

## Ambulance Visibility Issues

- Viewer awareness
- A vehicle livery & marking model
- Optimizing livery & livery errors
- Color blindness & vision degeneration
- Rear-facing chevron design
- Case studies
- A warning light model

## Awareness Indicators

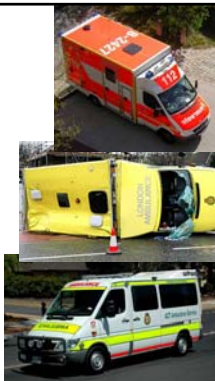
TIMELY, APPROPRIATE, SAFE REACTION

- Location
- Size
- Shape
- Speed
- **Intended path**



## Effective Base Colors

- Yellow green
- Euro Yellow RAL 1016
- Chromium Yellow
- White (+ fluorescents)
- Luminous Orange RAL 2005



Solomon, S.; King, J. Fire Truck Visibility. The Quarterly of Human Factors Applications, Volume 5, Number 2, April 1997, pp. 4-107

## Livery & Markings Model

- Retro-reflective/fluorescent panels or stripes
- Minimum 10% of total surface area
- No complex patterns
- Reflective outline of ambulance
- Minimise badges, text & signage
- Upper & lower case text
- Text - Black, dark blue, green
- Must be adaptable to different vehicles

Solomon, S. (1999) Emergency Vehicle Accidents-Prevention & Reconstruction, pp 65-79  
De Lorenzo, R; Eilers, M. Lights & Siren: A review of emergency vehicle warning systems, Annals of Emergency Medicine, December 1991



Fluorescence at dawn & dusk is a safety asset

Anders, R. (2000) On-Road Investigation of Fluorescent Sign Colors to Improve Conspicuity



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

De Lorenzo, R; Eilers, M. Lights & Siren: A review of emergency vehicle warning systems, Annals of Emergency Medicine, December 1991

## Livery Colors & Design

### Considerations

- Different working environments & landscapes.
- May need adjustment for differing cross-cultural interpretations or be country specific.
- Flexible layout to fit future vehicles.
- Visual interactions between single & multiple vehicles, the warning lights and staff clothing.
- **Making EMS staff proud enough to wash it!**

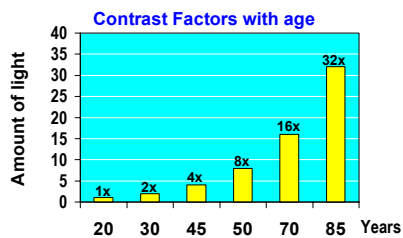
### Livery mismatch and corruption



### Avoid a thin waistline!



### Estimating size & direction from markings



- 9% of the general population are colorblind.
- Up to 50% of drivers require glasses or contact lenses to drive.
- Age-related vision degeneration increases after 40 years of age.

### Simulating the Color-blind Observer



Complex design & colour interactions between livery, warning lights and staff clothing

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

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## Rear-facing chevrons

- Almost no current research
- Wider stripes more effective
- Red & yellow color only?
- Do chevrons confuse or force depth-perception & braking errors in following drivers?
- Are they actually increasing the number of rear accidents?
- For motorway/rural use only?
- **Needs more research!**

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## Night recognition

### Thermal markings

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## Increasing safety with a 30% cost saving

Queensland Ambulance Australia

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## Summit County EMS - Colorado

New yellow vehicle markings

Staff use lime-green vests & jackets

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## A Warning Light Model



- Halogens, strobes & LED's should not be mixed
- Co-ordinated double flash - synchronised pattern
- Red & Blue component (or your authority colours)
- White forward facing flashing lamp - switched off at night
- Adequate light output in bright daylight & all weathers
- Optimise lamps to reduce glare for other drivers and personnel working at scene

## Pedestrian (worker) visibility



- Pedestrian visibility is reduced by glare from warning lights
- Longest detection distance – lamps flashing together
- Highest conspicuity - lamps flashing together
- Reflective clothing is effective, even under bright warning lights

Devonshire, J. Flannagan, M. (April 2007) - *Effects of Warning Lamps on Pedestrian Visibility and Driver Behaviour*

## Summary

### What we know

- Simple changes = large increase in safety
- The four visibility base colours are effective
- Fluorescent/reflective panels & stripes work

### What we don't know

- If chevrons decrease or increase the accident rate.
- How the latest livery designs perform when compared.

### What we need to know about

- The nature of visual interactions between the vehicle livery, warning lights & clothing under real conditions.
- Future visibility legislation that has design flexibility for different operational environments and encourages change as new research becomes available.



John Killeen  
Canberra, Australia

[www.ambulancevisibility.com](http://www.ambulancevisibility.com)  
[john@ambulancevisibility.com](mailto:john@ambulancevisibility.com)