**Institution: Birmingham City University**

**Unit of Assessment: 19**

**Title of case study: Occupational health and safety management of plant and machinery in business**

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

The Centre for Business, Innovation and Enterprise (CBIE) has conducted extensive research that has significantly, positively impacted upon the health and safety management of plant and machinery, throughout businesses in the UK and internationally. The outputs of this research are firmly embedded within an academic multi-collaborative framework that has profited from tangible contribution via partnerships with business, industry and government stakeholders. The impact has benefitted original equipment manufacturers (e.g. JCB); the equipment supply chain (e.g. Hilti UK Ltd., A-Plant plc.); end users (e.g. the US and UK armed forces); and society at large, by making people's workplaces safer.

**2. Underpinning research** (indicative maximum 500 words)

The importance of health and safety (H&S) management among (all types of) business has become increasingly important over recent years. This is evidenced through increasingly stricter legislation and, frequency of legal action against those that do not comply. CBIE has helped businesses in many sectors to improve their H&S management regimes, specifically, in the fields of: i) exposure to hand-arm vibration (HAV) (most recognised for its leading to 'vibration white finger'); ii) mini excavator stability (these machines have a tendency to overturn); and iii) excavators as cranes (using an excavator designed primarily for earth moving, to lift static loads).

***2.1. Hand-arm vibration (HAV)***

The HAV research derived accurate vibration levels (i.e. that an operative is exposed to) for almost all hand-held or -guided machinery in common use. These data are used in designing acceptable exposure times to such machinery as the first line of defence against hand-arm vibration syndrome (permanently debilitating illness affecting musculoskeletal, neurological and vascular systems). The research commenced in 2002 whilst Edwards worked at Loughborough University and has since been consolidated into practical business solutions in partnership with Holt at CBIE. Tangible outputs are: the now internationally used Hand-arm Vibration Database housed at OPERC; production of professional standards, industry guidance and training materials; and positive influence on health and safety policy. In 2011 the researchers were awarded a medal from the US Department of Defense who now widely use the various products of HAVTEC research to assess HAV risk amongst military personnel. *Underpinning research outputs: Edwards and Holt (2010a; 2010b).*

***2.2. Mini excavator stability research***

This strand of research was commenced by Edwards and Holt at CBIE in 2010 and was initially undertaken with utilities company Morgan Est. It was subsequently tested at the 'business face' in collaboration with Balfour Beatty Utilities Solutions (BBUSL), Scottish and Southern Electricity, and their associated supply chains of hire companies (including: Speedy Hire, A-Plant and GAP). Principal outcomes were: knowledge of machine operator competence and behaviours contributing to machine instability; and determination of significant physical machine characteristics that encourage /mitigate tendency to overturn. The research culminated in industry best practice technical guidance published through OPERC that has been adopted by many businesses to inform training and education of workers. The research has also informed original equipment manufacturers in helping to engineer-in stability enhancing characteristics – most notably J.C. Bamford excavators Ltd. *Underpinning research outputs: Edwards and Holt (2010c; 2011).*

***2.3. Excavators used as cranes***

This research addressed the problem of incidents that were occurring when excavators (a machine designed primarily for earth moving) was used as an item of mechanical lifting equipment to move static loads on site. Following a series of fatalities from this, consultation with industry was undertaken and best practice guidance was produced. The work was sponsored by Morrison Utilities and BBUSL, JC

Bamford Excavators Ltd, hire company A-Plant and the construction contractor Costain. *Underpinning research outputs: Edwards and Holt (2010d); Riaz et al., (2010).*

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

Edwards, D. J. and Holt, G. D. (2010a). Analysis of Hand-Arm Vibration Risk to Highway Utilities Maintenance and Repair Operatives. *Automation in Construction*. Vol.19, No.5, pp. 580-587.

Edwards, D. J. and Holt, G. D. (2010b). Cost-effective Risk Assessment of Hand-arm Vibration exposure. *Journal of Financial Management of Property and Construction*. Vol.15, No. 2, pp. 158-175.

Edwards D. J. and Holt, G. D. (2010c). Case Study Analysis of Construction Excavator H&S Overturn Incidents. *Engineering, Construction and Architectural Management.* Vol. 17, No. 5, pp. 493 – 511.

Edwards, D. J. and Holt, G. D. (2010d). Case Study Analysis of Risk from Using Excavators as 'Cranes'. *Automation in Construction*. Vol. 19, No. 2, pp. 127-133.

Edwards, D. J. and Holt, G. D. (2011). Mini-Excavator Safety: Toward Innovative Stability Testing, Procurement, and Manufacture. *Journal of Construction Engineering and Management,* Vol. 137, No. 12, pp. 1125-1133.

Riaz, Z., Edwards, D. J. and Holt, G. D. (2010). Data Flow and 'Constant Comparison' Analysis of Plant and Equipment H&S Management Processes. *International Journal of Project Planning and Finance*. Vol. 1, No. 1, pp 125-154.

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

***4.1. Impact claims***

This research has generated positive impact at the following levels:

- *Economic* – through organisational beneficiaries having access to improved (H&S) processes;
- *Public policy and services* – through informing HSE guidance/website and UK/US armed forces personnel;
- *Society* – through enhanced workplace welfare and the reduction of costs to society from workplace H&S incidents;
- *Health and Welfare* – human beneficiaries whose quality of life has been protected through mitigation of workplace risks;
- *Practitioners and services* – organisational beneficiaries whose H&S regimes have benefited from technical guidance; and
- *The Environment* – groups of individuals that gain from improved workplace safety.

***4.2. Impact evidence***

The products of CBIE's continuing research into plant and machinery health and safety management are now universally accepted as being a prime source of reliable professional practice standards and health and safety guidance.

*Hand-arm vibration*. Edwards and Holt designed the hand-arm vibration test centre (HAVTEC) which provides freely accessible independent data on power tools vibration emissions. This source is highly respected, endorsed by the construction industry and major hire companies such as A-Plant and utilised internationally by a broad spectrum of public and private sectors organisations. Edwards is the sole academic representative on the HSE's Noise and Vibration Partnership group (a position held to this day) and Holt is a regular peer referee for HSE vibration related publications, technical guidance and web content. BBUSL and Ashstead Plant Hire Limited, Speedy Hire and GAP (who between them represent 80 percent of the UK plant and equipment hire market) and now use HAV guidance documents throughout their outlets designed on this research. An 'at-a-glance' A1 HAV poster especially intended for the workplace designed by Edwards and Holt, is also used in such outlets and, among research institutes, professional practices, government bodies, The US Department of Defense [sic] and international industry.

CBIE's excavator stability research led to the production of a technical report that was submitted to the OPERC trade body for publication and distribution amongst sponsoring organisations. The results and

recommendations of this work have extensively been used by several companies within the utilities (including Morgan Est., Scottish and Southern Electricity, BBUSL and Morrison Utilities) sector to change and modify systems, procedures and processes that mitigate machine turnover risk. Tangential impact has also facilitated an improvement in the training and competence assessment of operatives and management, to equally mitigate risks through people's workplace mind-set and actions. Organisational procurement processes now actively seek to purchase the most inherently safe-by-design machines which equally have resulted from impacting OEMs to engineer-in solutions.

Research on excavators being used as cranes has led to the publication of two industry best practice standards that have been widely adopted and endorsed by extensive array of prestigious blue chip companies. These companies include JCB, BBUSL, Costain, Mentor FLTT, Morrison Utilities, Hewden Plant Hire and Finning (Caterpillar) UK. In turn, this guidance has influenced innovative manufacturing design (among sponsoring companies), contributing to a reduction in fatalities involving these machines within industry and provided industry with comprehensive training and educational materials with which to implement safer systems of working. It has also influenced HSE policy.

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

***5.1. People:***

- Health and Safety Manager, Simons who also acted as the lead contact for HAV within the then UK Major Contractors Group (MCG).
- Marketing Director and Strategic Accounts Director, A-Plant to confirm sponsorship of plant health and safety documents, grants awarded and sponsorship support.
- Head of Noise and Vibration Policy, Health and Safety Executive to provide impartial feedback on all work completed and contributions to government and industry policy.
- Group Director of Health, Safety and the Environment, Morrison Utilities Ltd. who can confirm use of the work study research.
- Head of Plant and Logistics Services, Balfour Beatty Utility Solutions who can verify that the work has improved plant and machinery policy, standards and procedures.

***5.2. Other corroborating evidence:***

- Vibration Pocket Guide: A Guide for Prioritizing Hand-arm Vibration Exposure (2012), Army Institute of Public Health, US Department of Defense. (This work confirms the use of the research and Commander's medal awarded; emails and physical evidence is available).
- Holt, G.D. and Edwards, D.J. (2013). *Guidance on Using Excavators for Object Handling (Using Excavators as 'Cranes').* Off-highway Plant and Equipment Research Centre. ISBN: 978-1-906977-07-8. (Technical guidance used among industry).