Deciphering emergency vehicle conspicuity research
10 simple steps to safer markings and warning lights

Ambulance VISIBILITY

John Killeen

3rd EMS Safety Summit
Colorado 2010

www.ambulancevisibility.com
www.wordpress.ambulancevisibilityblog.com

910 square miles

Canberra – a city/state within the Australian Capital Territory

Canberra Bushfires 2003

Structure

ACT Emergency Services Authority

ACT Ambulance Service

Intensive Care Paramedic on every ambulance

ACT Ambulance Service

Working across borders and throughout SE Australia




Australian Operations & Fleet

During the Summit – come see me or send an email



john@ambulancevisibility.com

Visibility & Conspicuity

It's not rocket science

The office wall photo?

Is this the only way your agency looks at markings & lights!

Markings & warning lights

Evaluate vehicle interactions under operational conditions

Adopting effective solutions

Three different agencies, three different solutions, three degrees of efficacy in marking safety

Markings & warning lights

- Important points to remember
- Ambulance detection
- Vision & visual effects
- Markings Toolkit
- Ad agency visibility style
- Battenburg markings
- Chevrons
- Warning lights Toolkit

Remember these points

Distracted drivers

May not see even the most conspicuous vehicle at times

Safety Markings

Vehicle markings can be manipulated for greater or lesser levels of visibility safety

Warning Lights

Both older & newer types of lighting will provide versatility and efficiency depending on the operating conditions

Marking & Light Testing

Test & review your designs on the vehicle, not on the bench

Some accidents will happen!

No matter how effective the markings and lights

The R&D process

Changes in research & development take time + trial & error

Legislation & agreements

Federal, State & local rulings may be in place to govern emergency vehicle warning lights and livery specifications.

Markings & lighting design

Assess the different viewpoints around the workplace

- Traditionalists (heritage & culture)
- Sensationalists (WOW factor)
- Economic rationalists (How much)
- Complacents (Why change)
- Researchers (Here's why)

Pride in agency vehicles

If the vehicle looks good, the crews will want to keep it clean

Ambulance detection

Takes place through the windscreen

Ambulance detection

CRITERIA - Emergency vehicle detection

Rapid detection & perception over short and long distances with positive unambiguous recognition by all members of the population as well as providing

maximum possible visibility

both day & night and especially during adverse weather & traffic conditions

Ambulance detection

Drivers need to negotiate complex accident scenes

- Rapidly identify & isolate individual vehicles & personnel
- Determine the safest route past the scene

Ambulance detection

Safe recognition distance-observation, reaction and evasion

250 -300 meters
270 -330 yards

Definitions

Engel + Langham & McDonald

Conspicuity (Engel 1977)
The detection of a target in a brief presentation

Conspicuity (Langham & McDonald)
Measures the propensity of an object to attract an observers attention

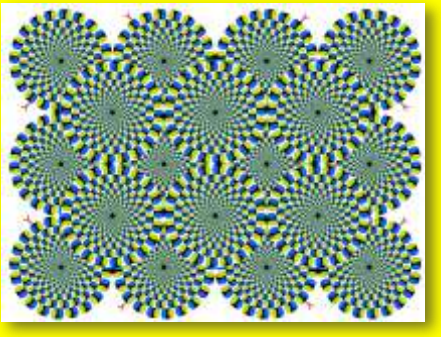
Visibility (Langham & McDonald)
Measures the ease of discrimination for an object with a known location

Ambulance detection
Conspicuity

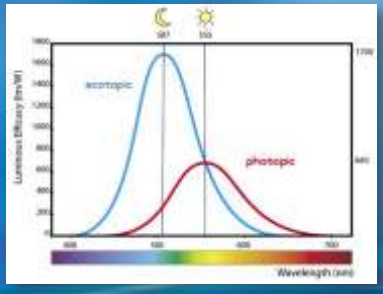
Size
Shape
Colour
Brightness
Motion

CONTRAST

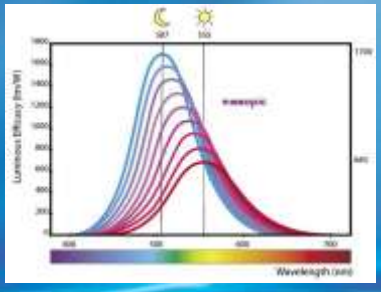
Vision & visual effects



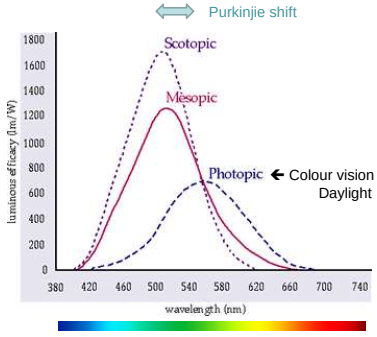
Vision & Visual Effects
Sensitivity of the eye during day & night



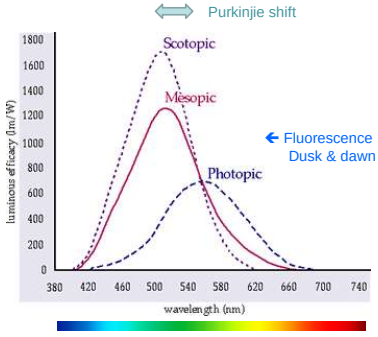
Vision & Visual Effects



Human vision adaptation
Daylight

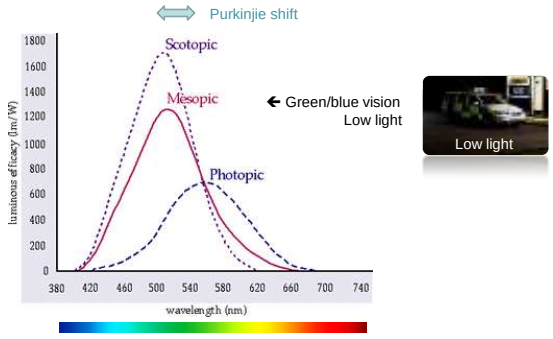


Human vision adaptation
Advantage of fluorescence at dusk & dawn



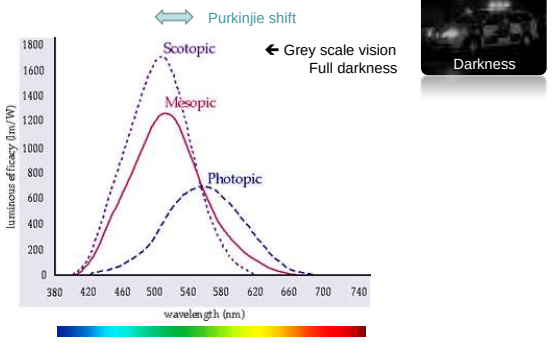
Human vision adaptation

Blue/green vision in low light - Mesopic



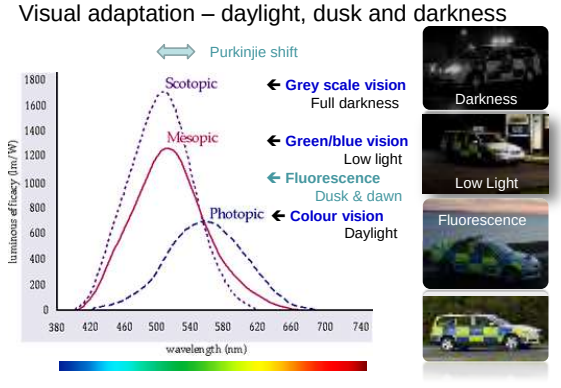
Human vision adaptation

Monochrome vision in darkness - Scotopic



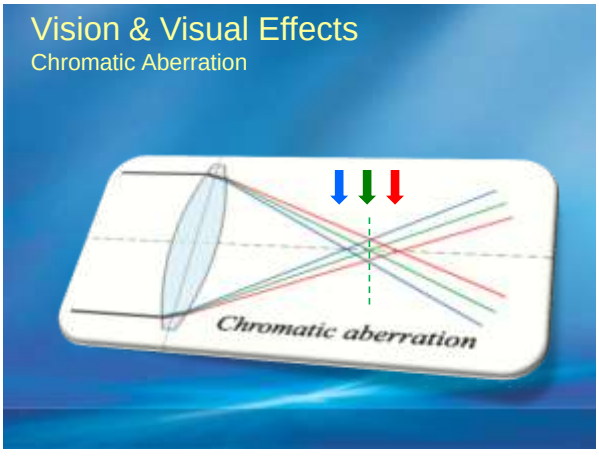
Vision & Visual Effects

Visual adaptation – daylight, dusk and darkness



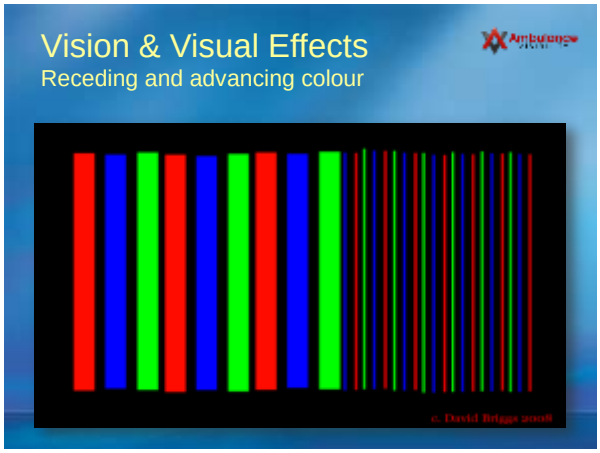
Vision & Visual Effects

Chromatic Aberration

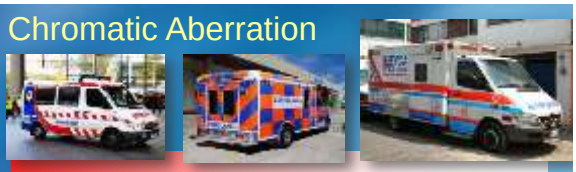


Vision & Visual Effects

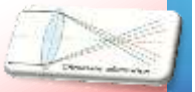
Receding and advancing colour



Chromatic Aberration



- Some colours used together force the eye to repeatedly adjust focal length = discomfort
- Slows reaction times
- Reduces depth perception
- Can influence braking distances
- Two dark colours side by side are worst (Example: Red & blue - especially at night)
- Yellow-green is the least affected colour



Vision & Visual Effects

Receding and advancing colour

Vision & visual effects

Blue Advancing – Red receding illusion

Stationary Flashing BLUE lamp

26% - 31% believed light was approaching

Stationary Flashing RED lamp

More than 50% believed light was moving away thus increasing the risk of rear end collision

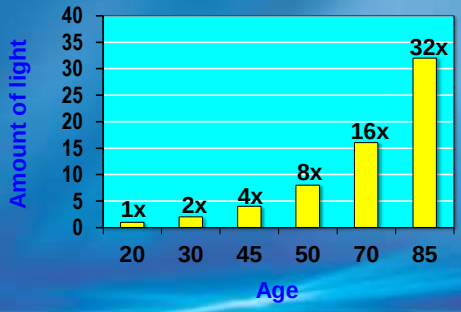
Overall for all colour combinations

Less than 50% realised the vehicle was stationary

Information transfer characteristics of moving light signals
Berkhout J. (1979)

Vision & Aging

Contrast factor changes in the eye over a lifetime



Vision & visual effects

Pupil size & contrast changes visual perception

Age	Pupil Size Day (mm)	Pupil Size Night (mm)	Difference (mm)
20	4.7	8.0	3.3
30	4.3	7.0	2.7
40	3.9	6.0	2.1
50	3.5	5.0	1.5
60	3.1	4.1	1.0
70	2.7	3.2	0.5
80	2.3	2.5	0.2

Green & Senders

Vision & aging

How visual contrast changes in the eye over life

Vision & colour-blindness

Up to 10% of the population have vision problems

Red & white vehicles

Camouflage – normal vision vs colour deficiency

Colour, text and conspicuity

Changing colour alters perception of the apparent visual size

Architectural Signing and Graphics, Follis & Hammer 1979

Colour, text & conspicuity

Yellow/green dominance over green with identical coverage

Vision & visual effects

Loss of night adaptation

- Up to 20 minutes for drivers to adapt to low light
- Bright light eliminates adaptation in 2-3 seconds
- Observers with vision impairment may see halos, blurring or irritating glare (even under normal conditions)
- Affects passing drivers and people around the incident scene
- Rapid flash rates intensify effects

Wake Effect

Accidents caused by passing emergency vehicles at night

- Caused by glare from overbright warning lights, especially waistline flashing lights
- Loss of night vision in passing drivers
- Accidents occur <u>after</u> the ambulance passes
- Difficult to quantify in research
- Also happens at major road incidents with emergency vehicles displaying multiple warning lights

Moth Effect

Collisions with parked emergency vehicles

- "Perceptual tropism" (Helander 1978)
- May affect distracted or fatigued drivers more
- Drivers that fixate pass closer (Kitamura & Matsunaga 1994)
- Bad weather – perceptual narrowing
- Any emergency vehicle at the roadside with or without lights may generate interest
- The affect has <u>not</u> been disproved

AV Markings Toolkit

Visual markings for emergency vehicles

- Effective body colour to suit landscape
- Include stripes/panels of fluorescent colour
- Balance the reflective colours at night
- Vehicle fully outlined with contour markings
- Include visual cues to enhance perception
- Eliminate any complex designs and patterns
- Minimise badges, text & signage
- Legible sentence case text - not oversized
- Design & colours to assist visually impaired
- Avoid visual conflict - other vehicles/clothing

Body colour

Vehicle body colour

Consider the backgrounds in your working environment

Vehicle body colour

Base colour must be suitable for current/future vehicles

Vehicle body colour

Changing scenes & complex backgrounds alter conspicuity

Vehicle body colours

The eye sees no detail when scanning quickly
Solid colours enhance form & shape

Vehicle body colours

Most effective body colours for emergency vehicles

- Yellow green
- Chrome or Euro yellow
- White + Fluorescent YG
- White + Fluorescent red
- Fluorescent red

Coloured infill panels should be at least 10% of total surface area

Vehicle body colours

Effective body colours for emergency vehicles?

Vehicle body colour

Not every vehicle can be painted safety yellow-green

Vehicle body colour

Reddish/orange fluorescent colours have significant visual presence under daylight conditions, but darkens at night

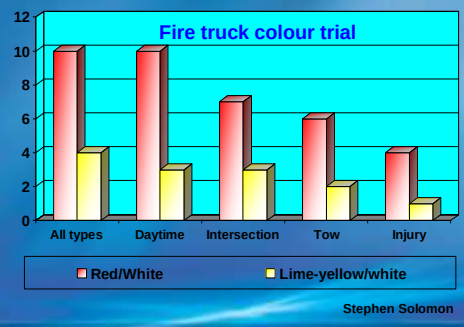
Popular in Europe around snow regions

Vehicle body colour

Single solid colour is best, especially for unusual shapes

Vehicle body colour

Lime-yellow versus red/white fire trucks



Fire engine red vehicles

Great camouflage, even on sunny days – Solomon

Colour deficient vision

Normal vision

Vehicle body colour

Lime-yellow and red paint daylight reflectance comparison

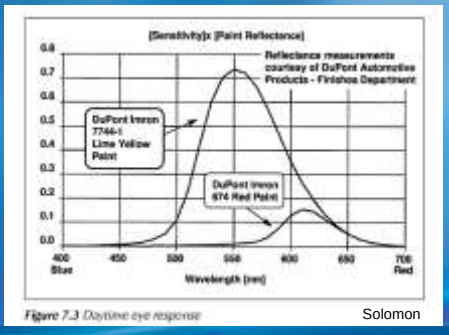


Figure 7.3 Daytime eye response

Solomon

Vehicle body colour

HiVis body colours are needed for pursuit or emergent situations to assist fast reaction times by other drivers

Vehicle body colour

Effective conspicuity - yellow body colour or Battenburg?

Case Study

ACT Fire Brigade – a single unifying colour on a complex vehicle shape

Case Study

Solid colours promote unity & reduce camouflage effects

Case Study

Airport Rescue & Fire Fighting vehicles
Air Services Australia

Case Study 2

Airport Rescue & Fire Fighting
Red vs HiVis yellow-green across runways

Case Study 2

Airport Rescue & Fire Fighting
Red vs HiVis yellow-green across runways

Case Study

Airport Rescue & Fire Fighting
Fluorescent/reflective contour striping

Marking patterns

Vehicle markings

Markings & lights must be adaptable – current/future vehicles

Vehicle markings

No clear or common designs in North America, although traditional designs are having a resurgence

Vehicle markings

Marking trends in Europe, the United States & Australia

Marking patterns

" The multicoloured (patterned) ambulance while distinctive, may suffer decreased conspicuity because of the effects of camouflage"
De Lorenzo & Eilers

Vehicle markings

A recognition marking is easily identified in monochrome

Vehicle markings

The oldest recognition marking is the Sillitoe Tartan - it is not a high visibility pattern

Vehicle markings

Hybrid markings promoted as Battenburg are not safer!

Battenburg

HYBRIDS

Sillitoe

Dodgy Rear-ends

Hybrid patterns induce visual confusion - increase collisions

Vehicle markings

Diagonal patterns break up the vehicle profile

Patterns, dashed lines and diagonal designs

Confuse size & shape

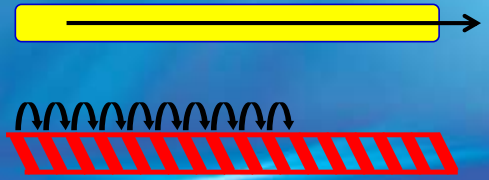
Slow object recognition

Waste reaction time

Vehicle markings

Micronystagmus

- Horizontal scanning pattern of eye
- Vertical or diagonal lines disrupt the flow & slow recognition



Vehicle markings

Mixing multiple colours & pattern is also confusing

Pattern corruption

Pattern corruption & camouflage

Vehicle Markings

Diagonal lines in two colours creates camouflage

Ad Agency Visibility Style

Ad agency visibility style

"It would appear the current industry expertise in emergency vehicle conspicuity resides within ad agencies and street-corner graphic shops...."

...Emergency agencies continue to take advice in good faith!

Ad agency visibility style

From large advertising groups to corner graphics shops

Ad Agency visibility

Ad Agency visibility

Designer markings that confuse

Ad Agency visibility

Even at night it is confusing
Question: What is a .....LANCE?

Ad agency visibility

Battenburg was never designed for use in this format



Ad agency visibility

Complex corporate pattern in low visibility colours

Ad agency visibility style

Ambiguous markings, low-vis blue & camouflage in snow

Ad Agency visibility

Hybrid pattern, text and graphics = camouflage

Ad agency visibility

Hybrid pattern with narrow fluorescent stripes
High visibility policing, not HiVis safety markings

Ad agency visibility

This coloured marking scheme from New Zealand was changed several years after being introduced

Ad agency visibility

Not a Battenburg variation – it is camouflage!
ACT policing park & hide the car in dappled shade
...but then visually, what changes during a pursuit!

Neonatal & Paediatric

Vital emergency response in low conspicuity vehicles

Case Study

NETS – Change of markings and text to improve recognition

Case Study

Safer markings that convey purpose + space for sponsors

".....people now notice NETS Ambulances. In fact; the staff have emphasized that the NETS Ambulances are now easily detected by motorists who are promptly moving to the side to allow the ambulance to continue its vital life saving journey." NETS Website

Fluorescent Markings

Fluorescent Markings

Enhanced conspicuity

Fluorescent Markings

Can overwhelm non-fluorescent colours & patterns

Did you notice the cones?

Fluorescent Markings

Advantages of fluorescent colours

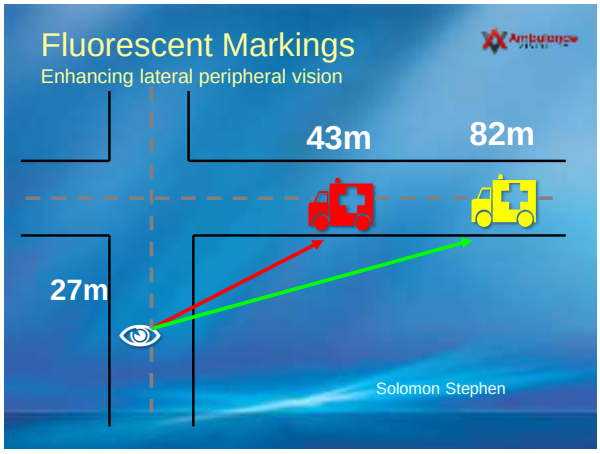
- Reflectance = peak eye sensitivity
- Best resolution
- Rare colour in nature
- Contrasts in rural & urban backgrounds, especially at dusk & dawn
- Unaffected by the Krovkov affect
- Least chromatic aberration with white
- Care in design – visually overwhelming

Fluorescent Markings

UV Fluorescence at dusk & dawn when most needed

Fluorescent Markings

Enhancing lateral peripheral vision

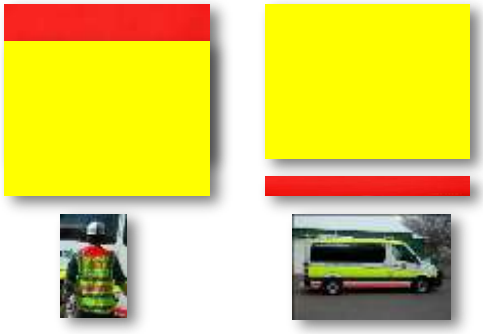


Fluorescent Markings

Used together equally they confuse and irritate your eyes!

Fluorescent Markings

Control the use of fluorescent colour carefully!



Fluorescent Markings

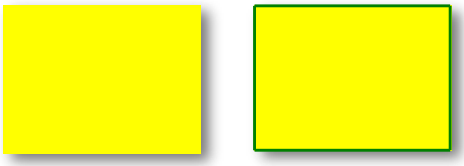
Red-orange designs

Fluorescent Colours

Saturation is enhanced by using a coloured keyline

Fluorescent Colours

Saturation and separation are enhanced by using a coloured key-line



Fluorescent Markings

Avoid unusual shapes without vertical contour edge markings

Fluorescent markings vs paint

Fluoro markings exceed the luminance of fluoro paint both night & day; especially during when overcast / dusk & dawn

Fluorescent Markings

Is the fluoro or the chevron marking most effective?

Fluorescent Markings

Which colour combination is more effective?

Manitoba – Canada

ACT – Australia

Manitoba is constrained by colour regulations

Fluorescent Markings

A narrow band of colour is ineffective?

Case Study

ACT Ambulance - care with fluorescent red near brake lights

Case Study

Queensland Ambulance - enhanced safety
Substantial cost savings

- Higher level of visibility
- Redesigned low-glare lighting
- Improved visual safety
- Positive new corporate image
- A realised safety & cost benefit
- 30% saving on markings/lights

Fluorescent Markings

Superior conspicuity in most situations

Reflective & Contour Markings

Reflective markings

Confusing scene lacking in detail vs contour markings

Reflective Markings

Lack of detail or shapes outlined by contour markings

Reflective Markings

No vehicle outline at night – no visual cues

Reflective markings

Contour markings provide the most effective identification

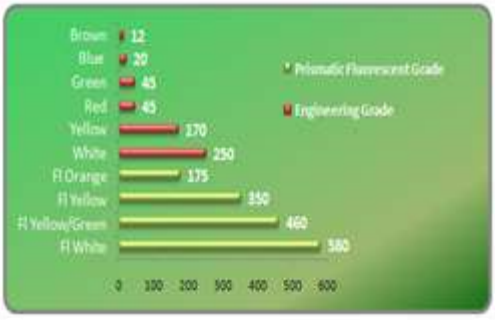
Reflective/contour markings

Estimating size & direction from contour markings

Reflective markings

Luminance of reflective colours at night

Darker colours waste reflected light

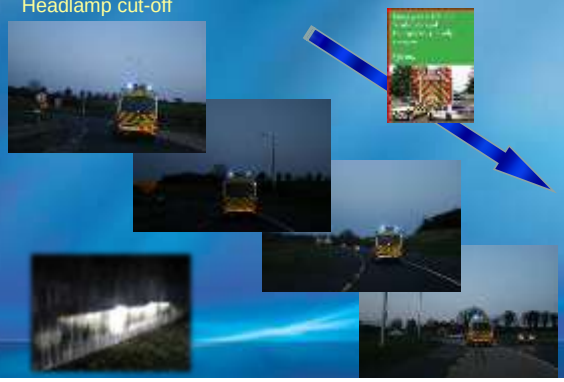


Reflective colours

Halation or over-glow

Reflective Markings

Headlamp cut-off



Reflective Markings

Narrow stripes are ineffective – wide stripes rule

Reflective/contour markings

Contour markings are the most important aspect

Outline the vehicle's:
- Shape & size
- Direction of travel
- Door openings
- Occupational purpose

Provide & inform:
- Visual cues
- Closing speeds
- Separation of vehicles
- Reference points

Reflective Markings

Properly designed, contour markings work with doors open

Reflective

Heavy body marking distracting from contour stripes

Reflective Markings

Contour markings do not detract from the daylight profile

Contour markings

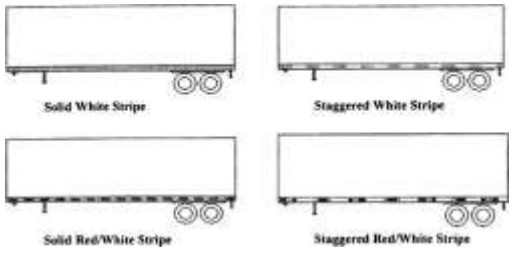
European research

Contour markings

European research recommended contour markings

Contour Markings

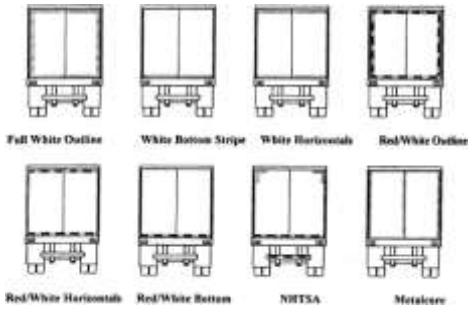
Canadian research in different weather conditions



Effectiveness of Heavy Truck conspicuity treatments under different weather conditions
Hildebrand & Fullerton

Contour markings

Canadian research



Contour markings

Canadian research

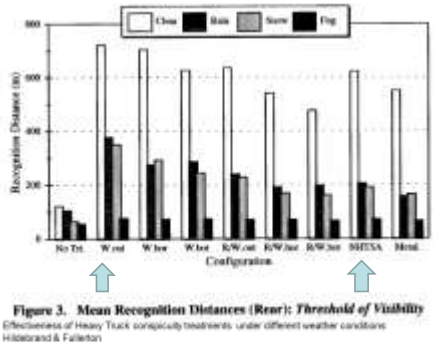


Figure 3. Mean Recognition Distances (Rear): *Threshold of Visibility*

Effectiveness of Heavy Truck conspicuity treatments under different weather conditions
Hildebrand & Fullerton

Case Study

Summit County - Colorado

- Snow & forest landscape

- Fluorescent yellow panels
- Staff in fluoro green/yellow
- White contour markings
- Reduced logo size
- Changed to rear chevrons later

Case Study

Summit County - Colorado

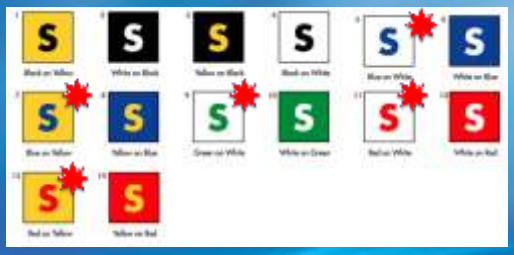
Signage & text

Signage & Text

Oversize & excess text/graphics is camouflage

Signage & Text

Only 5 combinations are effective for emergency vehicles



Signage & Text

100'	30'	3"
150'	40'	4"
300'	60'	6"
350'	80'	8"
400'	90'	9"
450'	100'	10"
525'	120'	12"
600'	130'	13"
750'	180'	18"
1000'	240'	24"
1250'	300'	30"
1500'	360'	36"
1750'	420'	42"
2000'	480'	48"
2250'	540'	54"
2500'	600'	60"

Case Study

ACT Ambulance Service

Protective clothing

Protective Clothing

Complex colour & pattern interaction between the landscape, vehicle markings, warning lights and safety clothing

Protective Clothing

Assess for different landscapes and colour deficient vision
Notice the long reflective tail panel


THE EFFECT OF COLOR CONTRAST ON DAYTIME AND NIGHTTIME CONSPICUITYOF ROADWORKER VESTS
James R. Sayer Mary Lynn Mefford - September 2000

Protective Clothing

Advantages of the H pattern over simple markings


Buonarosa, M. Sayer , J. Tuttle, S. (2008) *The Conspicuity of First-Responder Safety Garments: University of Michigan Transportation Research Institute*

Protective clothing

Change visibility garment or use two colour designs


SEASONAL VARIATIONS IN CONSPICUITY OF HIGH-VISIBILITY GARMENTS
MARY LYNN BUONAROSA , JAMES R. SAYER
University of Michigan TRI - 2007

Protective clothing

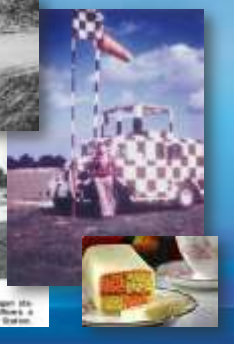
Two colours are more effective in some landscapes

Battenburg markings

Battenburg

Aviation origins of Battenburg





Tower on wheels directs Australian Navy fliers

Full Battenburg
Design principles by Home Office

- Identifiable at 500 metres (540 yards) on a motorway
- Increase the profile and recognition of police vehicles

Full Battenburg
Objectives

Clearly recognisable as a police car.
- The 500 metres minimum distance condition
- should apply during daylight hours in rain, mist, etc, *though not necessarily in heavy rain or fog*.
- Minimum illumination at night was …….. provided by an approaching vehicle with headlights set at the normal dipped position.
- This criterion applies without the roof lighting in operation

High Conspicuity Livery for Police Vehicles - Home Office

Half-Battenburg
Superior to Full-Battenburg in complex & city landscapes

Minimum visible distance: 270-300 yards

C. A simple evaluation exercise has indicated that it is likely that full battenburg livery offers little advantage over half battenburg livery within the visually cluttered context considered. Indeed the half battenburg livery performed the best in that environment.

High Conspicuity Livery for Police Vehicles - Home Office

Half-Battenburg
Superior to Full-Battenburg in complex & city landscapes

- The emphasis is on ease of recognition as a police vehicle to increase awareness among the public of the fact that police resources are present, thereby providing reassurance and a deterrent against crime; and
- Outright visibility is of lower importance since vehicles will generally be seen at close quarters by pedestrians and road users travelling comparatively slowly. It was suggested that the likely maximum viewing distance would be closer to 200m.

High Conspicuity Livery for Police Vehicles - Home Office

Battenburg
The great talent of Full Battenburg is recognition in low light

Battenburg
Official Colour combinations

Original test colour

"Other services " adopted colours that were not included in the Battenburg testing

Full Battenburg
Benefits

- Full Battenberg recognition = 500meters/600 yards
- Half Battenberg recognition = 200meters/220 yards
- UK has national standards and protects yellow & blue
- Blue/yellow is a true high-visibility marking scheme

Minimum visibility range for emergency vehicle 270-300 yards

Full Battenburg
Advantages

- Overlays & covers full side of any coloured vehicle
- Large block pattern - visually superior & conspicuous
- Includes fluorescent retro-reflective yellow/green
- Blue blocks – last colour to be visualised in low light
- Similarity to traditional police Sillitoe pattern
- Includes rear chevron pattern to ? reduce collisions
- Effective under different types of street lighting

Full Battenburg
Disdvantages

- Ignores fluorescence on front hood area of the vehicle
- Difficult to apply to small, curved/odd shaped vehicles
- Pattern has to be die-cut for most vehicle shapes
- High cost of materials and labour

Full Battenburg
Disdvantages continued

- Cannot sign-write over pattern
- Confusing when several vehicles visually overlap
- Rear chevron pattern has never been individually tested
- Different colour combinations are not as effective

Battenburg
In common use by the public across the UK

Battenburg markings
Not effective on some colours >>> visually confusing

Battenburg markings

Taking Battenburg to other countries

- Recognition factor is reduced or non-existent
- Cross-cultural variations & misinterpretation
- Colours other than police yellow/blue
- No standardisation of colour for Police, EMS & Fire
- Public use is not regulated
- Local legislation – may not permit Battenburg colours or patterns on local vehicles

Battenburg markings

Breaks up vehicle shape in complex landscapes

Battenburg

Open doors & hatches interrupts the integrity of the pattern

Battenburg

This layout in red becomes camouflage

Battenburg markings

Variations that confuse

Battenburg markings

Hybrid markings are not true Battenburg

Battenburg markings

You are never completely safe!

Chevrons

Chevrons

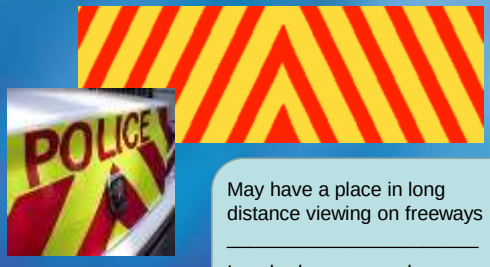
The original version

Chevrons

Queensland Main Roads descriptions

Fluorescent Colours

More research is needed!



May have a place in long distance viewing on freeways

In suburban areas: chevrons may increase rear collisions by forcing distance perception mistakes

Chevrons

Origins in Battenburg

Initially red & white before Battenburg

Borrowed for Battenburg adding fluorescent colours

Never tested separately for effectiveness

Chevrons

Facing two different ways

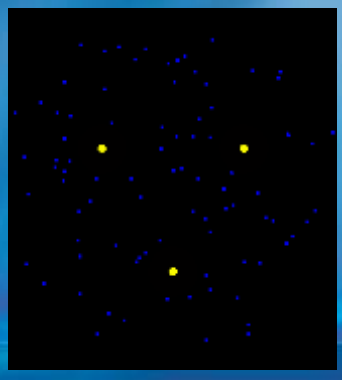
Looked but failed to see

Echalon parking – Graham Hole

- *59% occurred when the police vehicle was definitely parked `in-line'; in the case of the other reports, the orientation of the vehicle was not always explicitly recorded.*
- *All but one of the accidents occurred when there was only one police vehicle parked, due to it being either the first or last vehicle at the scene.*
- *The early deployment of warning signs and traffic cones did not guarantee detection of the parked vehicle.*

An analysis of `looked but failed to see' accidents involving parked police vehicles
MARTIN LANGHAM, GRAHAM HOLE, JACQUELINE EDWARDS and COLIN O'NEIL
{School of Cognitive and Computing Sciences, University of Sussex,

Looked But Failed To See



Wrong way up

The V-pattern should be inverted with points upwards

Skewed chevrons

Avoid pattern distortion to fit around vehicle architecture

Chevrons

Night-time trial of solid panel compared to chevron panel

Chevrons - unusual shapes

Do not attempt to cover entire rear surface with chevrons
Try using just the centre panel + contour markings

Chevrons

Chevrons diffuse & break-up the vehicle outlines

Chevrons – too close for comfort

Chevrons

Avoid attempts to match agency colour schemes or place text over the chevron panel

Chevrons

Is the solid fluorescent colour or the chevron most effective?

Chevrons

Side-facing chevrons confuse the issue even further

Chevrons

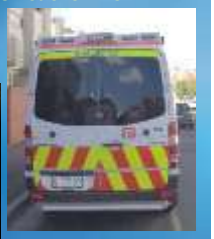
Complex or busy rear end – use a solid colour

Chevrons

Good rear door layouts but the right chevron needs cutting

Chevrons

25%-50% coverage works well and does not overwhelm



Chevrons

Am effective layout using the recommended wide stripes

Chevrons

Too narrow, blue has a low reflective value and crowding

Chevrons

Segments and checker-plate dot solutions do not work

+ crowded rear-end

Chevrons

The arch effect works well – here there are too many lights

Chevrons

Too much gear on the rear – often a simple stripe is effective

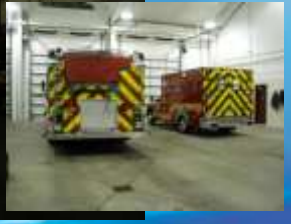
Depth of field

The chevron pattern can alter your perception?

↑ Fairing is sloping toward viewer

Chevrons

Confusing shapes – argument for solid fluorescent colour



Fluorescent Colour

The solid colour creates vehicle unity

Chevrons

Multiple panels or a chevron panel + contours make sense

Chevrons

Outline doors – don't add extra chevrons hatches

Fluorescent Colours

Accidents continue to happens LBFTS

Warning Lights

Warning Lights

Conspicuous
Recognizable
Help to define size and shape
Indicate course & speed
Generate an appropriate response

AV TOOLKIT

Warning lights for emergency vehicles

- Standardised warning colours
- Effective light output day/night
- Try not to mix different lamp types
- Use lamps with larger lenses (control glare)
- Synchronise all flashing lights
- Ideal flash pattern is double or quad flash
- Lamp ON time ≥ OFF time
- Consider steady burn lights
- Switch off any flashing white lights at night
- Avoid fitting lamps along sides at eye level

Light colour tests

Constant intensity tests (laboratory)		Real world trials
Poorest detection time (day & night)	Amber	Fastest detection times (day & night) with greatest glare (night)
Minimal glare (day & night)	Blue	Least glare (day & night)
Fastest detection time (day) Poorest for glare (day and night)	Green	Poorest detection time (night) least glare (night)
Fastest detection time (night) Least glare (day & night)	Red	Least glare (night)
	Magenta	Amongst slowest detection (day & night)

Warning lights

Flashing lights

- Not perceived as quickly as steady lights
- Once seen - attract and hold attention
- Often induce slower reaction times
- Flashing lamps (especially small lamps) require greater light output than steady-burn lights
- Increase difficulty of tracking a moving vehicle at night

"Fewer lights, flashing slower & less brightly"

Stephen Solomon

Warning Lights

Synchronisation

- Researchers agree – this is the preferred option
- Defines the vehicle - size and shape
- Improves perception of course and speed
- Reduces blue-red and motion illusions
- Recognition of a single vehicle within larger group
- Difficult to achieve with current systems

Warning lights

Is White is the brightest light under all conditions

Ideal *"attention-getter"*

Must be deactivated at night

Rapidly destroys observer's night vision

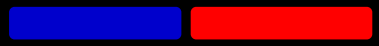
Warning Lights

Skylight effect – Blue lamps

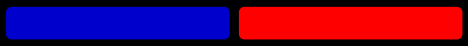
Warning Lights

Skylight effect – Red lamps

Vision & Visual Effects
Receding and advancing colour



Vision & Visual Effects
Receding and advancing colour



Vision & Visual Effects
Receding and advancing colour

Vision & Visual Effects
Receding and advancing colour

Vision & Visual Effects
Receding and advancing colour

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Receding and advancing colour

Vision & Visual Effects
Receding and advancing colour

Vision & Visual Effects
Receding and advancing colour

Vision & Visual Effects
Receding and advancing colour

Warning Lights
Steady Burn yellow

- Visible in all directions from the ambulance
- Observer can follow path and orientation of ambulance
- More easily seen by vision impaired observers
- Increases kerbside safety = “Ring of light”
- Very popular day & night with crews parked outside homes on busy streets

Warning lights
Steady-burn yellow lamps

Warning Lights
Yellow scene lighting

- Increases vehicle and personnel safety at scene
- One or two vehicles use red & blue flashing lights
- All other vehicles display steady yellow lights
- Distinct light groups enhance individual vehicle safety
- Reduces the “moth affect” and “wake effect”
- Decreases overall scene glare

Warning Lights

Warning Lights

Lamp state and conspicuity ratings

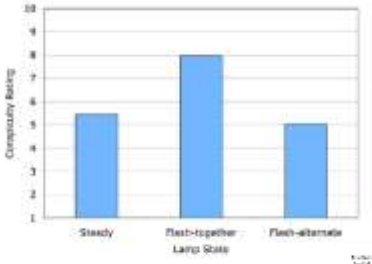

Figure 16. The effect of lamp state on conspicuity ratings.

Warning Lights

Lamp state and detection distance

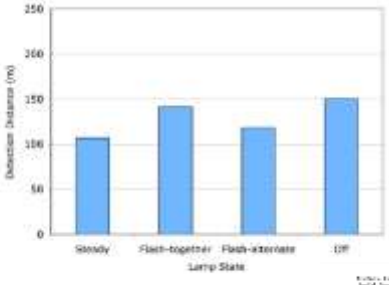

Figure 12. The effect of lamp state on detection distance.

Warning Lights

Blue lamps are more conspicuous than red

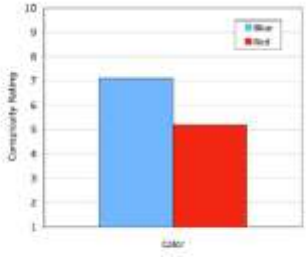

Figure 15. The overall effect of color on conspicuity ratings. This summary does not take into account the actual photometry of the blue and red lamps. See text for details.

Case Study

Ambulance Victoria – synchronised alternating red & blue

Case Study

Air Services – synchronised beacons

Ambulance
VISIBILITY

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