



Engagement and Impact 2018

Queensland University of Technology

QUT11-BCS (HLS) - Impact

Overview

Title

(Title of the impact study)

Translating vision research into national standards for high visibility clothing for night-time workers

Unit of Assessment

11 - Medical and Health Sciences

Additional FoR codes

(Identify up to two additional two-digit FoRs that relate to the overall content of the impact study.)

Socio-Economic Objective (SEO) Codes

(Choose from the list of two-digit SEO codes that are relevant to the impact study.)

88 - Transport

92 - Health

Australian and New Zealand Standard Industrial Classification (ANZSIC) Codes

(Choose from the list of two-digit ANZSIC codes that are relevant to the impact study.)

32 - Construction Services

50 - Other Transport

Keywords

(List up to 10 keywords related to the impact described in Part A.)

Night-Time Visibility

Biological Motion

Road Workers

Standards

Night-Time Driving Safety

High Visibility Clothing

Biomotion

Sensitivities

Commercially sensitive

No

Culturally sensitive

No

Sensitivities description

(Please describe any sensitivities in relation to the impact study that need to be considered, including any particular instructions for ARC staff or assessors, or for the impact study to be made publicly available after EI 2018.)

Aboriginal and Torres Strait Islander research flag

(Is this impact study associated with Aboriginal and Torres Strait Islander content?)

NOTE - institutions may identify impact studies where the impact, associated research and/or approach to impact relates to Aboriginal and Torres Strait Islander peoples, nations, communities, language, place, culture and knowledges and/or is undertaken with Aboriginal and Torres Strait Islander peoples, nations, and/or communities.)

No

Science and Research Priorities

(Does this impact study fall within one or more of the Science and Research Priorities?)

No

Impact

Summary of the impact

(Briefly describe the specific impact in simple, clear English. This will enable the general community to understand the impact of the research.)

Road workers at night can be difficult to see and risk being killed or injured at work. QUT's Optometry research team studied the night-time visibility of road workers and demonstrated that retro-reflective markers positioned in a 'biomotion' configuration on clothing can significantly enhance the night-time visibility of road workers, hence reducing their risk of collisions with vehicles.

Citing this research, the Aust/NZ Standards "Committee SF-004-03" introduced the 'biomotion' configuration into AS/NZS 4602.1 2011 (high visibility safety garments). The Queensland Department of Transport & Main Roads was an early adopter along with VicRail with others following, as high visibility clothing providers produced work clothing incorporating the 'biomotion' configuration.

Beneficiaries

(List up to 10 beneficiaries related to the impact study)

Night-time road workers (Queensland)

Road traffic controllers (Queensland)

Rail Workers (Victoria)

Queensland Department of Transport and Main Road

Workers wearing high visibility clothing

Countries in which the impact occurred

(Search the list of countries and add as many as relate to the location of the impact)

Australia

New Zealand

Details of the impact

(Provide a narrative that clearly outlines the research impact. The narrative should explain the relationship between the associated research and the impact. It should also identify the contribution the research has made beyond academia, including:

- who or what has benefitted from the results of the research (this should identify relevant research end-users, or beneficiaries from industry, the community, government, wider public etc.)*
- the nature or type of impact and how the research made a social, economic, cultural, and/or environmental impact*
- the extent of the impact (with specific references to appropriate evidence, such as cost-benefit-analysis, quantity of those affected, reported benefits etc.)*
- the dates and time period in which the impact occurred.*

The visibility of pedestrians and road workers at night is a significant road safety issue, representing 14% of road fatalities in the US and Australia in 2013, with 72% of these fatalities occurring at night. A variety of approaches have been used to make pedestrians more conspicuous to drivers at night, including vehicle and roadway lighting technologies and night vision enhancement systems. However, QUT Optometry researchers, led by Prof Wood, have clearly demonstrated, through a series of studies, a more effective, economical and practical approach for improving visibility of people at night. This approach involves positioning retro-reflective markers on their clothing, at the moveable joints, to create a sensation of "biological motion" (biomotion). This research, carried out over a decade from 2004, was the primary evidence base the AS/NZS 4602.1 standard was changed in 2011, providing a legislative framework to aid in the protection of workers operating in low light situations. The background research involved a collaboration/partnership with international researchers including Professor Richard Tyrrell at Clemson University, USA. The industry partner was Queensland Main Roads (MR), now merged with Queensland Transport to form Transport & Main Roads (TMR), and with RoadTek (a commercialised arm of TMR), which is the main employer of road workers in Queensland with responsibility for implementing road worker clothing standards. The research built on a long and productive relationship with TMR who has collaborated with Prof Wood on several projects.

While QUT had strong evidence regarding the conspicuity (visibility) advantages of biomotion clothing under controlled closed road conditions, a critical factor in demonstrating the application and translation of this research into practice, was to also demonstrate its effectiveness in the context of road work sites - visually complex environments that can involve temporary and challenging alterations in traffic patterns, signage and lighting. This added complexity could potentially alter the value of conspicuity aids such as biomotion retro-reflective markers.

Funding from an ARC Linkage grant with industry partner TMR, enabled the QUT Optometry researchers to show the addition of retro-reflective markers to clothing in a biomotion configuration did indeed enhance the detection of people at night in complex closed and in-traffic environments. This research was disseminated in a pivotal presentation by QUT, at the 2010 US Transportation Research Board meeting in Washington DC. Attendees included an industry representative from the Australian/New Zealand Standards Committee SF-004-03: "Light reflective protective clothing", which was reviewing the standard AS/NZS 4602.1 (High visibility safety garments – Garments for general use), the guideline for Australasia.

The ongoing review of the Standard had reached a critical point where a draft was about to be circulated. As a result of QUT's research presentation at this meeting, followed by representations from QUT's TMR collaborator and with the interest and cooperation of the Australian Standards officer, the recommendations of the research were incorporated into an informative appendix to the existing draft Standard. This rapid translation of research into guidelines was a significant achievement. Following a prescribed period of consultation and amendment, the revised standard AS/NZS 4602.1 2011 came into effect in 2011. Importantly, it incorporates the recommendations made on the basis of the QUT research (AS/NZS 4602.1:2011, Appendix B, p17) which cites Ref [4] (see section A7).

The importance of the research was immediately clear to TMR and their advocacy for it to be quickly adopted resulted in their Workplace Health and Safety Branch pre-empting the change in the AS/NZS standard ensuring the 'biomotion' requirement was incorporated into the state purchasing contract in 2011/2012. The impact of this process of collaborative research and translation into practice is that all road workers exposed to traffic at night in Queensland now wear clothing that complies with the recommended standard of 'biomotion' retro-reflective markers that were contributed to by QUT.

The 2011 AS/NZS Standard recommends adding 5cm wide retro-reflective strips just above the elbow and around the wrist for sleeves and just above the knee and around the ankle for legs, facilitating the significant visual benefit of what is commonly referred to as 'biomotion'. The evidence of its effectiveness in improving visibility and hence safety, plus the negligible cost to manufacturers of introducing this to high visibility clothing, means that companies such as Hard Yakka® and Maxcool Workwear® have adopted the recommendation with the expectation that it will be mandated in the future.

Around Australia a range of other work areas that require visibility of workers at night or in low light are now mandating the use of 'biomotion' work wear. In 2014 Metro Trains Melbourne (Vic Rail) included 'biomotion' as a clothing standard requirement for all rail track staff. In July 2016, TMR mandated 'biomotion' be applied to all traffic controller shirts, weatherproof garments and trousers worn by traffic controllers working in periods of darkness. Papers presented by the QUT researchers at the 2015 NSW Coal Operators Conference and Queensland Mining Safety Conference also illustrated the safety benefits of 'biomotion' clothing to the mining industry, where work in low light levels is prevalent and hazardous.

Overseas, bio-motion has been incorporated into high visibility clothing standards. The International Standard for High Visibility Clothing ISO 201471:2013 Appendix D, D4.1 p21, refers to the 'biomotion effect', stating that it has been demonstrated to be useful for drivers to recognise a distant object such as a human being through motion cues; this further indicates the wide reaching impact of the research.

Associated research

(Briefly describe the research that led to the impact presented for the UoA. The research must meet the definition of research in Section 1.9 of the EI 2018 Submission Guidelines. The description should include details of:

- what was researched*
- when the research occurred*
- who conducted the research and what is the association with the institution)*

QUT research, undertaken under closed road conditions, demonstrated that clothing with retro-reflective markers on the moveable joints creates a sensation of "biological motion", highly effective in improving the visibility of pedestrians and road workers at night. Drivers recognised a pedestrian wearing biomotion markers at a 3.4x longer distance than when wearing a vest with an equal amount of retro-reflective material (ref [1] in A7). The visibility advantages of biomotion configurations are robust to the effects of driver age (ref [1],[9]), visual impairment, optical blur & headlight glare (ref [3],[6],[9],[10]), visual clutter surrounding the pedestrian [2] and allows determination of pedestrian walking direction [9].

To validate the application of biomotion clothing for road workers at on-road sites, additional "real world" driving studies were undertaken under in-traffic conditions at suburban and freeway sites, as well as on a closed road (ref [4],[5],[8]). This research provided the first robust evidence of the visibility benefits of biomotion markings in both closed and open-road work zones, providing the required evidence to incorporate biomotion markers into AS/NZS 4602.1 2011 standard for a range of workers across Australia [7].

The research conducted by the QUT Optometry team between 2004 and 2016 included collaboration with Prof Richard Tyrrell and his research team at Clemson University, USA and industry partner TMR and RoadTek.

FoR of associated research

(Up to three two-digit FoRs that best describe the associated research)

11 - Medical and Health Sciences

References (up to 10 references, 350 characters per reference)

(This section should include a list of up to 10 of the most relevant research outputs associated with the impact)

[1] Wood, JM, Tyrrell RA, Carberry TP (2005) Limitations in drivers' ability to recognise pedestrians at night. Human Factors, 47(3), p.644-653. DOI:10.1518/001872005774859980

[2] Tyrrell RA, Wood, JM, Chaparro A, Carberry TP, Chu BS, Marszalek RP (2009) Seeing pedestrians at night: Visual clutter does not mask biological motion. Accident Analysis & Prevention, 41(3), p.506-512. DOI:10.1016/j.aap.2009.02.001

[3] Wood JM, Chaparro A, Carberry TP, Chu BS (2010) Effect of simulated visual impairment on nighttime driving performance. Optometry & Vision Science, 87(6), p.379-386.

[4] Wood J, Marszalek R, Lacherez P, Tyrrell R, Chaparro A (2010) In M.R. Morris (Eds). Perceptions of visibility and conspicuity of biomotion clothing configurations for road workers at road work sites. Transportation Research Board 89th Annual Meeting Compendium of Papers (pp.1-10). United States of America: Transportation Research

Board.

[5] Wood JM, Tyrrell RA, Marszalek R, Lacherez P, Chaparro A, Britt T (2011) Using biological motion to enhance the conspicuity of roadway workers. *Accident Analysis & Prevention*, 43(3), p.1036-1041.
DOI:10.1016/j.aap.2010.12.002

[6] Wood JM, Tyrrell RA, Chaparro A Marszalek, R, Carberry T, Chu BS (2012) Even moderate visual impairments degrade drivers' ability to see pedestrians at night. *Investigative Ophthalmology & Visual Science*, 53(6), p.2586-2592. DOI:10.1167/iops.11-9083

[7] King MJ, Wood JM (2013) Translating vision research into policy and practice to improve the visibility, and hence safety, of road workers at night. *Road & Transport Research*, 22(3), p.62-71.

[8] Wood JM, Marszalek R, Lacherez P, Tyrrell RA (2014) Configuring retroreflective markings to enhance the night-time conspicuity of road workers. *Accident Analysis & Prevention*, 70, p.209-214.
DOI:10.1016/j.aap.2014.03.018

[9] Wood JM, Tyrrell RA, Lacherez P (2014) Seeing pedestrians at night: effect of driver age and visual abilities. *Ophthalmic & Physiological Optics*, 34(4), p.452-458. DOI:10.1111/opo.12139

[10] Wood JM, Marszalek, R, Carberry T, Lacherez P, Collins MJ (2015) Effects of different levels of refractive blur on night-time pedestrian visibility. *Investigative Ophthalmology & Visual*, 56(8), p.4480-4485.
DOI:10.1167/iops.14-16096

Additional impact indicator information

Additional impact indicator information

(Provide information about any indicators not captured above that are relevant to the impact study, for example return on investment, jobs created, improvements in quality of life years (QALYs). Additional indicators should be quantitative in nature and include:

- name of indicator (100 characters)*
- data for indicator (200 characters)*
- brief description of indicator and how it is calculated (300 characters).)*