

VISUAL DISTRACTION WHILE DRIVING

— Trends in Research and Standardization —

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One of the problems brought into focus by the development of navigation and other ITS devices is that the operation of such devices draws the driver's eye from the visual field where it belongs while driving and creates a visual distraction that may impede safety.

The article provides background information and summarizes worldwide trends in research on accident rates, the special characteristics of visual behavior and the effects of visual distraction on drivers and vehicle behavior. It also reports on the state of ISO standardization efforts and related technological trends. Finally, it defines a number of topics for future research in the field of human engineering.

Key Words: Visual distraction, Navigation, ISO, Driving safety, Human factors, ITS, IT

1. INTRODUCTION

Since automobiles are both fabulously convenient and easy to drive, yet carry with them the constant risk of traffic accidents, attaining a high level of driving safety is of paramount importance. Achieving safety requires both passive safety measures, which protect passengers and pedestrians during a collision, and active safety measures, which prevent accidents from happening at all. Recent efforts to achieve safety have focused on electronic technologies like Intelligent Transport Systems (ITS) and Information and Communication Technology (IT).

Passive safety attempts to protect passengers from injury in case of an accident and generally focuses on the body and chassis of the vehicle. However, from the perspective of improved communication and transportation, ITS also concerns itself with such passive safety themes as the speed with which one can call for help after an accident - how quickly one is able to receive aid. Nevertheless, this article focuses on areas of active safety that are directly affected by advances in IT and ITS.

The development of ITS has led to a number of proposals to improve active safety - methods of preventing the occurrence of accidents. Table 1 presents a selection of the concepts and technologies demonstrated to the public at the Smart Cruise 21 Demo 2000 held in Tsukuba

City in October 2000¹.

Such systems are designed to incorporate electronics and communication technologies to prevent accidents, but there is an even more fundamental and important de-

Table 1 Excerpts from the Smart Cruise 21 Demonstration¹

Support for prevention of collision with forward obstacles
Support for prevention of overshooting on curve
Support for prevention of lane departure
Support for prevention of crossing collision
Support for prevention of right turn collision
Support for prevention of collision with pedestrians crossing streets
Support for road surface condition information for maintaining headway, etc.
Drowsiness Warning System
High Illumination Head-lights
Forward Obstacle Warning System
Side Obstacle Warning System
Rear Vehicle Approach Monitoring System
Lane-keeping Support System
Adaptive Cruise Control System
Vehicle Dynamics Control System
Blind-spot Obstacle Collision Prevention Support System
etc.

mand made of drivers. In order to ensure safety while at the wheel, they must visually scan the driving environment, paying close attention in order to avoid unsafe situations.

As Figure 1 describes, drivers must recognize the condition of the vehicle and the state of its surroundings (collectively called driving information) through primarily visual (but also auditory and haptic) means. Drivers then process this in the brain, draw on their memory to identify problem situations, decide on a plan of action and execute it in order to avoid an accident.

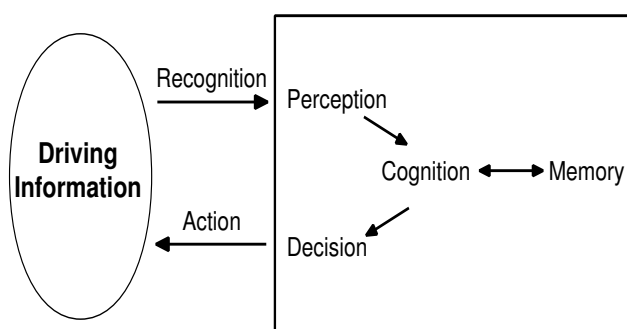


Fig. 1 Process of driver cognition

Visual distraction while driving, whether intended or not, can interfere with recognition, perception and other cognitive behaviors.

There are a number of types of visual distraction while driving. The first is where the driver's visual field is blocked where he should be looking while driving - the front, sides or rear of the vehicle. The second is where the driver neglects to look at these areas, focusing instead for some period of time on another visual target, which creates a safe driving issue. The third is when the driver is distracted and his attention wanders from his driving. Any of these three types of problems can impede safe driving and have long been restricted. Concrete examples of the three types are described below.

The first type concerns the driver's visual field. Automobiles are subject to strict visibility conditions such as those contained in the safety standards established by the Ministry of Land, Infrastructure and Transport. Only certain stickers may be applied to windshields, glass tinting must allow light transmission of no less than 70%, and mirrors are required to compensate for blind spots around the vehicle. If, then, a driver affixes various attention-getting items or dolls to the windshield, his eyes will be drawn from the road where they should be. This type of problem interferes with the recognition step in Figure 1.

The second type of the problem is now receiving a great deal of attention with the rapid development of ITS.

From 1993 to 1994, the effects of car navigation systems were a topic of concern in Europe and the United States. In Japan, an appropriate role for in-vehicle display systems (that is, car navigation systems) was described in guidelines established by the Japan Automobile Manufacturers Association³⁷, while the National Police Agency and the Ministry of Land, Infrastructure and Transport (then the Ministry of Transport and the Ministry of Construction) also understood them to be route guidance methods that lead to better safety by reducing indecision while driving. Overseas, however, the overwhelming opinion was that route guidance should be limited to Turn-by-turn Navigation, which provides only directional arrows at turns, since map displays that need to be read by the driver were thought to be problematic. The idea was that it was wrong to ask drivers to think, that they should instead be given only instructions to follow.

On this basis, the Dedicated Road Infrastructure for Vehicle Safety in Europe 2 (DRIVE II), a joint research effort among Europeans, published the Harmonization of ATT Roadside and Driver Information in Europe (HARDIE) guidelines². For a concrete example, please refer to Figure 2. The difference between the illustrations on the left and the right is in the orientation of the road name text. The thinking is that the text on the right is a visual distraction that takes longer for the driver to read, leading to an increase in mental workload.

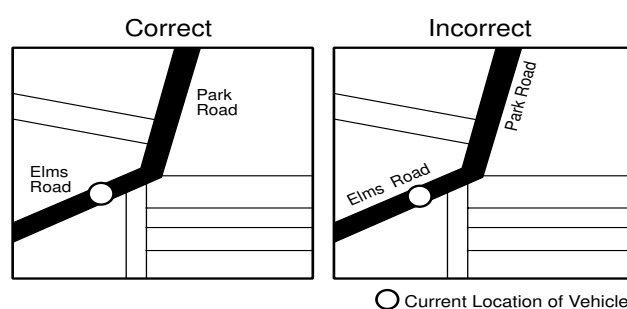


Fig. 2 Display of street names on digital map screens

The authors have attended International Organization for Standardization (ISO) conferences on human factors in ITS since the initial conference in Paris in 1994. We remember leaving for that first conference with a video prepared by the Society of Automotive Engineers of Japan's Human Interface Working Group titled "Why Car Navigation Systems are Needed in Japan".

Since then, Japanese car navigation systems have seen a number of display advances. They can now be understood at a glance (very short comprehension time) and

Table 2 Excerpts from the HARDIE guidelines²

Guidance should be presented in the form of simple, step-by-step instructions at the time of each driving operation. Drivers cannot be expected to process complex information when determining their desired route. In other words, the system may not display a map with a highlighted route.
Road layout information should be presented in abbreviated form.
Text should be avoided on maps whenever possible. If text overlays are necessary, they should be oriented horizontally.
If map information is required while driving, the direction of forward movement should be at the top.
Sound messages should be as simple as possible, limited ideally to the direction of the driving operation.
The information presented in a route guidance system must match the information actually on the roads.

incorporate effective sound guidance functions that are leading to greater acceptance in Europe and America. This second type of problem interferes with the perception and decision-making steps in Figure 1, or increases the time required.

The third type of problem is a loss of attention. Telephone usage has received particular attention. In Japan, only car phones that can make calls using pre-recorded numbers are permitted, and only hands-free portable phones may be used in vehicles (Road Traffic Act, revised). However, permitting only certain behaviors is not the same as regulating attentiveness. Most countries overseas also only permit hands-free cellular phones while driving. This type of problem interferes with the recognition step in Figure 1. Further research is needed in this field.

The topics addressed in this article are most deeply concerned with the second type of visual distraction. The issue was raised first by automobile manufacturers and other organizations in Europe and America, but it was the ISO standardization effort that brought the issue to the practical level, starting with ISO/TC204/WG13. At the 2nd Working Group held in Detroit in May 1994, it was decided that America would work on standardization of human factors in car navigation, Great Britain would focus on standardization of ITS human factors associated with vehicle control, and Japan would be responsible for integration.

In America, a Human Factors Working Advisory Group was created within the Society of Automotive Engineers, Inc. (SAE) to examine how much manipulation of car navigation systems was acceptable while driving³⁵. This failed to receive the approval of the SAE, the ISO, the National Highway Traffic Safety Administration (NHTSA) or the Department of Transportation (DOT), and attention turned from car navigation factors to visual

distraction, where the deliberation continues at the SAE and the ISO.

Back-up is provided to the NHTSA by supporting activities such as the Public Meeting and Internet Forum on Driver Distraction³ held from July to August, 2000. In Japan, this issue, as well as others related to the international standardization of human factors in ITS, is being addressed by the SAE of Japan's Human Interface Working Group, of which the authors are members.

The second chapter looks at the trends of research addressing these problems, while the third summarizes trends in standardization and the fourth describes issues for the future.

2. RESEARCH TRENDS

Detailed studies of traffic accidents have shown that among accidents where human error is a cause, reasons related to driver inattentiveness, such as improper attention (23%), inattention (15%) and internal distraction (9%), occupy a large percentage⁴. Turning to the objects of drivers' attention, we see them looking at both other people on the road and the various devices inside the vehicle. Drivers talk on mobile phones, lose themselves in thought and engage in other non-visual distractions that do not involve turning their gaze. Research indicates that drivers are aware that watching television while driving, using the phone, scanning paper maps and thinking can be "dangerous"⁵.

In a 1980s study of accidents resulting in injury or death⁶, 70% of the accidents caused by visual distraction involved looking at other cars or pedestrians, or occurred when looking at road signage. The recent popularity of information-providing devices like car navigation systems, however, provides increased opportunities for eye movement within the vehicle. Roughly 40% of drivers sensed some danger when using car navigation systems⁷, thus giving evidence perhaps to a latent factor leading to distraction. Below are a number of examples of research on the effects of operating in-vehicle display systems on driving behavior.

2.1 Characteristics of visual behavior

Driving while looking at the contents of an in-vehicle display system reduces the frequency and duration of glances at the road to identify traffic conditions. For example, in research conducted under real road conditions where text was displayed on an in-vehicle display sys-

tem, the average length of a glance at the outside environment was 1.5 to 1.7 seconds, while the amount of time spent watching the road decreased to about 50 to 65% of total eye movement⁸.

Visual behavior toward in-vehicle display systems varies with the content displayed, the type of operation conducted and road conditions. For example, glances are longer when choosing a radio station than when checking the speedometer⁹ while glance time for most standard interior instruments is said to range from 0.5 to 2.0 seconds^{10, 11}. At the same time, research looking at in-vehicle display systems incorporating the latest technology found that glance time for interior instruments was 1.38 ± 0.44 seconds on a test course¹² and averaged about 1.4 to 1.5 seconds under real road conditions¹³. Other research indicates that glances at in-vehicle display systems vary with traffic conditions by 1.1 to 1.5 seconds in duration and by 20 to 30% in frequency⁸.

As Figure 3 shows, a greater amount of information presented on an in-vehicle display system leads to a greater number of glances by drivers, who tend to gather information in this way without lengthening the average duration of each glance¹³.

2.2 Effect on detection of traffic conditions

Research indicates that drivers notice fewer events outside the vehicle while using car navigation systems and take longer to notice the ones they do¹⁴. In addition, the effect on the driver's ability to detect events is more pronounced the further the in-vehicle display system is in-

stalled from the driver's forward line of sight. Effects include a reduced likelihood of detecting pedestrians or events outside the vehicle^{15,16}, a slower response time to the brake lights of cars ahead and increased uneasiness¹².

2.3 Effect on vehicle behavior

Visual distraction while driving affects vehicle behavior such as maintaining lane position. The degree of lateral divergence while operating an in-vehicle display system is 18 to 24cm, with an even greater degree of lateral divergence when the driver focuses only on the in-vehicle display system and neglects to look outside the vehicle¹⁷. Such test results have led to a proposal for a method for measuring lateral vehicular movement caused by visual distraction^{18, 19}. Additional research that reproduced the temporal pattern of glances at in-vehicle display systems by using liquid crystal shutter glasses (discussed below) worn by the driver to cut off forward vision found that lateral vehicular movement increased by from 20 to 30cm¹³.

2.4 Methods of improvement

A number of methods to reduce the effect of glancing at in-vehicle display systems have been considered, including changing their location and adding voice displays.

Using the Heads-up Display (HUD) image position and providing visual information near the instrument panel appear to be effective in improving the ability of drivers to see road conditions outside the vehicle. For example, the HUD position leads to shorter glance time and reduced frequency of eye movement relative to other im-

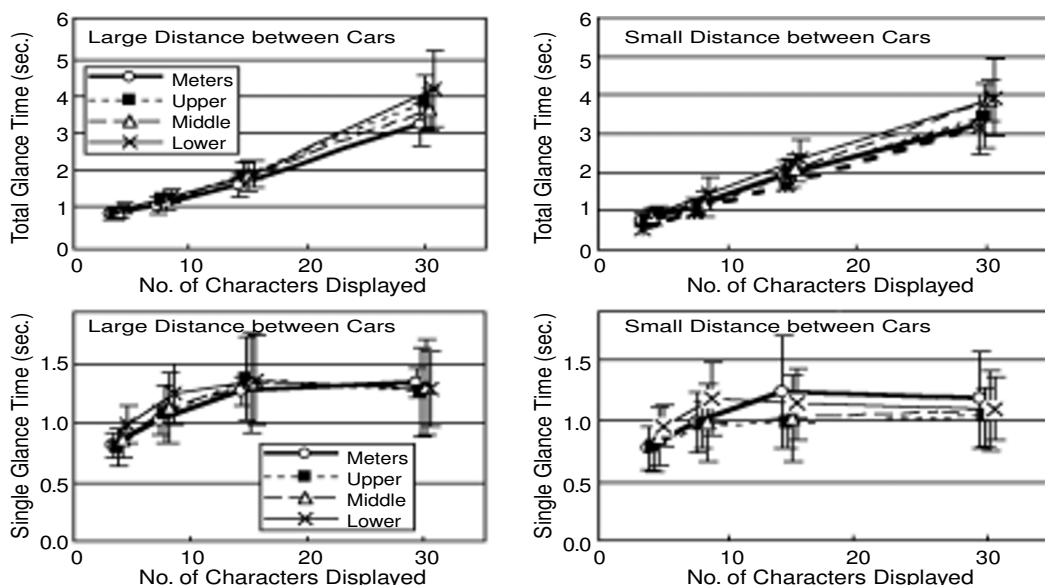


Fig. 3 Change in total glance time (upper row) and single glance time (lower row) with increasing numbers of characters displayed

age positions^{20,21}. In addition, the closer the HUD image position is to the driver's forward line of sight, the greater the likelihood of detecting pedestrians²². When the HUD position is within 20° of the forward line of sight the frequency of eye movement is reported to be significantly lower than when it is placed greater than 40° from the forward line of sight²³.

As for the effect on vehicle operation, the results for lane maintenance are best in the following order: HUD > instrument panel location > dashboard location²⁴. If the visual display is located within 30° of the forward line of sight, the driver's peripheral vision can detect as much as 80% of events outside the vehicle¹⁶, while displays that meet this criterion and are located at the instrument panel permit detection using peripheral vision as good as with HUDs²⁵.

However, if the visual display device is too near the forward line of sight, the driver may feel annoyed by its presence. Research has shown that locating the device at least 10° off the driver's forward line of sight eliminates annoyance, while the ideal position for display devices is said to be between 10° and 20°²⁶.

When using the HUD position it is important not only to avoid annoyance but also to ensure that the location of the visual display does not interfere with the driver's forward line of sight, and that the display is bright enough that its contents can be clearly seen. To ensure clarity in a vehicle interior whose level of illumination and other environmental factors vary widely with traffic and road conditions, it is important to rely not only on HUDs, whose visibility varies widely with the external environment. There are probably also real advantages to providing information at the instrument panel or top of the dashboard.

In addition to changing the location of installation, improvements can also be made by adding voice or warning sounds. For example, the addition of voice-based guidance to car navigation systems reduces the frequency and duration of glances at in-vehicle instruments and alleviates physiological stress^{10,27}. Supplementing visual warnings with warning sounds reduces the time to warning detection and increases the accuracy of reaction, regardless of the location of the visual display²⁸. Such research indicates that the addition of aural information improves acquisition of the visual information presented, reduces the burden on visual behavior and improves both vehicle operation and detection of events outside the vehicle.

Distraction, which is not necessarily accompanied by eye movement, also affects driving behavior. For example, the use of mobile phones is known to affect the detection of events outside the vehicle as well as vehicle

control and operation, leading to increased deviation from course and decreased ability to follow forward vehicles³⁰. Such effects on driving behavior are not limited only to the use of handheld mobile phones. Using hands-free mobile phones has also been shown to affect brake reaction time and lane maintenance on straight roads and to lead to unstable lateral position on curving roads^{31,32}.

3. TRENDS IN STANDARDIZATION

3.1 ISO standardization

The effect on driving of operating ITS devices is mainly due to the effect of looking at the ITS device (taking the eye from the visual driving field). We will address this topic later, but the ISO is currently debating the standardization of the measurement method for driver visual behavior and, to minimize the ill effect on driving of visual behavior, how much visual operation is acceptable during driving.

3.1.1 Concerning measurement of visual behavior

Glance time and operation time are generally measured by analyzing the driver's line of sight using small video cameras to record the movements of his face and eyes. This is, in fact, becoming the standard method for measuring visual behavior (ISO/DIS 15007) as established in ISO/TC22/SC13/WG8 (Transport Information and Control System - Onboard Man-Machine Interface)³³.

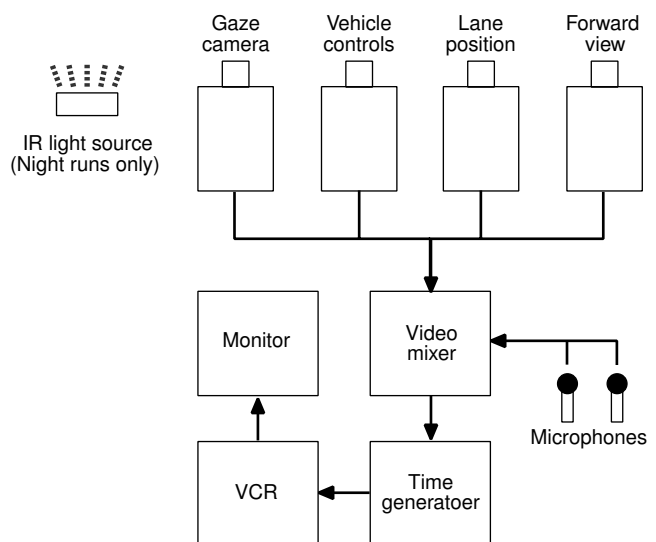


Fig. 4 Schematic of a typical video data capture system³³

Figure 4 describes the measurement system discussed in ISO/DIS15007 above. Images recorded on a Video Cassette Recorder (VCR) can be analyzed frame by frame to determine where the driver is looking - straight ahead or at the ITS device - and counter data recorded at the same time can be used to conduct time-series analysis.

The measurement method itself is a good one that does not restrict the driver, but it has the weakness of taking a great deal of analysis time. Many of the characteristics of visual behavior discussed in Section 2.1 are measured and analyzed using this method.

3.1.2 Concerning acceptable operation while driving

The ISO is debating the standardization of how much visual operation is acceptable while driving without causing negative effects of visual and operational behavior on driving. At the current stage, a number of measurement and evaluation methods have been proposed from around the world and the measurement indices and acceptable standards are being debated, but a decision is a long way off. The various measurement methods proposed and their characteristics are discussed below.

(1) **Total Glance Time During Operation:** Glances toward the ITS device are measured using Charge Coupled Device (CCD) cameras as described in 3.1.1 above, with total time used as an index. The acceptable standard for operation while driving is set below a certain total glance time (see Figure 5).

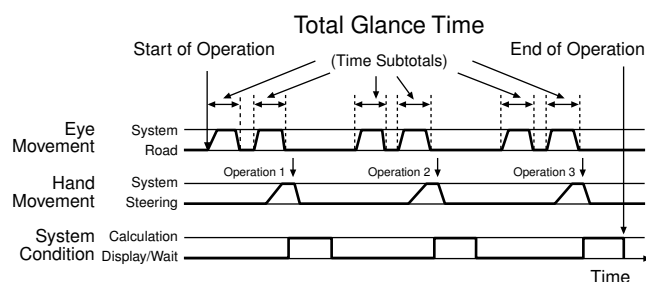
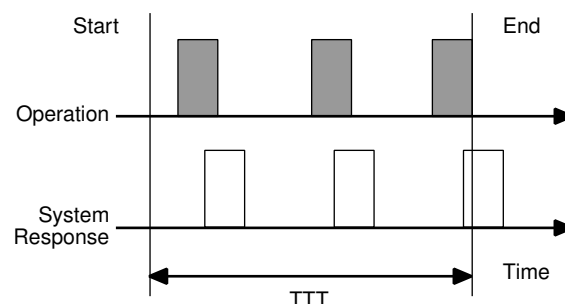


Fig. 5 Schematic of car navigation system operation

This is considered a standard index of the interference of visual behavior on driving tasks, and is reported to have a high correlation with other factors that negatively impact driving, such as driver unease and vehicle unsteadiness³⁴. Japan has proposed this index as a standard both for measurement and for permissible operation. Its disadvantage is that it depends on a video recording of actual driving, the capture and analysis of which is time-consuming.

(2) **Total Task Time (TTT):** This method allows easy measurement and evaluation in a test room during development of the device. The time required for a given

function from beginning to end can be measured either in a stopped car or at a bench, and a standard upper limit established (see Figure 6).



Note: System response in this case is always 1.5 sec. or less

Fig. 6 Calculation of Total Task Time (TTT)

This method permits easy measurement of complicated and lengthy operations, but has the disadvantage of being unable to reflect long, continuous gazes. This is reported in the deliberations of the American Society of Automotive Engineers (SAE)³⁵.

(3) **Visual Occlusion Technique:** This method involves measuring a series of actions in a stopped vehicle whose driver wears liquid crystal shutter glasses that obstruct vision at set intervals. A determination is made as to whether the driver can perform the operation using repeated short glances (see Figure 7). This method permits testing of operations that require long, continuous gazes and has no upper limit on the number of glances.

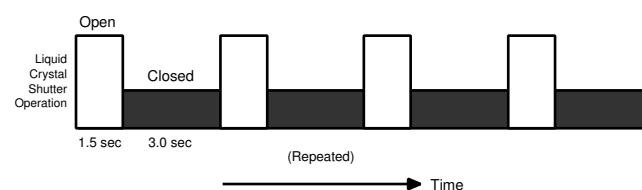


Fig. 7 Pattern of liquid crystal shutter movement in Visual Occlusion Technique

(4) **Total Open Shutter Time:** A method using the liquid crystal shutter glasses discussed in the previous paragraph but with limitations on the time the visual field is available (time that the shutter is open) and the number of times the process is repeated. The measure is found by adding up the total time that the shutter is open in Figure 7. It is able to measure not only operations requiring long, continuous gazes but also operations that are complicated and lengthy, this index is highly correlated with Total Glance Time. Deciding the right open and closed times is a matter for debate. Japan has pre-

sented this as an easier alternative to Total Glance Time that can be measured at rest or on a bench³⁶.

As mentioned above, the ISO is conducting a comparative evaluation of the proposed indices and debating the selection of an evaluation method and the establishment of standards. Nevertheless, it is no easy task to determine a standard value that can be used to evaluate the point at which something becomes a hindrance. Given the existing differences between road conditions and the tasks that must be conducted, the determination is likely to differ from country to country.

3.2 Trends within Japan

In Japan, the Japan Automobile Manufacturers Association acted early, in 1990, to establish effective guidelines for permissible car navigation system operations while driving³⁷. These guidelines have been revised to account for subsequent advancements in information provision systems.

Also, since 2000 a Standards Review Committee centered at the Ministry of Land, Infrastructure and Transport has explored legislative possibilities for establishing safety and other standards. Made up of people with experience or academic standing, this organization conducts new experiments and debates the issues based on the Japan Automobile Manufacturers Association guidelines discussed above.

3.3 American information

In America the SAE has been debating standards for acceptable operation of car navigation systems while driving, and suggested a standard TTT of 15 seconds or less³⁵. This was the recommendation of the Safety and Human Factors Subcommittee (the Working Advisory Group mentioned above was elevated to Subcommittee status), but was rejected at the Committee level and sent back for revision. In the process of revision, attention is being paid to other methods being considered by the ISO such as the Visual Occlusion Technique. At the same time, the Alliance of Automobile Manufacturers (AAM) is pursuing the creation of its own standards, although the relationship to the SAE is uncertain.

3.4 Conclusions concerning standardization efforts

As discussed above, standardization is proceeding as the ISO and various nations have recognized the need for appropriate standards for visual distraction while driving. As automobiles have become an international commodity, there is a need for harmonization among international standards such as ISO and domestic standards.

4. FUTURE RESEARCH

As mentioned above, visual distraction can be divided into improper attention, inattention and inner distraction, each involving a failure to direct an appropriate amount of attention to the appropriate objects. Attention can be examined across two axes: focused/divided and transient/sustained. When driving, one notices momentary changes with transient, focused attention; concentrates on something with sustained, focused attention; and looks back to check something with sustained, divided attention. The type of attention employed depends on the requirements of the driving task. For example, when following another vehicle the driver must concentrate on the actions of the forward vehicle (sustained, focused) and when driving through a shopping arcade must keep an eye out for pedestrians or bicycles that could leap out into the road (sustained, divided). When driving on an expressway the driver must notice a flat tire as soon as possible (transient, focused). Visual distraction is a failure to apply the appropriate attention to each task. At the same time, driving tasks vary from moment to moment. A change in driving task may occur at the driver's will (top-down) or because of a change in driving conditions (bottom-up). Therefore, the problem of visual distraction arises when information or action unrelated to the driving task creates an inappropriate division of attention, preventing the driver from obtaining the information necessary to complete the task or preventing him from making the necessary shift of tasks.

Most driving tasks involve obtaining information from outside the vehicle and, based on this, turning the steering wheel or performing some other operation, but the cycle time (sampling interval for feedback) varies for different tasks. For example, turning left or right at an intersection has a short cycle time, depending on traffic conditions, while driving straight on a broad road with little traffic has a long cycle time. When cycling time is longer there is enough time to gather information and conduct the necessary operation, but at shorter cycle times there is the risk of failure to gather necessary information or make the required switch of tasks. Therefore, the permissible time for operation must differ by task. One way to make this clear is to use the Visual Occlusion Techniques discussed above. Here we refer not to the blocking of sight during the operation of a device as discussed above but the cutting off of the field of vision while driving. In other words, using liquid crystal shutter glasses, for example, to close the shutters during a

driving task to check the impact on performance of the length of time closed. There are a number of testing methods: repeated opening and closing of the shutter at set intervals; closing off the field of view for a set period of time at the push of a button by the driver; and opening up the field of view for a set period of time at the push of a button. The third option is least stressful for test subjects since they can gain sight at their own choice. Since the field of view is blocked, such testing cannot take place on regular roads but must take place in a driving simulator or under other controlled conditions. When using a driving simulator there is no need to use liquid crystal shutter glasses since the screen can simply be made to go black. This method enables the researcher to determine how many seconds the driver can receive no information from the road and still successfully complete the driving task, and to derive the permissible time for visual distraction.

Operating a device is an active behavior of the driver, who can time his own actions when the cycle time is long. On the other hand, information is most likely to be provided by the device irrespective of the state of the driver. When information is presented to the driver on the display of an ITS device, this is perceived by the driver as a remarkable change to external conditions. This causes focusing and can distract the driver's attention from the task he was performing to the task of retrieving information from the ITS device. Controls must, therefore, be implemented such that information is provided when the task being performed has a long cycle time or when the information is more important than the task being performed, but to delay it in other cases.

One topic that often comes up in discussions of visual distraction is the functional visual field. Depending on the place where the system's information is provided (display location), the driver may be able to look at the display and still obtain visual information using peripheral vision. The functional visual field describes the range within which the driver can see using peripheral vision. One way to measure the functional visual field is to use the dual task method, which might test to see if a driver can detect a light shone on the periphery as he looks at the display of his car navigation system. However, this method measures only transient, focused attention. The functional visual field differs when concentrating on the movements of an object or scanning the environment. Therefore, the effect of attention paid to the information provided differs depending on the driving task. Further research is required on this point.

5. CONCLUSIONS

One argument that can be made is that when one considers the damage to vehicles and people caused by automobile accidents, it would be best if drivers did nothing other than what is necessary to drive, focusing only on driving safely. And yet, as a practical problem, while everyone agrees that non-driving activities should not be too numerous or too complicated, nobody suggests banning them completely.

For example, ITS devices such as the route guidance function of car navigation systems can be effective in reducing driver indecision and leading to smoother driving. The Front Vehicle Collision Warning System, which is expected on the market in the near future, has been developed to improve accident avoidance but if the information does not reach the driver he may take inappropriate action and worsen the situation.

Non-ITS devices such as car audio systems can cause mental distraction in drivers but are socially acceptable because they reduce stress while driving and help prevent sleepiness due to boredom. In this way, many items have both negative and positive effects, and it is the negative effect that must be accounted for.

In this way, the topic of how much non-driving glancing and operation is permissible while driving, particularly the appropriate range for looking at ITS devices, is a field of research that will continue to attract attention. This article has reported on research on this acceptable range but it is extremely difficult to establish a given line indicating exactly "how much." We presented the trends in research on applied human engineering, trends in standardization and themes for future research. In the future, it will be important not only to promote research and standardization efforts but also, since the pace of product and system development is so fast in this field, we must be flexible enough to adopt things as they become known.

Many international organizations such as ITS, CEN, SAE and IEC are involved in the standardization of the broad fields of automobiles, electronics, communication and human engineering. Since each country's governmental agencies are also involved, we must keep legislation in mind as we proceed with research and development. ISO/TC204/WG14 works on ITS standardization while a number of organizations in Japan are working on research and development of ITS systems, and the Human Interface Working Group and JSAE exchange related information. In the field of human engineering, promising research is also being conducted on

driver workload and accommodation to various driving operations themselves.

Moreover, it is important for those who put IT and ITS products and systems in vehicles, that is, the manufacturers who sell them, to guarantee that they will not increase the risk of accidents. The ISO is working on the standardization of product and system assessment³⁸, which we hope can also be applied.

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