Emergency Vehicle

Visual Warning EBulletin

No 1 – February 2008

An occasional E- bulletin sharing the latest information and research on warning lights and livery conspicuity for emergency organisations in Australia and overseas

In this Bulletin

"The dominant influence on drivers' lateral position..... appears to have been the visibility of the pedestrian mannequin, with drivers allowing greater lateral clearance when the pedestrian was more visible".

Nadine Levick @ Objective Safety

This is a very useful website about ambulance safety and research. Nadine is an Australian doctor working in the US. She travels extensively presenting her research at conferences around the world. The website has PDF files with links to her research and detailed presentations.

View the site: http://www.objectivesafety.net

SAE Report - Effects of Warning Lamps on Pedestrian Visibility and Driver Behaviour – April 2007

This new document was released in April 2007 as joint research between SAE International and several safety agencies in the United States. The report investigates aspects of light colour, flash patterns and glare in relation to pedestrians (read police, paramedics and fire-fighters). The testing includes driver response to personnel working around test sedans with roof mounted lights (distinct from the higher lights on ambulance van configurations). Shown below is part of the conclusion:

At least under the test conditions used here, which includes reasonably alert drivers, there is no evidence of a tendency for driving behavior to be affected by the characteristics of warning lamps. The dominant influence on drivers' lateral position while passing the experimental scene appears to have been the visibility of the pedestrian mannequin, with drivers allowing greater lateral clearance when the pedestrian was more visible.

Flashing lamps have long been used because of their attention-getting qualities.
The present results appear to indicate that flashing also has benefits in reducing the negative effects of glare. The flash-together pattern used in this study (i.e., all lamps flashing in phase) had less effect of the visibility of pedestrians than steady burning lamps. This is probably because the dark periods in the flash pattern permitted drivers to see without glare.

Flashings lamps also received higher subjective attention-getting ratings. In this study, the duty cycle of flashing lamps was always 50%. Even shorter duty cycles, with the extreme being strobes, would probably be even better in this way. Further work would be necessary to evaluate the effects of duty cycle more quantitatively, and to consider the many issues involved in whether and how to coordinate flashing among multiple warning lamps.

View the full report: http://www.sae.org/standardsdev/tsb/cooperative/nblighting.pdf

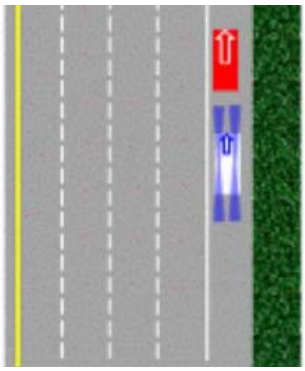
"Test participants expect an in-line police vehicle to be moving, while the 45-degree parking orientation provides a visual stimulus that helps reject this false hypothesis.".

Echelon parking at accident scenes enhances emergency vehicle visibility and scene safety

Continuing research is finding that parking an emergency vehicle at an angle at the accident scene triggers a perception by approaching motorists that there is danger ahead. The angled position of the emergency vehicle is more effective than parking in the straight-on position. The motorist sees the angled vehicle, assumes that the odd vehicle position is unusual and then begins to take precautionary action. This response appears to be independent of other warning devices and occurs even when the echelon parked vehicle uses no warning lights. Below is the abstract of the initial research:

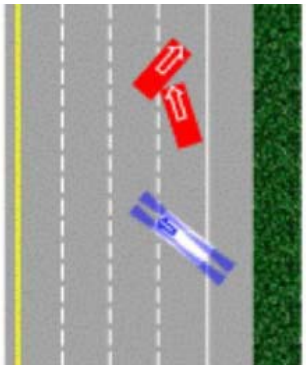
An analysis of 'looked but failed to see' accidents involving parked police vehicles

Martin Langham [a]; Graham Hole [a]; Jacqueline Edwards [a]; Colin O'Neil [b]



Drivers who collide with a vehicle that is parked on the hard shoulder of a motorway or dual-carriageway sometimes claim not to have seen it before the collision. Previous research into vehicle conspicuity has taken such 'looked but failed to see' claims at face value, and concentrated on attempting to remedy the problem by making vehicles more conspicuous in sensory terms. However, the present study describes investigations into accidents of this kind which have involved stationary police cars, vehicles which are objectively highly conspicuous. Two laboratory studies showed that experienced drivers viewing a film of dual-carriageway driving were slower to respond to a parked police car as a 'hazard' if it was parked directly in the direction of travel than if it was parked at an angle; this effect was more pronounced when the driver's attention was distracted with a secondary reasoning task.

Taken together with the accident reports, these results suggest that 'looked but failed to see' accidents may arise not because the parked vehicle is difficult to see, but for more cognitive reasons, such as vigilance failure, or possession by the driver of a 'false hypothesis' about the road conditions ahead. An emergency vehicle parked in the direction of travel, with only its blue lights flashing, may encourage drivers to believe that the vehicle is moving rather than stationary. Parking at an angle in the road, and avoiding the use of blue lights alone while parked, are two steps that drivers of parked emergency vehicles should consider taking in order to alert approaching drivers to the fact that a stationary vehicle is ahead.



Go to the website of the research abstract
http://www.informaworld.com/smpp/content~content=a713808723~db=all

Additional information & interpretation on the echelon parking report is available at the Ford Motor Company website - an extract of this second report is printed below:

"Results of experiment 1 indicated that the 'echelon' orientation was detected earlier than the 'in-line' orientation by experienced drivers."

Committee Report: Conspicuity Enhancement for Police Interceptor Rear-end Crash Mitigation

Prepared by Louis Tijerina Ford Motor Company The Blue Ribbon Panel Committee on Lighting and Conspicuity Lt. James D. Wells, Florida State Police 2/13/03

Results of experiment 1 indicated that the 'echelon' orientation was detected earlier than the 'in-line' orientation by experienced drivers. There was no difference in detection time by inexperienced drivers as a function of police vehicle orientation. In experiment 2) the echelon orientation was detected earlier than the in-line orientation when the test participant was performing a working memory span task (highly cognitively demanding) while concurrently watching the film than when watching the film only. These results suggest an 'expectation' or 'false hypothesis' effect.

Committee Report: Conspicuity Enhancement for Police Interceptor Rear-end Crash Mitigation
(continued)

"…… the echelon parking method may be more indicative of a stopped …vehicle because vehicles normally do not travel down the road at a crab-angle."

Test participants expect an in-line police vehicle to be moving, while the 45-degree parking orientation provides a visual stimulus that helps reject this false hypothesis (for inexperienced drivers, this latter point need not be true because inexperienced drivers have presumably not developed problem sensitivity of this kind). This false hypothesis might be a part of the stopped lead vehicle rear-end crash phenomenon in general. People expect that in-line vehicles on an active roadway are moving because they usually are. A related hypothesis (not yet tested) is that a driver might detect an in-line vehicle, decide incorrectly (due to the false hypothesis) that it must be moving, and not visually sample it again until it is too late to avoid a collision. One caveat to mention is that the Langham, et al. experiments were conducted with police vehicles parked in a travel lane, not on a shoulder. In terms of the schema explanation, the echelon parking method may be more indicative of a stopped lead vehicle because vehicles normally do not travel down the road at a crab-angle.

Read this report and see the next article for more details:
https://www.fleet.ford.com/showroom/CVPI/pdfs/CVPI_Conspicuity_Report.pdf

Markings and Conspicuity website @ Ford USA

This sub-site is little-known outside the US and forms part of the Ford Crown Victoria website. The Crown Victoria is one of the most popular vehicles in use by American law enforcement agencies. The site refers to all types of vehicle research, not just Ford vehicles. It is made up of general research projects undertaken by Ford in co-operation with other agencies and provides a very good overview of a wide range of warning light and conspicuity topics. The subjects include livery patterns, warning light colours and flash rates.

Read all of these reports via this homepage:
https://www.fleet.ford.com/showroom/CVPI/OfficerSafetyDefault.asp

Read the individual reports:

Committee Report: Conspicuity Enhancement for Police Interceptor Rear-end Crash Mitigation
https://www.fleet.ford.com/showroom/CVPI/pdfs/CVPI_Conspicuity_Report.pdf

Police Vehicle Struck Rear-end Crashes: Problem Description
https://www.fleet.ford.com/showroom/CVPI/pdfs/CVPI_Problem_Description.pdf

Countermeasures
https://www.fleet.ford.com/showroom/CVPI/pdfs/BRP_Report_Out_Countermeasures.pdf

Human Factors Analysis
https://www.fleet.ford.com/showroom/CVPI/pdfs/BRP_Report_Out_Human_Factors_Analysis.pdf

Recommendations
https://www.fleet.ford.com/showroom/CVPI/pdfs/BRP_Report_Out_Human_Factors_Analysis.pdf

"Britain experienced a rash of accidents where drivers struck police cars parked on road shoulders.

In order to reduce these accidents, the entire police car rears were painted (in] the "highly conspicuous" chevron pattern as shown [below].

Although cars might now seem conspicuous, the rate of these accidents actually increased"

Visual Expert/Human Factors – A discussion paper on Inattentional Blindness & Conspicuity

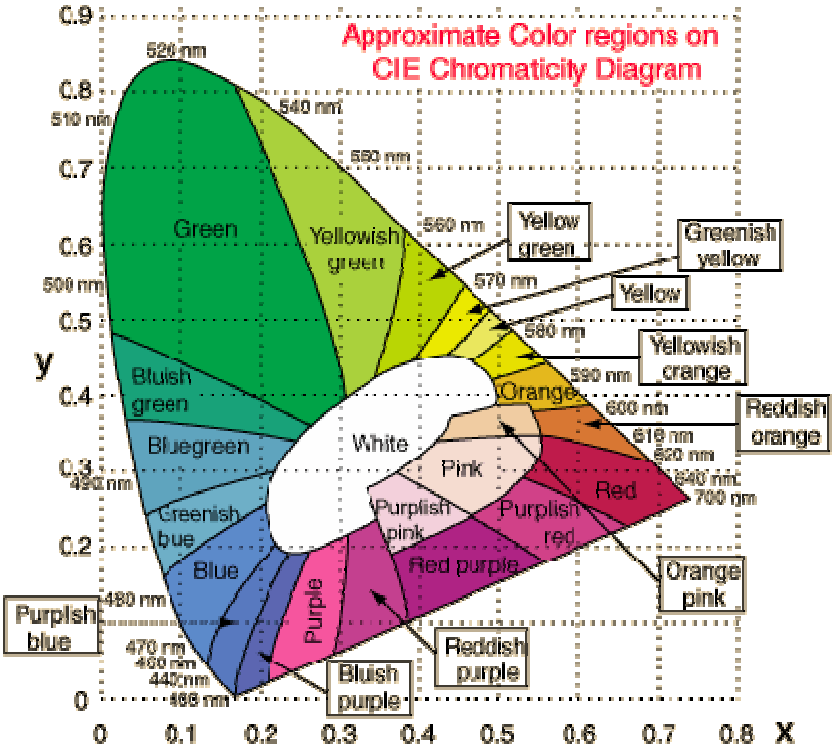
Written by Dr Marc Green of Pittsburgh, this discussion paper outlines the cognitive process of human perception, attention and reaction time. He looks at mental workload and how it affects attention levels, especially in sometimes automatic and often complicated driving scenarios. Expectation may also affect the way we perceive and react to changing tasks. More controversial is the extract written in the teaser box at the left referring to the common use of chevron patterns on the rear of emergency vehicles. An extract of the paper's conclusion is below:

It is difficult to reduce errors due to inattentional blindness. One reason is that people are unaware of the blindness. Training mainly affects conscious, voluntary behavior, so it helps little. You can tell a driver to be sure to check the oncoming lane before turning, but the advice will do little good if the driver is looking for a specific address, is in a hurry and in an unfamiliar part of town.

Read this paper:
http://www.visualexpert.com/Resources/inattentionalblindness.html

Painting, Lighting and Markings of vehicles used on an airport - Federal Aviation Administration (FAA) Advisory Circular AC 150/5210-5c (Draft)

This circular provides guidance, specifications and standards for airport vehicles including emergency response fire appliances. This is the only readily available document that lists accurate detail of colour specifications for emergency vehicle painting and lighting.
The circular outlines spectral data, tolerances and finish tests for chrome yellow, yellowish-green and international orange high-visibility paint. All three colours are referenced to the international CIE colour system. The paint colour specification would be the perfect reference for specify vehicle painting in a contract.



The high visibility yellowish-green paint would be **DuPont Imron 7744-1 Lime-Yellow.**
The CIE Chromaticity diagram at the left is provided as a colour reference.

Read the full FAA circular:
http://www.faa.gov/airports_airtraffic/airports/resources/draft_advisory_circulars/media/draft_150_5210_5c.pdf

View the CIE Chroma diagram with explanations:
http://hyperphysics.phy-astr.gsu.edu/hbase/vision/cie.html

What is the Wake Effect?

Emergency vehicles proceeding under lights & sirens may instigate collisions behind them as they make their way to an emergency. These collisions often appear to have been caused by the passage of the emergency vehicle but they do not actually involve the emergency vehicle itself. The collisions may occur between nearby vehicles or a single vehicle running into a roadside object. This effect can be exacerbated at night by the residual glare of bright warning lights on the emergency vehicle diminishing the night vision of nearby drivers. The small quantity of research that has been undertaken found the Wake Effect very difficult to prove or disprove. Anecdotal evidence and these reports appear to support the concept that the Wake Effect really does cause accidents.

Read these reports:

http://www.emergencydispatch.org/articles/wakeeffect1.htm
http://emj.bmj.com/cgi/content/full/20/3/277 (registration required)

Is the Moth Effect a myth?

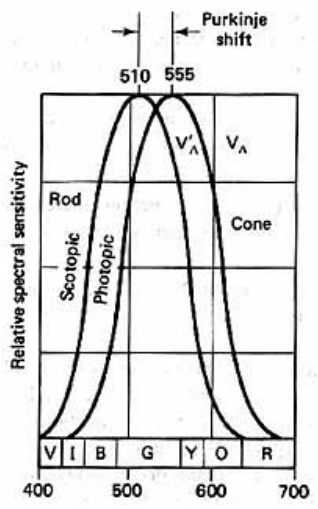
There may be a tendency for drivers to unintentionally steer towards an emergency vehicle that is parked with it warning lights activated. The effect name is derived from the phrase "*like a moth to a flame.*" A study by Helander in Sweden during 1978 termed the condition *perceptual tropism.* The nature of the moth effect is poorly understood and empirically it has been used to explain most rear end collisions with parked vehicles. Research has linked the motion effects of some lighting displays to the likelihood of being struck by a driver who steers their car towards the brightly flashing lights.

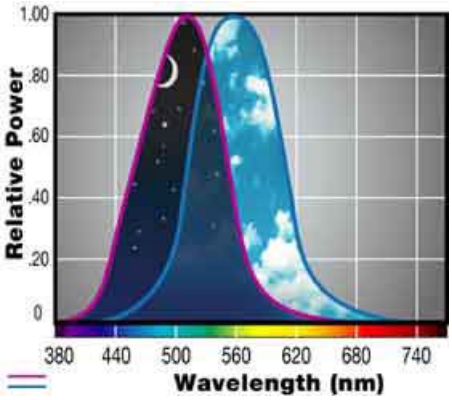
Later studies have discussed the use of yellow lighting to reduce the risks associated with roadside collisions. Helander suggests that more research may in fact prove that police or similar vehicles parked on the roadway are so significant and interesting that people will continue to strike them regardless of the lighting or the time of day.

Read these reports:

http://www.emsnetwork.org/artman/publish/article_14314.shtml
http://www.visualexpert.com/Resources/motheffect.html
http://www.policedriving.com/article145.htm

Explain the Purkinjie Shift?





Emergency vehicles combine red & blue warning lights to increase visibility during daytime & nightime.

The Purkinje effect is a shift in the maximum sensitivity of the eye from photopic to scotopic vision.
The relative spectral sensitivity curve for cones (photopic curve) peaks at 555 nm. During rod or scotopic vision, the relative spectral sensitivity curve shifts 45 nm toward the 400-nm (blue) end of the spectrum so that the peak occurs at 510 nm. This shift results in an increase in sensitivity to shorter wavelengths (400 nm) and a decrease in sensitivity to longer wavelengths (700 nm) for the rod system. Even though objects will be colourless under rod vision [at night], a blue object will appear brighter or more intense during scotopic (rod) vision than a red object of equal reflectance due to this shift in sensitivity. - Doug Kniffen

Welcome to the first issue of *Visual Warning Update*

This free "occasional" E-Bulletin can be emailed quarterly (on request) to interested emergency service personnel and their associated organisations. I have come to realise when talking about my research to different people in organisations around Australia and overseas that no common pipeline exists to promote the sharing of visibility research or information. This bulletin is an attempt to fill that communication gap and make the increasing knowledge base more easily available. The aims are:

- To generate an informal clearing house and low-key forum for visual warning research (readers are to make their own judgements about linked documents)
- To circulate information on new research resources as they become available.
- Provide details of current or new projects – thus helping researchers to find existing data, share data or seek help with the production of new research, especially from individuals or organisations that may not be previously known to the initial group.
- Provide a common point of contact and a path of introduction for researchers and emergency service personnel while respecting & maintaining individual privacy.

Please send in any interesting new research links, project details, photographs, questions, comments or letters for publication to johnandfatima@ozemail.com.au
I will expand and add new sections + many more links as extra material becomes available!

To Subscribe or Cancel the free EV Visual Warning Update E-Bulletin

Just send an email to johnandfatima@ozemail.com.au with your name, organisation, position title and one line about your research or interest in visual warning systems.

I will send each issue out to you as an undisclosed recipient. Your contact details will not be provided to any other person or third-party organisation. Introductions requested by other users will only be undertaken after formal request and with your written consent.

About the bulletin editor – John Killeen

I have been a member of the Australian Capital Territory Ambulance Service since 1997, working in Canberra with the Operations Support team and on-road as an Intensive Care Paramedic.

In 1998-99 I compiled a comprehensive research project titled *"The theoretical and practical aspects of visual warning methods in use on emergency vehicles."* I continue to maintain an ongoing interest in this field and have presented my report at several conferences. Since 2005 I have been working on the transition of ACT Ambulance vehicles to a new high-visibility livery and an advanced warning light system. In May 2006, the Tasmanian Ambulance Service began to progressively introduce a similar high-visibility livery onto their ambulances.

Over the last two years a number of Australian state ambulance services have been assessing the effectiveness of the new ACT livery and warning light design.
In October 2006 I was presented with an ACT WorkCover Award. The presentation of the award generated much interest in Australia and overseas. Further comparison testing and research on the new ACT vehicles and the design continues throughout 2007.

A CD ROM containing personal research, detailed ACT vehicle specifications and photographs are available from johnandfatima@ozemail.com.au

Having trouble with the links?

All the links are tested before publication - If the folded multiple line links are not working, try the following:

1. Use the full length / one line links shown below (Control + Click) for XP or (CLICK) for PDF

http://www.objectivesafety.net/

http://www.sae.org/standardsdev/tsb/cooperative/nblighting.pdf

http://www.informaworld.com/smpp/content~content=a713808723~db=all

https://www.fleet.ford.com/showroom/CVPI/pdfs/CVPI_Conspicuity_Report.pdf

https://www.fleet.ford.com/showroom/CVPI/OfficerSafetyDefault.asp

https://www.fleet.ford.com/showroom/CVPI/pdfs/CVPI_Conspicuity_Report.pdf

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https://www.fleet.ford.com/showroom/CVPI/pdfs/BRP_Report_Out_Countermeasures.pdf

https://www.fleet.ford.com/showroom/CVPI/pdfs/BRP_Report_Out_Human_Factors_Analysis.pdf

http://www.faa.gov/airports_airtraffic/airports/resources/draft_advisory_circulars/media/draft_150_5210_5c.pdf

http://hyperphysics.phy-astr.gsu.edu/hbase/vision/cie.html

http://www.emergencydispatch.org/articles/wakeeffect1.htm

http://www.visualexpert.com/Resources/motheffect.html

http://www.policedriving.com/article145.htm

OR

Copy & paste the link above into the address bar and press ENTER