the assistance of ESRA Consulting Corporation.

Our findings underscore the significance of vision measures other than standard acuity for assessing at-risk drivers and, in particular, older drivers. Due to the high collision, injury, and fatality rates of all drivers in the State of Arizona, and the disproportionate number of at-fault older drivers in the States of Arizona and Florida, new vision screening methodologies and standards are urgently needed to promote road safety, predict visual impairment, and evaluate possible restriction or confiscation of driver's licenses. Automation techniques of other components of the driver's license test, such as the ESRA DAT™, as we identify, should also be explored. The results of our study, which spanned an 11-year period, not only apply to Arizona and Florida, two states with some of the largest populations of older individuals in the United States, but, as our global survey demonstrated, any state, country, province, territory, or commonwealth with an increasing number of older drivers.

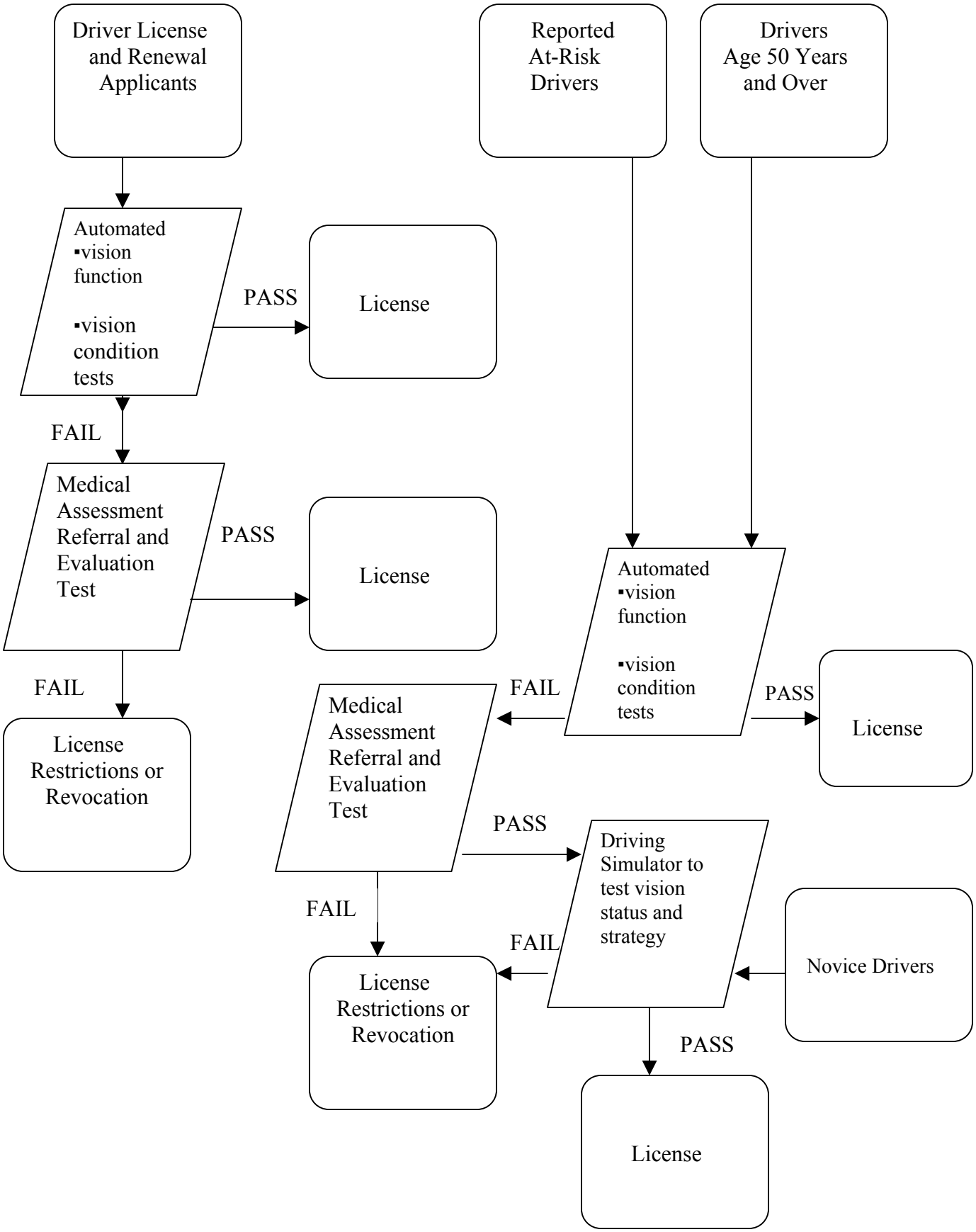

Figure 6. ESRA Vision Assessment Procedure for Transportation (ESRA VAPT™)

- At a minimum, ADOT should employ the B1Max ™ VACS, a fully automated visual acuity and contrast sensitivity screening test. This test powers the Roadwise Review™ home-based assessment tool released by AAA in January 2005. The reliability of this procedure is demonstrated by its use as part of the DRIVINGHEALTH® Inventory, which is used for driver evaluations by the Medical Advisory Board of the Maryland Motor Vehicle Administration. It provides a quick and useful screening measure of visual deficiencies that can potentially put an end to mechanical failures and long queues associated with existing vision screening techniques in transportation licensing agencies and medical facilities.
- While automated vision function testing methodology is needed, so is a new comprehensive system, including an automated vision condition test and, a driving simulator, to adequately screen the vision of driver's license applicants and renewals.

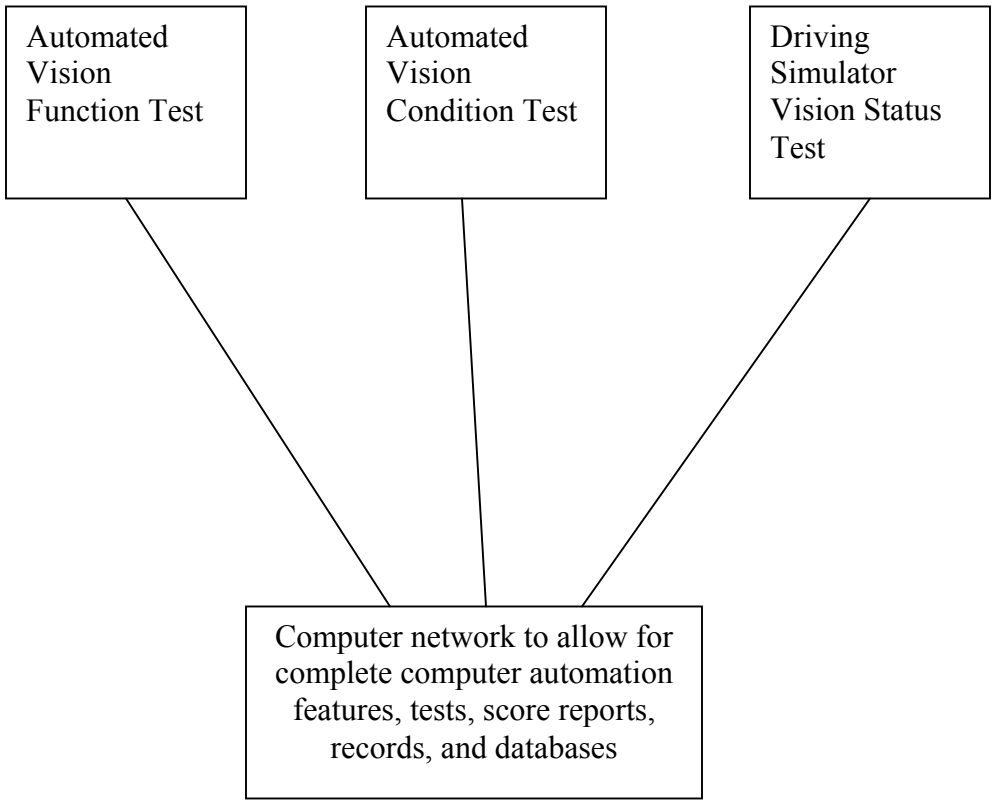

Figure 7. ESRA Dynamic Vision Assessment for Transportation (ESRA DVAT ™)

- Ultimately, all other parts of the driver's license test should be considered for automation, as illustrated in Figure 8., ESRA Dynamic Assessment for Transportation (ESRA DAT ™), once adequate safety concerns are addressed.

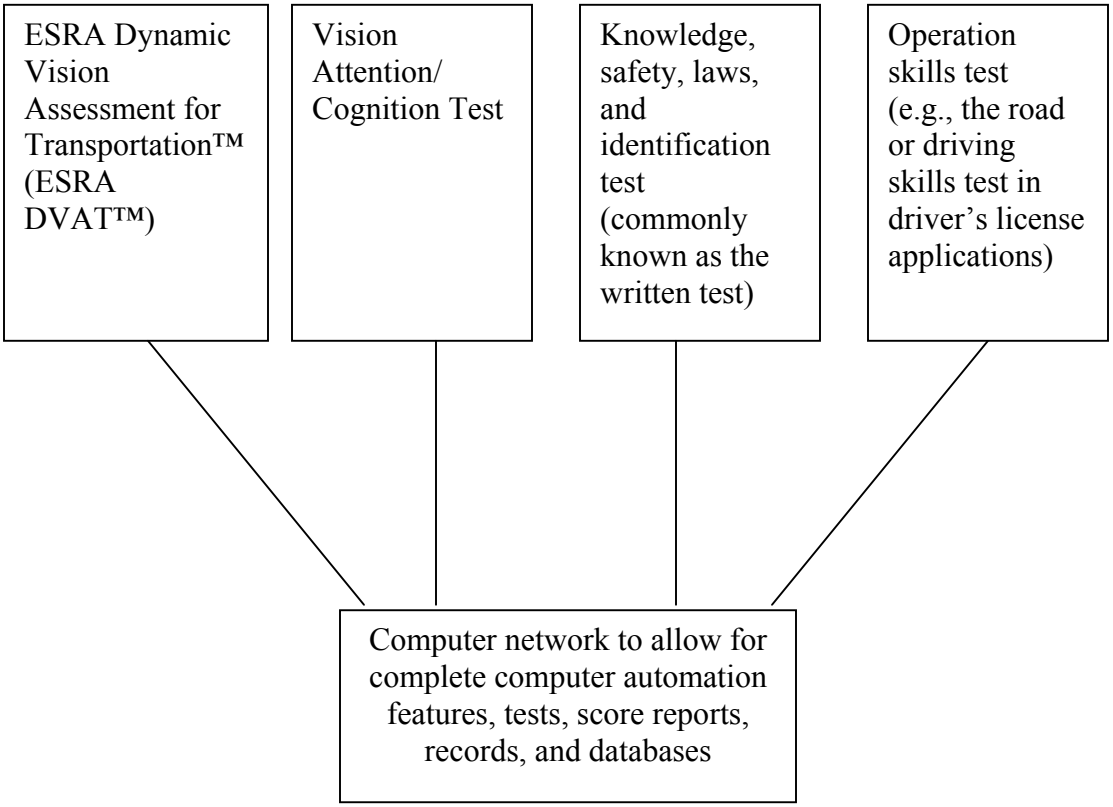

Figure 8. ESRA Dynamic Assessment for Transportation (ESRA DAT ™)

Although Figure 7 illustrates the vision function test and vision condition test as two separate tests, this configuration, as part of the comprehensive and automated vision testing system developed by ESRA, may be combined into one test because the B1Max ™ VACS is available as a software product. This product provides quick and reliable PC-based administration on local and networked systems and in diverse operating systems.

The ESRA Vision Assessment Procedure for Transportation™ (ESRA VAPT™) (Figure 6) and the ESRA Dynamic Vision Assessment for Transportation™ (ESRA DVAT ™) System (Figure 7) allow ADOT to validate the use of new and improved vision testing technology through a full-scale study. The ESRA Dynamic Assessment for Transportation™ (ESRA DAT™) (Figure 8) also merits further consideration, especially with the availability of the cognition tests (UFOV) and ReFb-06 ™ Road Sign Knowledge Tests. The results of such studies, as demonstrated through our global survey, stand to not only benefit drivers and driver's license bureau officials in Arizona and elsewhere, but to also benefit transportation personnel in many other agencies as well. Hence the automation of data and information between other transportation agencies may ultimately result in significant cost-savings, especially through the avoidance of repeatability of the ESRA Dynamic Vision Assessment for Transportation™ (ESRA DVAT™) and vision attention/ cognition tests, which provide broad transportation applications.

Implementation

As this study has shown further safety gains could be achieved by more substantial improvements to the current testing methodology. The ESRA Dynamic Vision Assessment for Drivers (DVAT ™) is envisaged as a fully automated system that rigorously screens vision function, condition, and status of drivers. These include eye diseases and neuropsychologic and neuromotor disorders such as dementia. Recent studies indicate that many drivers are unaware that they have these conditions. Given the more limited option, we prescribe the ESRA DVAT ™ to significantly reduce statewide motor vehicle collisions, fatalities, and injuries.

Therefore, ESRA DVAT ™ justification can be accomplished through a system of evaluating the anticipated safety gains and collisions avoided. The estimated costs and benefits for a five-year period in approximately 50 Arizona Motor Vehicle Division offices can be quantified as follows:

Component	Five Year Cost	Annualized Cost
Visual Acuity Test	$6,875,000	$1,375,000
Eye Condition Test	$2,500,000	$500,000
Driving Simulators	$2,750,000	$550,000
Contingency	$4,243,750	$848,750
Total*	$16,368,750	$3,273,750

* These itemized costs were conservatively calculated on the basis of a range of estimates provided to ESRA by different manufacturers. The prices for all products are subject to change and may be considerably higher if any custom or technical modifications are required.

Benefits of ESRA DVAT ™

The benefits of this improved driver testing system would be the reduction of collisions on the roadways. It is estimated that about 2 percent of drivers have serious vision or other conditions (for example, dementia) that raise their risk of collisions (National Institute of Health, 2004). Collision rates for those with diplopia are estimated to be 20 percent above average, (McCloskey *et al.* 1994) for glaucoma 50 percent above average (McCloskey *et al.* 1994) and for cataracts 150 percent above average (Owsley, *et al.*. 1999). Taking the lowest of these estimates as the factor for the 2 percent of impaired drivers, these drivers are projected to account for about $70 million of the annual $2.8 billion in collisions costs in Arizona. If the two-step test weeds out 80 percent of these impaired drivers (Fink, 2004) and denies them driver's licenses, and keeps them off the roads, the benefit in terms of collision losses avoided would be about $55 million per year.

The estimated potential benefit of $45 million per year is 13 times larger than the estimated $3.3 million annualized cost of the improved testing system. The magnitude of the benefit compared to the cost creates a strong argument for pursuing a further effort to explore possible implementation of the improved test.

Granted, the benefits will not flow directly to ADOT Motor Vehicle Division in the form of funds with which to pay for implementation. Benefits will be dispersed throughout the community in the form of fewer lives lost or damaged by collisions that might have been avoided if more impaired drivers were taken off the roads. Revenues gained and costs avoided will occur in the State's general fund. A case can be made for funding the improved driver testing procedure from these sources.

The ESRA DVAT ™ model may serve as a prototype for other states, countries, and government agencies to follow.

Note: The benefit/cost estimate was calculated by John Semmens, ADOT, from data provided by ESRA.

The ESRA DAT ™ System is developed by:

ESRA Consulting Corporation
ESRA DAT ™ Sales Division
1650 South Dixie Highway, Third Floor
Boca Raton, Florida 33432
USA
Telephone: (561) 361-0004
Arizona Fax: (520) 844-8555
e-mail: dat@esracorp.com
web: http://www.esracorp.com