Quality of motorcyclists vision: a summary report.

Quality of Motorcyclists Vision

Summary Report

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Prepared for:

The Department for Transport, Local Government and the Regions

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Table of contents

1.0 Introduction

1.1. Aim of the project

It is the aim of the Department for Transport, Local Government and the Regions (DTLR) to provide a safe transport network. Driver/rider vision has been identified as an important determinant of this and factors which impede it require further investigation.

Research was therefore commissioned to investigate aspects of rider vision. Factors important to rider vision such as glare, misting and abrasion were identified by means of a survey and the role of luminous transmission was examined by means of experimental trials.

This report summarises the aspects investigated to address these aims and includes problems in visor use, patterns of visor use, alternative visor designs and transmission levels.

1.2. ICE Ergonomics

ICE Ergonomics is one of the largest ergonomics research and consultancy organisations in the UK. It was founded in 1970 and is wholly owned by Loughborough University. ICE has over twenty-five years experience in transport ergonomics, particularly applied research into driver vision in the road environment. It has provided advice in this field, based on scientific research, to several government departments thus helping to define both national and EC regulations.

In addition to the relevant specialists at ICE ergonomics, expert personnel from the Transport Research Laboratory (TRL), Defence Evaluation and Research Agency (DERA) and the Applied Vision Research Unit at the University of Derby formed a Peer Group who were consulted in the course of the work.

2.0 Review of research

ICE Ergonomic's library undertook a search of relevant internal and external databases. This included its internal collection of over 10,000 paper based items from the field of transport and vehicle ergonomics as well as the access to the databases of Transdoc, the International Road Research Database, Motor Industry Research Association, the Highway Research Information Service and the Transport Research Laboratory.

The literature reviewed tended to suggest that there was difficulty, when considering accident data, in determining the level of contribution tinting and abrasions have on the cause of accidents, as it is rarely the case that a tinted visor involved in an accident will not be abraded as well. It is also often difficult to say whether either were the main cause of an accident.

From looking at the experimental studies, it appears that abraded visors reduced visual acuity more than tinted visors and at a quicker rate. Most studies tend to agree that tinted visors are acceptable at day, sometimes at lower transmissions than the currently accepted 50%, but should be strictly prohibited at night since it makes the detection of low contrast objects more difficult. Interchangeable tinted/clear visor pairs appear to be a more acceptable and efficient way of getting the most out of tinted visors for day and clear visors for night (Wigan, 1979) and helps to reduce visor misuse. This is opposed to the method of wearing sunglasses under clear visors, which some riders have been reported to do. The work of Morris et al. (1991) suggests an acceptable transmission level of 12.5% for combinations of materials (e.g. sunglasses & screens) to avoid reducing visual acuity, spot detection and contrast sensitivity.

Very little research on the fogging of visors was found to be available to evaluate the extent to which it could affect the visual acuity of motorcycle riders and understand the extent to which it could be a problem. However, methods have been developed to determine reduced clarity due to fogging.

3.0 Rider surveys

3.1. Survey of riders' views

A survey of 42 motorcyclists (28 members of the public and 14 professionals) was undertaken concerning the quality of vision through motorcyclists eye protection systems. The results of this survey were that:

- The high levels of abrasion resistance of modern materials means that scratched visors are no longer a significant problem for riders.
- Misting however is a problem, especially when travelling at slow speeds.
- Sun-glare is a significant problem which some riders have addressed through the use of tinted visors. However half of those surveyed had used tinted visors under low levels and half of these reported that their vision was reduced.
- Sunglasses are a partial solution to the problem but can be uncomfortable when worn under a helmet.

3.2. Survey of visor usage

A survey of 100 motorcyclists drawn from the general public was undertaken by ICE Ergonomics to estimate the extent of visor misuse. The transmission level of each visor was measured using the 'Tintman' vehicle window transmission meter, a technical instrument used to measure window and visor transmission levels. It was found that:

a) 80% of visors had transmission levels above 80%.
b) 9% had transmission levels between 50% and 80% (daytime use only level)
c) 11% had transmission levels below 50% (below permitted transmission levels).

Indirect questions were asked to determine if the visor would be used after dusk on the day of the survey. Of the 20 respondents whose visor transmission levels were below 80% i.e. below the level currently regulated as being suitable for use in conditions of low light (b and c above), all stated that they would be riding home at dusk or later. It can therefore be concluded that from the sample of 100 motorcyclists that there was a 20% misusage rate.

4.0 Luminous transmission trials

4.1. Laboratory trials

4.1.1. Experimental conditions

The first series of laboratory trials using ICE Ergonomic's Model Road were undertaken to investigate a wide range of variables in order to identify those suitable for further investigation. The variables assessed included:

- Ambient lighting conditions: These were – bright daylight, bright daylight with potential hazardous objects in shadow, cloudy/overcast day, low sun, dawn/dusk, night-time with streetlights and headlamps (dry and wet) and night-time with no street lighting.
- Transmission levels: 82%, 74.5%, 51%, 45.3%, 33.4% and 19.6%.

The tests were conducted using the Model Road which consists of a light proof box 8m long by 1.25m wide with a 1:20 scale road modelled inside. The road's surface reflectivity characteristics and macro texture are modelled on black asphalt (Q_o 0.07). The top surface of the box has seven apertures over which streetlights are placed to allow light to fall onto the road's surface in a manner representative of night-time streetlighting. Through combinations of different lighting, a range of daytime lighting conditions can also be simulated.

The model road scene is viewed through a shutter mechanism which gives the observer a 200 millisecond glimpse of the road scene. (This represents the time in which anything important to safe riding must be observed as the rider constantly scans the road scene). The participant's viewing position in the model is equivalent to 1.5m above the road's surface and gives a realistic rider's eye view of the scene. Refer to Figures 1and 2.

In all the trials conducted, twenty participants drawn from members of the public were required to detect the presence of a 'target' on the road ahead. Their performance was measured by the number of times that the target was seen (it was only present on 50% of occasions) and the time taken to see it after the scene was exposed by the shutter. The target consisted of a scaled adult male pedestrian and a 20cm disc. This latter target is frequently used in road lighting and vision research since although it is small in comparison to a pedestrian it is still large enough to present a hazard.

Figure 1:
Observers view of model road

Figure 2: Model road in use
(Side removed for photo only)

4.1.2. Findings

The participants' detection performance was significantly [1]worse using the 19.6% transmission material compared to the 74.5% under the dawn/dusk condition and the night-time with streetlighting (dry). (This concords with previous research which found that tinting can be problematic for low contrast objects under low ambient lighting conditions). The results also indicated that there were no detection benefits to the use of dark visors in daytime conditions.

After convening a peer group, a second series of laboratory trials were conducted in order to increase the data set of the original model road trials and therefore increase the "confidence" of the results. These latter trials also included the condition of night-time with no streetlighting but with a glare source representing on-coming headlamps. Significant differences in the participants' detection performance were found between the 74.5% and 33.4% transmission levels when the street was unlit and a glare source was present. Whilst significant differences were not found for the dawn/dusk and the night-time with streetlighting conditions, the trends in the data appear to confirm the previous findings.

[1] All data was tested for statistical significance using a two-tailed, paired t-test at 5% significance.

4.2. Field trials

4.2.1. Experimental conditions

The aim of the field trials was to investigate the effect on rider vision of varying levels of transmission under real world conditions and provide information to guide an acceptable lower limit for luminous transmission.

The field trials, which were designed by the Peer Group, were conducted on a disused airfield, currently used for daytime, off-road driving entertainment. This site enabled the correct ambient conditions to be tested and minimised safety risks. Disk targets, off-set to the right and left, were located along a three mile route around the track facility. The participants' performance was measured according to the number of targets seen and the distance which they were seen at. The transmission levels used were: 80%, 47%, 28% and 18%.

To increase the realism, an element of multi-tasking was introduced by requiring the participants' to drive the route themselves. Due to safety, experimental control and data collection requirements, the participants were required to use cars not motorcycles. This is unlikely to have had any large effect since the comparative performance of the different transmission levels was of interest. Additionally for the night-time trials, vehicles with the same headlamps as many motorcycles (halogen H4 lamps compliant with ECE Regulation 20) were used and the targets were off-set to less intense areas of the beam.

4.2.2. Findings

Under the dusk condition it was found that visors with 80% and 47% transmission levels had significantly better detection distances than visors of 28% and 18% transmission levels. Using mean values, this equates to a difference in detection distances of 14m. Under the night-time without streetlighting with a glare source condition, no significant differences were found.

4.3. Results summary

A summary of the significant findings of the luminous transmission trials described above is given in Table 1 below.

	No significant difference between transmission levels of . . .	Significant difference between transmission levels of . . .	Range for lower limit to luminous transmission
First laboratory trials (Dusk)	74.5% and 33.4%	74.5% and 19.6%	33.4% and 19.6%
Second laboratory trials (Night-time + glare)	74.5% and 45.3%	74.5% and 33.4%	45.3% and 33.4%
Field trials (Dusk)	80% and 47%	80% and 28%	47% and 28%

Table 1: Summary of significant experimental findings

Based on the work undertaken to date in the course of this project, as summarised in Table 1 above, it is recommended that a lower level for luminous transmission be set in the order of 47% to 33.4%.

5.0 Expert appraisal of visor alternatives

An expert appraisal was undertaken by ICE professionals to investigate the benefits and disbenefits to alternative means for reducing glare. These included: a 50% visor, a graduated visor, a visor with a 45mm silver shade band, a two-stage visor (a helmet with a clear visor and an additional, raisable sun shield), an iridium visor, a visor with a mirror insert and a peak. Each of the options was evaluated in terms of the distance at which an item on the road could be seen, the benefits provided against glare, ease/speed of changing between clear and darkened states and the opportunities for accidental and deliberate misuse.

The results of this appraisal indicated that detection distance is likely to be maximised over all lighting conditions if a clear visor is used i.e. darker forms of visor did not aid detection. However the peak, the mirror insert and the two-stage, 50% and iridium visors were similarly beneficial in reducing discomfort glare from unacceptable to just acceptable levels. However, aside from the peak (which did not provide benefit against glare from high levels of ambient illumination), these alternatives if used at night on lit roads gave rise to shorter detection distances than the clear visor. Since the rider surveys indicate that 20% of riders will choose to use darkened visors under low light conditions, the use of such products has safety implications. Visors which can be adjusted without having to stop the motorcycle are likely to be preferred for their convenience, however they should require some deliberate action to change between the dark and clear states since this will help to reduce misuse. With improved operability, the two-stage visor appears to offer a good compromise across these aspects.

An investigation of other vehicle technologies and discussions with various interested parties indicated that the best option appeared to be the use of a photochromatic visor which would automatically adjust its transmission level to suit the current ambient condition. (However whilst such a product is under development, many aspects relating to its design need to be addressed and so this will not provide an immediate solution). Additionally, polarised visors may also offer benefits.

6.0 Conclusions and recommendations

Although discomfort glare is likely to be reduced at lower transmission levels, the reduced ability to detect targets when such visors are misused under darkened conditions must be the priority consideration. The lowest limit for luminous transmission must be the lowest transmission level which does not significantly differ from a clear visor in terms of detection. Based on the work undertaken to date in the course of this project, as summarised in the table above, it is recommended that a lower level for luminous transmission for visors which might be used at night be set in the order of 47% to 33.4%.

The conflict of night-time and daytime trade-offs as described above may be eliminated in the future through the use of a photochromatic visor which is currently under development, or possibly by a polarised visor. Of the currently available alternatives, a peak offers some benefit against direct glare sources such as a low sun, whilst a two-stage visor, which is relatively convenient to use, offers benefit against high ambient illumination in terms of comfort but would reduce detection distances if misused at night.

Additional areas for research into motorcycle helmet and visor design include aspects such as misting, visor retention, aerodynamics, hearing loss, ventilation and screen interactions.

7.0 References

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