



Colour, markings and warning lights for emergency vehicles

A safer workplace or a flawed corporate vision?



- * Accidents & research
- * Siren limitations
- * Human Vision
- * Vehicle markings
- * International livery
- * Warning lights



SAFE Ambulance Operations

- Efficient passage to incident
- In vicinity of ambulance on-scene
- Around the entire scene
- For transport or return phase



Criteria

- Rapid detection & perception over long and short distances
- Positive unambiguous recognition
- Maximum visibility
 - ☛ Day & night
 - ☛ Adverse traffic & weather



Driver Awareness

- ☛ Location
- ☛ Size
- ☛ Shape
- ☛ Speed
- ☛ Intended path

ALLOWS A TIMELY APPROPRIATE SAFE RESPONSE



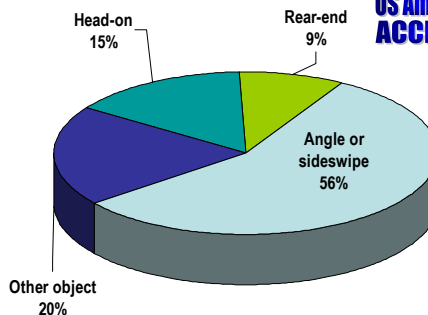
Safe recognition distance is 250 – 300 meters



Ambulance Accidents & Research



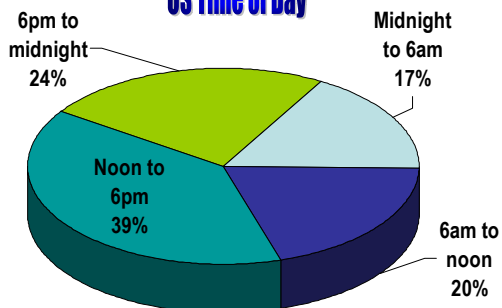
US Ambulance ACCIDENTS



Pre-hospital Emergency Care July/September 2001



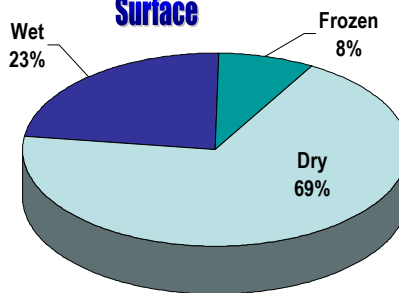
US Time of Day



Pre-hospital Emergency Care July/September 2001



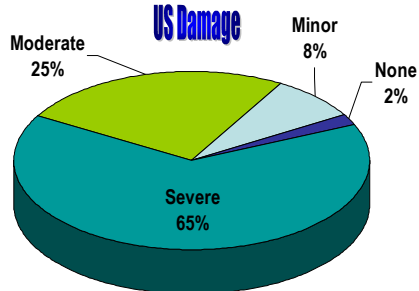
US Road Surface



Pre-hospital Emergency Care July/September 2001



US Damage



Pre-hospital Emergency Care July/September 2001



US Ambulance Accidents

Averaged Statistics

6,500 ambulance crashes per year

10 people injured every day

Fatalities average 2-3 month

74% - Ambulance is striking vehicle

Pre-hospital Emergency Care July/September 2001



US Ambulance Accidents 2

- 41% High risk driver*
- 22% Prior accidents
- 19% Speeding
- 8% Suspensions
- 1% DUI
- 11% Other vehicle convictions

Pre-hospital Emergency Care July/September 2001



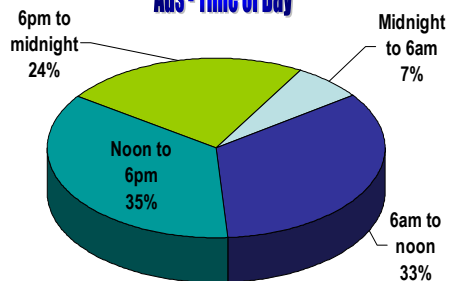
US Ambulance Accidents 3

- Speeding
- Fatigue
- Inadequate driver training
- Flawed dispatch procedures
- Ambulance driver distraction

Pre-hospital Emergency Care July/September 2001



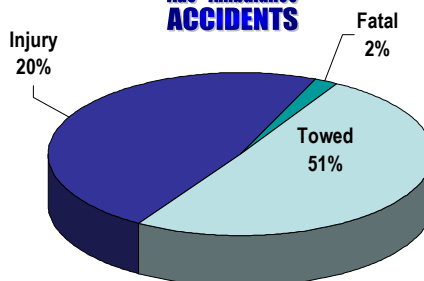
Aus - Time of Day



Monash University Accident Research Centre 2005



Aus - Ambulance ACCIDENTS



Monash University Accident Research Centre 2005



Aus - EMERGENCY VEHICLE Accidents

- 21% Speeding
- 1% Fatigue
- 0% DUI
- 0.6% No seatbelt

Monash University Accident Research Centre 2005



The highest number of ambulance accidents occur:

- afternoon
- dry roads
- clear weather
- at intersections



Litigation in the US

- Increasing litigation – driving research
- More operators being found at fault
- Vehicle litigation is 10x more than malpractice
- Most cases settled out of court
- intersection accidents = no insurance
- Speeding proven, sinks any defence.
- Response times are being questioned
- Dispatch procedures faulty



“It is 35 times more dangerous per capita to be in an ambulance in America than it is in Australia!”

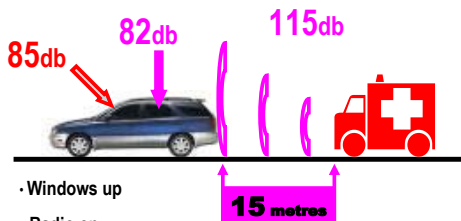
*Dr Nadine Levick
Safety researcher – Harlem Hospital*



Siren Limitations



Siren penetration – 60 kph



- Windows up
- Radio on
- Air conditioner

Stephen Solomon

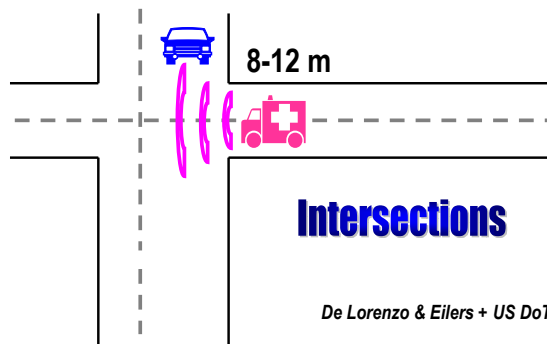


Siren penetration–100 kph



- Windows up
- Radio louder
- Air conditioner

Stephen Solomon

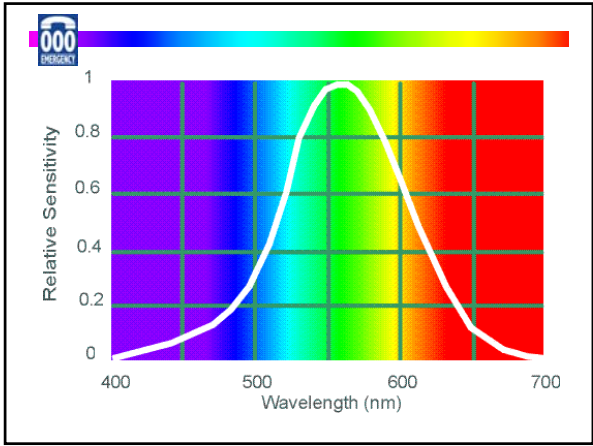


Intersections

De Lorenzo & Eilers + US DoT

000 ENERGY

HUMAN VISION



000 ENERGY

Viewing factors 1

Age
Adaptation State
Arousal level
Uncertainty

Stephen Solomon

000 ENERGY

Viewing factors 2

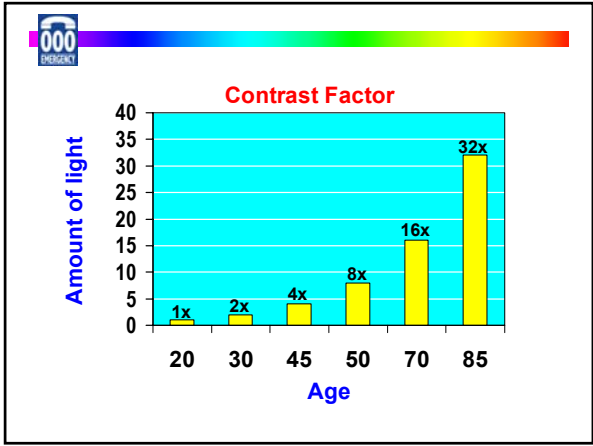
Experience & expectation
Optical correction
Eye conditions
Medication, drugs & alcohol

Stephen Solomon

000 ENERGY

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





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EMERGENCY

Environmental Factors 1

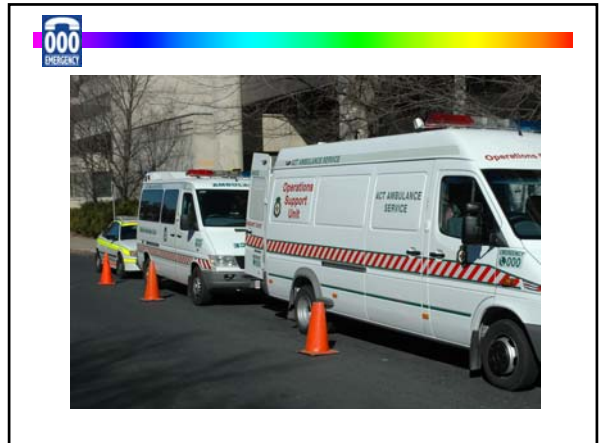
Size
Shape
Colour
Brightness
Motion

CONTRAST

000
EMERGENCY

Environmental Factors 2

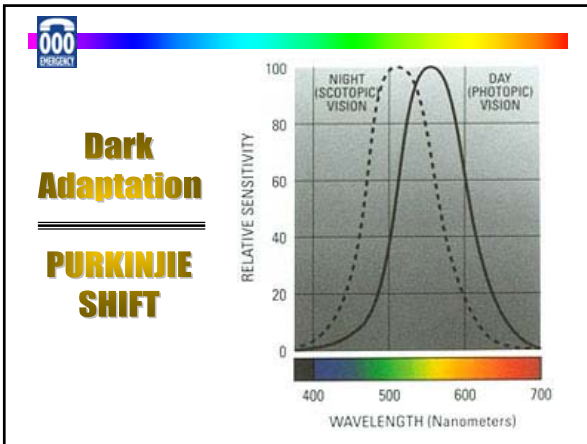
Distance
Visual Field location
Duration
Masking/camouflage
Glare



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EMERGENCY

“Anything that lengthens reaction time increases the chance of an unwanted event”

Stephen Solomon



Krovkov Effect

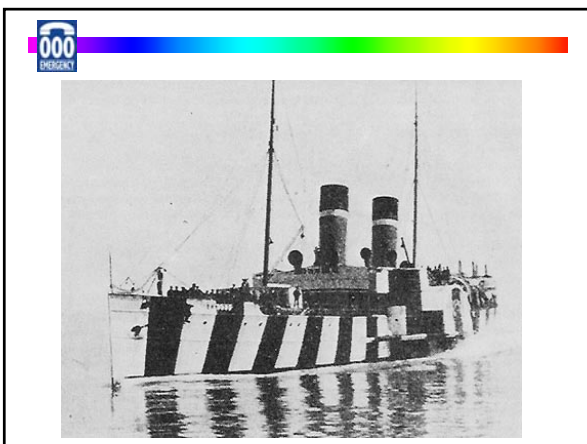
- Decreases red sensitivity
- Attenuates orange perception
- Increases blue response
- Green – yellow unchanged

Chromatic Aberration

- Different colours force the eye to change focus
- Slows reaction time
- Makes depth perception more difficult
- Can directly affect braking distance
- Dark colours + white are worst

“The multicoloured (patterned) ambulance while distinctive, may suffer decreased conspicuity because of the effects of camouflage”

De Lorenzo & Eilers



Micro-nystagmus

- Horizontal scanning pattern of eye
- Vertical or slanted lines disrupt and slow the recognition of shape

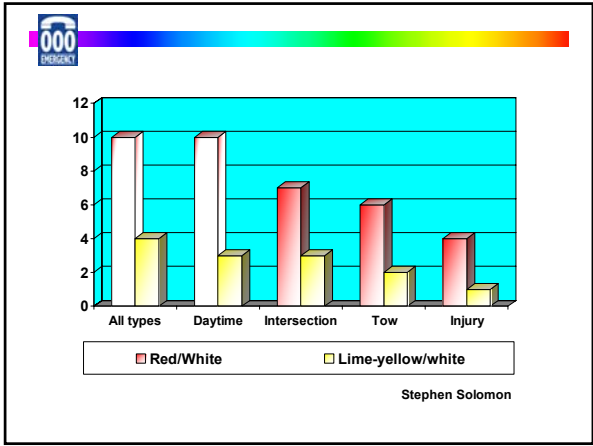
000 EMERGENCY

Patterns, vertical stripes and diagonal designs

Confuse size & shape

Slow object recognition

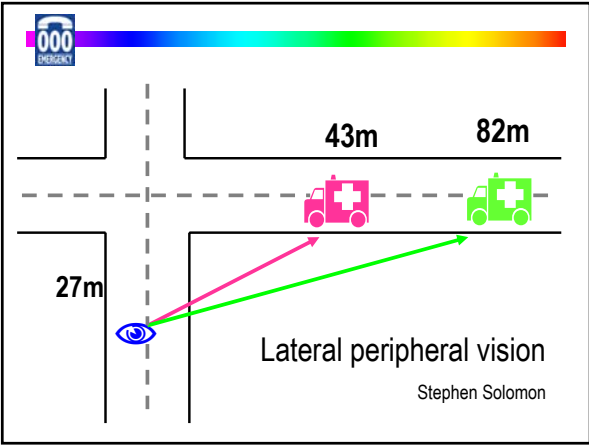
Waste reaction time



000 EMERGENCY

GREEN/YELLOW

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





Body Colour

Yellow green
Chrome or Euro yellow
White

Additional colour should be about
10% of total surface area



Body Markings

- **Retro reflective/Fluorescent stripes**
over 10% of total surface area
- **Absence of complex pattern**
- **Reflective outline of ambulance**
- **Minimal badges, text & signs**
- **Text in upper & lower case and black, dark blue or green**



Ambulance Markings in different countries



UK Battenberg + Euro Yellow RAL 1016



KKK-A-1 822



Australian Ambulance Colour

- Enhanced visibility
- Standardised colour
- Resale value
- Paint-matching repairs
- Heat reflection
- Ease of cleaning



Warning Lights



Warning Lights

- 🚒 Conspicuous
- 🚒 Recognizable
- 🚒 Define size and shape
- 🚒 Indicate course & speed
- 🚒 Generate appropriate response



- 🚒 Flashing & steady lights
- 🚒 Colour
- 🚒 Visually co-ordinated
- 🚒 Adequate light output in daylight & adverse weather
- 🚒 Controlled to prevent glare



Lamp types

Incandescent
Halogen
Gas Discharge (strobe)
LED
Electroluminescence



Wake Effect

- Loss of night vision by other drivers
- Caused by glare from warning lights
- Accident occurs after ambulance passes
- Difficult to quantify in research
- Also happens at large road incidents



Blue advancing - Red receding illusion

Flashing RED lamp

> 50% believed stationary light was moving away = Increased risk of rear end collision

Flashing BLUE lamp

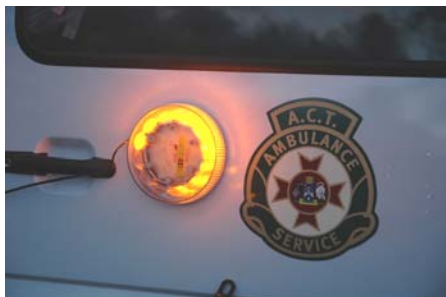
26% - 31% of believed stationary light was approaching

Berkhout



Ideal warning lights

- **Standardisation of colour**
- **Different types should not be mixed**
- **Lights should be synchronised**
- **On time > off time**
- **Glare should be controlled**
- **Include steady burn lights**



Flashing Lights

- Not perceived as quickly as steady lights
- Attract and hold attention, once seen
- Require increased light output over steady lights
- Difficult to track when in motion
- Often produce slower reaction times

"Fewer lights, flashing slower & less brightly"

Stephen Solomon



Synchronised Lights

- Most researchers agree
- Define a singular size and shape
- Better indication of direction and speed
- Isolates individual vehicles within groups
- Difficult to achieve with current systems



Yellow Scene Lighting

- Increased safety at scene
- One or two vehicles with flashing lights
- Other vehicles display yellow steady light
- Shows individual vehicles among group
- Reduces the "wake effect"



**Increased safety
for ambulance crews,
patients & the public**



Thank you

John.Killeen@act.gov.au