



**The Ohio Department of Transportation
Office of Research & Development
Executive Summary Report**

Human Factors Opportunities to Improve Ohio's Transportation System

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Problem

Human factors engineering or ergonomics is the area of engineering concerned with the human-machine interface. As Ohio's road systems are driven on by people, human factors engineering is certainly relevant. However, human factors have often been deemphasized in highway construction compared to the design of structures and pavements based on principles of civil engineering and physics. There are thus many overlooked opportunities for improvement in Ohio's highway system to be realized by making it more user-friendly. This is particularly important as the density of traffic increases, making human responses and interactions even more important.

Objectives

The aim of this study was to identify opportunities to apply human factors principles and research to improve Ohio's transportation system. The Office of Traffic Engineering assigned thirteen topic areas to provide information and the study was limited to these topics even though there may have been other areas that are important from a human factors perspective. The topic areas included: rumble strips, changeable message signs (CMS), work zone delineation, half-size pavement markings, accident mitigation, older drivers, traffic signal operations, highway lighting, curve delineation, wet/dark delineation, raised pavement markings (RPM), information dissemination, and work zone safety. The aim was to identify opportunities to improve each of these areas by providing the human factors rationale and make recommendations to ODOT that can be adopted to improve Ohio's transportation system.

Description

For each topic area an extensive literature survey, using published documents as well as web-based sources, was conducted to identify research that has been done by others in the United States and in other countries. A statewide DOT survey was conducted to determine the best practices of other states with respect to each area. In addition, a product survey was conducted to identify promising new products. Based on this information, human factors opportunities in each area were identified.

We found considerable information in the following topic areas: rumble strips and accident mitigation. Some information was found in the topics of work zone safety, changeable message signs (CMS), older drivers, work zone delineation, curve delineation, and information dissemination. Little information was available on raised pavement markers (RPM's), highway lighting, traffic signal operations, half-size pavement markings, and wet/dark delineation.

Recommendations

Based on information gathered from all the described sources recommendations regarding the introduction and implementation of various measures to improve the transportation system are made.

Rumble Strips

With respect to rumble strips it was found that longitudinal rumble strips provide audible and vibratory warning to drivers in danger of running off the road or into oncoming traffic and have been found to reduce applicable accidents by as much as 90%. A pavement marking edgeline or centerline visibility is enhanced when placed over a rumble strip in a configuration called a rumble stripe. The use of these two types of rumble stripes namely Milled-in Shoulder and Centerline Rumble Stripe are recommended for Ohio highways.

Changeable Message Signs (CMS)

There are various factors such as CMS board size, height, sign height, viewing angle etc. that affect the legibility and comprehension of CMS messages. Guidelines for proper design and installation of CMS considering factors that are important from a human factors perspective are outlined in detail in the report.

Work Zone Delineation

We recommend the use of two strips (each half the original width) of Type VII and Type IX material of the same color instead of using a single strip of a particular color (orange or white) on drums to increase their visibility from far and near distances. Placing directional arrows on barrels where many lanes of travel are present and in the center of the lane at lane shifts and crossovers can also help to delineate the path of travel. Glare screens are also recommended to improve comfort level of drivers at night time.

Half-size Pavement Markings

We recommend the use of two half scale arrows in succession whenever feasible instead of using one half scale or one full scale arrow. This will increase the recognition distance at a lower cost. It is further recommended that pavement word legends, such as "ONLY" be reduced to half size and used in pairs. However stop bars and other similar transverse markings should be kept at their existing standard size.

Accident Mitigation

We recommend that tailgating DOTs be used to mitigate rear-end accidents on Ohio's roads. This will encourage drivers to maintain an adequate headway distance. A stop intersection gap warning system can be applied at intersections to aid drivers in judging the time required to cross an intersection. We also recommend that ODOT consider the use of X-boxes when there are railroad crossings close to signalized intersections. Delineation of utility poles could also help mitigate accidents particularly at nighttime. The use of pedestrian islands in crosswalks and separate bicycle lanes are two other measures that can be used to mitigate accidents.

Older Drivers

In order to accommodate the requirements of older drivers we recommend that ODOT should avoid placing signs which are similar in regard to color, features, or message in close proximity. Reaction time required can be decreased by making symbols as easily understandable and by using familiar symbols. Advance warning signs, advance guide signs and street name signs, increase in size and letter height of roadway signs, and improved roadway delineation are also recommended.

Traffic Signal Operations

We recommend that countdown peds be implemented at locations of high pedestrian

traffic. In order to reduce the red light running, the yellow interval might be extended, visibility of signal with yellow LED's might be improved, conspicuity of signals with back plates and retro reflective strips could be increased, and advance warning signs with flashers could be installed. Roundabouts should be installed at locations with significant delay on minor roads, lots of left turns, more than four legs or other unusual geometry, or where U-turns are desirable.

Highway Lighting

It is recommended that highway lighting in pedestrian areas be increased which may help in reducing accidents by making pedestrians more visible. An illumination system such as that used in Swiss crosswalks can help drivers to view pedestrians under positive contrast conditions.

Curve Delineation

The strategies that can be adopted to improve curve delineation such as providing advance warning when there are unexpected changes in horizontal alignment, providing adequate sight distance, and using barrier and attenuation systems are described.

Wet-Dark Delineation

The conspicuity of materials used in pavement markers under wet and dark conditions is important for safe driving. A wet weather tape with enclosed lens design is recommended due to its superior performance under different weather conditions as compared to others. The use of additional signs can also be considered to warn drivers of a no passing zone thereby providing redundancy.

Raised Pavement Markers (RPM's)

Raised pavement markers are effective in providing visual guidance to drivers. Increased visual guidance gives higher preview times and therefore safer driving.

Information Dissemination

We recommend that the information needs of drivers be always taken into account in all ODOT's information dissemination efforts: details on if there is a problem, what the problem is, the delay, prescribed remedy/alternate route etc. Information updates could be sent to travelers on a real-time basis using a device such as the Traffic Gauge used by WSDOT which could be implemented by ODOT. A statewide 511 traveler information service number could be developed and implemented. ODOT could also use various symbols on the variable

message signs to improve message transfer and understanding among travelers.

Work Zone Safety

A major problem in ensuring work zone safety is the enforcement of speed limits. The use of flashing speed limit signs and additional reduced speed limits are recommended. Speeds of the vehicles in the work zones could be measured and displayed next to the speed limit in the work zone using PCMS. We also recommend that a 'Fines Tripled' strategy be used instead of the existing 'Fines Doubled' strategy in work zones. The use of radar units with automatic enforcement is another alternative to control speeding. The use of dancing diamonds arrow panel designs were also found to prompt safe driving in work zones and can be considered for implementation.

Implementation Potential

The recommendations above are based on the literature survey, DOT survey, and product survey conducted. However, in most cases these recommendations would have to be evaluated by ODOT before a systemwide implementation.

A study to evaluate the photometric visibility to compare the daytime and nighttime visibility of rumble stripes may be required. Such a study could also be conducted using different driver groups. Further evaluation may be necessary to quantify the benefits and determine conditions for statewide use of longitudinal rumble strips. Before and after studies may have to be conducted to evaluate the effectiveness of transverse rumble strips.

The effectiveness of using two stripes of Type VII and Type IX materials in drums and the spacing between drums would have to be evaluated before implementation.

An evaluation study is required prior to using two half-size pavement markings in succession wherever possible instead of the full sized counterpart. The effectiveness under different traffic volumes, vehicle mixes, and geometrics will have to be tested.

The use of tailgating 'DOTs' would have to be evaluated to determine if they are effective and warrant widespread implementation. The intersection gap warning system has only been tested as a pilot study and requires evaluation if

ODOT is interested in implementation. The X-boxes must also be tested to determine the best design and their placement to be effective.

The use of larger pavement markings and larger traffic signs would have to be evaluated to determine if they are beneficial to older drivers. The use of longer acceleration and deceleration lengths to provide for safer driving could also be evaluated.

A more comprehensive instrument that is based on the TTI curve radiusmeter can be used to determine optimal curve speed and other parameters in curve design. Evaluations can be carried out to see how this can be done by incorporating it with ODOT's OCARD program.

One factor that influences effectiveness of RPMs is their spacing. Further evaluations could be conducted to determine the effect of RPM spacing on speed and lane control.

A survey could be performed to better identify information needs of different driver groups. This information can then be used to improve ODOT's existing dissemination efforts. The multiple colors and symbols to disseminate traveler information may also have to be evaluated before implementation.

Before and after pilot studies may have to be conducted to evaluate the usefulness of messages for speed control in work zones, displaying traveled speed, and the use of automated cameras. The driver response to tripling fines and the impact of the strategy on reducing speeds in work zones will also have to be evaluated.