Institution: Loughborough University

Unit of Assessment: D34 Art and Design, History, Practice and Theory

Title of case study: Improving the conspicuity of high risk vehicles through ergonomics and design

1. Summary of the impact (indicative maximum 100 words)

The conspicuity of high risk vehicles has been improved through research in ergonomics design at Loughborough University from 1993 to 2005 funded by the Department for Transport; Home Office and a further organisation. This research founded an amendment to European Regulation (2010) and was identified as good practice (Sweden 2008; USA 2009) (research significance). The Battenburg markings, which represent the UK's first national police livery, have demonstrated a greater speed reduction amongst motorists and have been adopted by a number of countries worldwide (research impact and reach).

			[Image removed for publication]	[Image removed for publication]
a)Truck contour markings	*b) Police 'Battenburg'*	*c) Police motorcycle*		

2. Underpinning research (indicative maximum 500 words)

The following consolidated body of research, undertaken by Loughborough University, follows a user-centred design approach. It is founded upon ergonomics principles which are combined with robust scientific methods to address real world transport issues.

Conspicuous markings for police vehicles *(Commissioning body: Home Office).*

Motorway patrol vehicles (1991-1994: DS; SC & AS)*

The research founded a scientifically derived and validated marking standard which would enhance 'at a distance, conspicuity and recognition as a police vehicle'. Laboratory, field and road trials using samples of the UK driving public, police officers and police fleet managers were conducted. Overall the perceived conspicuity of the proposed 'Battenburg' markings (Fig b), compared against existing markings, was found to be superior by the driving public and police drivers. **[3.1] [G3.1]**

Motorcycles (1994–2003: DS; SC & AS)*

The research brief above was extended to police motorcycles/motorcyclists. Research included: state of the art review; accident/near miss/vulnerable situation police rider questionnaire; development/assessment of three concept marking schemes and comparative evaluation of finalised version against legacy schemes. Overall, the proposed markings (Fig c) exhibited superior mean luminance, contrast and visibility compared to the existing markings. **[3.2] [G3.2]**

Conspicuous markings for trucks *(Commissioning body: Department for Transport)*

Research into marking performance (1995–1998: DS; SC & CQ) *

A bespoke research programme, using representative samples of the driving public, assessed the performance and acceptability of proposed European truck conspicuity markings against UK practice. The research confirmed the superior performance of the proposed full vehicle contour markings (Fig a) and recommended regulatory amendment to additionally permit red markings and a minimum separation from the stop lamps of 200mm. **[3.3] [G3.3]**

Research into project societal impact (2003-2005: JR & CL) *

The research evaluated the relative costs/benefits to UK society for mandating the introduction of the proposed markings (Fig a). Research methods of accident data interrogation and stakeholder consultation were employed. It was concluded that restricting the markings to large trucks only could reasonably be expected to provide most of the potential benefit of the change in regulation. **[3.4] [G3.4]**

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3. References to the research (indicative maximum of six references)

3.1. [Text removed for publication]
Motorway patrol vehicle livery – Research report
The research culminated in the first national Home Office guidance publication for police car markings and has been cited as an example of international best practice by FEMA Federal Emergency Management Agency, USA. It was also awarded the Institute of Ergonomics and Human Factors 'Ergonomics Design Award 2013' as judged by representatives from the Design Council, the Chartered Society of Designers, the Royal Society of Arts, and Which? Magazine; the first time awarded to an academic institution. **[G3.1]**

3.2. [Text removed for publication]
Police motorcycle livery – Research report
The research report culminated in the first national Home Office guidance publication for police motorcycle/motorcyclist markings. **[G3.2]**

3.3. **Cook, S, & Quigley, C.** (1998) Motor vehicle and pedal cycle conspicuity: part 3 - retroreflective and fluorescent materials, final report. Ref 9/33/13. Department for Environment, Transport and the Regions. https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/545
This research report formed the basis of an amendment to ECE Regulation 104 which was debated amongst world experts at the World Forum for Harmonization of Vehicle Regulations - Working Party on Lighting and Light-Signalling. **[G3.3]**

3.4. **Richardson, J. & Lawton, C.** (2005) The safety benefit of retro-reflective markings on HGVs and Buses: Partial RIA (Regulatory Impact Assessment). Department for Transport. https://dspace.lboro.ac.uk/dspace-jspui/handle/2134/552
This research report was reviewed by experts within UK Government. **[G3.4]**

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4. Details of the impact (indicative maximum 750 words)

Taken together, the body of vehicle conspicuity research presented in Section 2 can be demonstrated to have had policy and practice impacts at national, European and international levels.

Conspicuous markings for police vehicles [3.3 & 3.4]

Nationally, it is estimated that the Battenburg markings have been applied to more than 95% of police vehicles equating to over 25,000 vehicles. The motorcycle marking scheme has been widely adopted with evidence suggesting safety improvements to motorcycle mounted officers when compared with heritage schemes **[5.1]**. Additionally, the Battenburg scheme has been further adopted by other UK emergency services including: ambulance; fire and rescue; national blood; HM coastguard; mountain rescue and rail response services **[5.2]** and is the subject of a Statutory Instrument concerning an Explanatory Memorandum to the Road Vehicle Lighting and Goods Vehicle Regulations 2009 and the Road Vehicles (Construction and Use) Regulations 2009. ***Significant*** impacts internationally include the influence on Vagverket, the Swedish Road Administration, whose own research demonstrated a 90% reduction in other vehicles travelling in excess of 15km/h over the speed limit in the vicinity of road maintenance vehicles marked with a Battenburg themed livery **[5.3]**. Furthermore, and with reference to the Home Office produced guidance documents resulting from this research **[5.1]**, the US Federal Emergency Management Agency acknowledged the significant research underpinning the UK Battenburg markings and cited it as the only example of international best practice. It also noted anecdotal evidence of its use across the range of emergency services in the UK, Australia, South Africa, Sweden, New Zealand and that 'Some public safety agencies in the United States have extrapolated the United Kingdom high-conspicuity liveries, including the Battenburg pattern, to their vehicles' **[5.4]**. Indeed, the chevron markings used to the rear of vehicles within the Battenburg marking scheme have been incorporated within the US National Fire Protection Association's standard for automotive ambulances – 2013 edition. Evidence of ***reach*** concerning the Battenburg markings is demonstrated in the number of countries which now use them **[5.2].** Sweden, in addition to the road maintenance vehicles discussed above, deploys the

Battenburg markings with respect to: police vehicles; ambulances and fire tenders whilst elsewhere in Europe, the Czech Republic employs the markings on ambulances and, in a modified form, on police cars**.** In the US, there is evidence of Battenburg markings applied to ambulances with the Vice President of the American Ambulance Service stating that 'It's safer for our responders, safer for the community and safer for the patients, because we can get there faster without having incidents of our own' **[5.5]**. There is also evidence of the presence of the Battenburg markings in Canadian ambulance liveries**.** In Hong Kong, Battenburg liveried vehicles, which have been tasked with patrolling strategic road networks, have been favourably received by front line staff who consider that it will ' . . .definitely enhance the safety of police officers and road users as it is very conspicuous and can be spotted from far away' and that it is 'clearly identifiable as a police vehicle'. In New Zealand, the Police Executive agreed that all vehicles will carry a blue/yellow half battenburg livery since, as stated by Acting Assistant Commissioner for Crime Reduction and Public Safety, this 'brings a consistent look to the marked vehicle fleet, with proven high-visibility and cost-savings associated with just one livery' **[5.6]**. In Australia, the Battenburg markings are in use on some fire appliance vehicles.

Conspicuous markings for trucks [3.1 & 3.2]

This research was used to inform the UK Government position on the acceptance of ECE Regulation 104 concerning retro-reflective vehicle markings. The research recommendations were discussed and approved at the United Nations by world experts at the World Forum for the Harmonization of Vehicle Regulations - Working Party on Lighting and Light-Signalling. The UK Department for Transport estimates the potential prevention of 76 killed or serious injury accidents annually if all goods vehicles have the ECE Regulation 104 conspicuity markings **[5.7]**. The research ***significance*** is the revision to ECE Regulation 104 **[5.8]** (and by implication to ECE Regulation 48) and its ***reach*** is indicated by the obligatory or optional adoption of the regulation in 24 EU member states as well as Australia, New Zealand, Norway, Russian Federation and Switzerland.

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5. Sources to corroborate the impact (indicative maximum of 10 references)

The following sources of corroboration can be made available at request.

5.1. Project Manager, Centre for Applied Science and Technology, Home Office

5.2. Wikipedia (2013) Battenburg markings http://en.wikipedia.org/wiki/Battenburg_markings

5.3. Granlund, Johan; Hedlöf, Stefan & Nilsson, Tommy (2008) Reinforcement markings on road maintenance vehicles with UK Battenburg patterns - Evaluation of the speed reducing effect http://www.ambulancevisibility.com/web_images/Reinforced%20marking%20of%20road%20maintenance%20vehicles-Swedish%20Translation2.pdf

5.4. FEMA (Federal Emergency Management Agency) (2009) Emergency vehicle visibility and conspicuity study. Department of Homeland Security. http:/www.usfa.fema.gov/downloads/pdf/publications/fa_323.pdf

5.5. Groves. Emily (2009) Emergency vehicles get new look - American Ambulance touts safety in European-style design. Norwich bulletin.com http://www.norwichbulletin.com/news/x931224855/Emergency- vehicles-get-new-look#axzz2838oxWyO

5.6. New Zealand Police (2008) Vehicles move to single livery. Ten One – Community edition. The New Zealand Police on-line magazine. http://www.police.govt.nz/tenone/20080229-306/March08Livery.html

5.7. Department for Transport (2008) Impact assessment of The Road Vehicle Lighting regulations amendment covering conspicuity markings on good vehicles. Quoted at: http://www.fta.co.uk/export/sites/fta/_galleries/downloads/conspicuity_guide.pdf

5.8. United Nations (2010) Uniform provisions concerning the approval of retro-reflective markings for vehicles of category M, N and O - Regulation No. 104 – Revision 1 http://www.unece.org/fileadmin/DAM/trans/main/wp29/wp29regs/r104rev.1.e.pdf

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