Institution: Coventry University

Unit of Assessment: 34

Title of case study: Integrating Human Factors into Health Design

1. Summary of the impact.

This case study highlights research excellence in health design by a Group of four multi-disciplinary researchers. Collectively the Group of researchers apply user-centred approaches to design and evaluation of products and services which improve health and wellbeing. The Group employs user-engagement throughout the design lifecycle to achieve societal benefits through improved products, information, services, and systems. The research has delivered:

- **Economic Impact**: by working with companies and organisations to deliver new products for the growing market in assistive technologies and services which support health and lifestyle improvements
- **Health Impacts**: by improving health and quality of life for those with specific conditions and disabilities. This includes working with medical practitioners to translate ideas into products.
- **Impact on User Engagement in Policy Making**: by addressing the challenges of collecting the needs and views of hard-to-reach groups and by using their techniques to develop Europe-wide guidelines for telehealth care services.

Beneficiaries include end-users of assistive technology, patients with long-term conditions and their carers, medical practitioners, policy makers and commercial organisations.

2. Underpinning research.

The Health Design Technology Institute (HDTI) [A] hosts both commercial and academic research in health design with a particular, but not exclusive, focus on assistive technologies. The HDTI provides testing and prototyping facilities. This focus on health design has brought together an interdisciplinary group consisting of **Shippen** (Biomechanics of Human Movement), **Woodcock** (Educational Ergonomics and Design), **Moody** (User-Centred Health Design) and **Ward** (Assistive Technology). Shippen joined Coventry University in 2006, Woodcock in 1999, Moody in 2006 and Ward in 1999 and all remain in post.

The research integrates understanding of the physiology, biomechanics and psychology of humans and the implications for the application of technology. The Human Factors focus has developed from Shippen's research on human physiology [3], [F]. He has applied this to calculate muscle loadings determined by certain movements and product interactions e.g. opening a car door. This biomechanical analysis and anatomy expertise was brought together in the development of new human modelling software, which has since been applied to design and performance improvements in areas as diverse as dance, sport and vehicle design. Woodcock's, Moody's and Ward's research has led to a richer understanding of the Human Factors of specific groups, such as those with specific disabilities e.g. [1] or conditions associated with old age [C], [F].

The advantages of undertaking a User-Centred Design approach to product and system development has been well articulated by ergonomists over many years. However, the Group's research with Small to Medium-sized Enterprises (SMEs) has shown that, although the need is understood, the practice of User-Centred Design may not be followed as thoroughly as articulated in ISO 13407. The reasons for this are varied but are mainly due to lack of knowledge, limited choice of methods and inappropriate tools. To ensure the user is central to the design process, the Group has applied its members' research knowledge and expertise in ergonomics and design directly to industry, through research and consultancy supported by the HDTI.

The Group has developed new models and methods of working such as the Hexagon-Spindle model [5]. In addition, the Group has undertaken interdisciplinary research with engineers, clinicians and human geographers to support projects with large organisations, SMEs and others to engage meaningfully with wider and previously excluded groups e.g. children, older people and those with disabilities [2], [D].

The practical application of the new research models developed by the Group has focused on the design of products and services for new markets. The Group developed expertise in delivering health and lifestyle improvements especially to under-represented or hard to reach communities. This research has been supported by funding from TSB in particular [C]. Such projects have involved the Group and companies working together to determine the needs of new markets, and

developing products to meet the functional and emotional needs of the user Group. The Group research has been recognised by other companies and organisations which have engaged Group members to tackle work in related areas [4], [B].

3. References to the research

1) Ward, G., Holliday, N., Fielden, S and Williams, S. (2012) "Fall detectors: a review of the literature", Journal of Assistive Technologies, Vol. 6 (3) pp. 202 - 215. ISSN: 1754-9450. DOI: http://dx.doi.org/10.1108/17549451211261326. IF = 0.273 (SJR) IF = 0.466 (SNIP).
2) Moody, L. Choudhry, K. (2013) Views on the Provision of Informed Consent for Expanded Newborn Screening, Health Expectations Volume 16, (3), pp 239–250. DOI: http://dx.doi.org/10.1111/j.1369-7625.2011.00710.x IF = 0.793 (SJR) IF = 1.200 (SNIP)
3) Shippen, J., and May, B. (2010) Calculation of muscle loading and joint contact forces during the rock step in Irish dance. Journal of Dance Medicine and Science. Vol. 14 (1) pp 11-18. ISSN 1089-313x. IF = 0.164 (SJR). Citations = 3
4) Moody, L. (2010) *Development of a Crisis Competency Profile and Evaluation of Crisis Workshops.* Confidential Report for Unilever
5) Woodcock, A., Woolner, A. and Benedyk, R. (2009) Applying the Hexagon-Spindle Model to the design of school environments for children with Autistic spectrum disorders. Work: A Journal of Prevention, Assessment and Rehabilitation 32 (3) pp 249-59. ISSN 1051-9815. DOI: http://dx.doi.org/10.3233/WOR-2009-0823 IF = 0.271 (SJR) IF = 0.949 (SNIP) IF = 0.513

Key Research grants

A. PI: A. Woodcock, Title: Health Design Technology Institute (HDTI) Sponsor: HEFCE and Advantage West Midlands (AWM), Period: 2006 Funding: £19.5m (HEFCE £15m, AWM £4.5m)
B. PI: L Moody Title: Identification Of Global Crisis Training Providers & Development of Crisis Training Materials & Scenario Bank. Sponsor: Unilever, Period: 01/11/2008 – 30/11/2009 Funding: £35,943 (original plus follow on)
C. PI: Gillian Ward Title: i-Focus Warm Neighbourhoods Service Design, Sponsor: The Advanced Digital Institute (ADI) through the TSB, Period: 1/6/12 – 31/1/13, Funding: £65,000
D. PI: L. Moody, Title: Exploring Parental Experiences Of Receiving False Positive Screening Results, Sponsor: Sheffield Hospitals Charity Period: 2012-2014, Funding: £23,744.00
E. PI: A. Woodcock Title: The use of digital technologies by connected communities, Sponsor: AHRC, Period: 2010, Funding: £32,000 to Coventry
F. PI: J. Shippen, Title: Biomechanical analysis of dancers to reduce injuries Sponsor: Leverhulme Trust, Period: 30/9/07 – 31/8/10 Funding: £95,000

4. Details of the impact

The group's research has made tangible improvements in wellbeing, health and quality of life, by progressing the design, development and implementation of products, services and policy guidelines. The research has also supported companies and organisations to unlock new markets and strengthen the quality of products and services in the assisted living sector which worldwide has over 1.5 billion consumers. Examples of the main categories of impact are described below.

Economic Impact: Since 2007 the group's research expertise has supported over 197 companies and organisations to deliver 141 products and 9 services [A]. These companies have been assisted in expanding into new markets and successfully launching products, and have thereby also increased employment. While the research has focussed on health and assistive living products and services, the Group's expertise in obtaining hard to collect information has been recognised more widely. For example, the Group provided Human Factors consultancy to Unilever [4], [a], one of the world's largest consumer goods companies. The research contributed to the design of a global strategy for crisis prevention and response to ensure the health and wellbeing of the Unilever business, customers and employees. The 'crisis toolkit' has been used internationally to guide teams in situations as diverse as disaster recovery (e.g. the recent flooding in Thailand) and in crisis management that could damage Unilever's global reputation. Unilever has provided follow-on funding for further research and consultancy.

The Group and staff at the HDTI have worked with entrepreneur Ian Jones to develop a series of

innovative walking aids and accessories. New materials and manufacturing processes were used to create a comfortable and stylish walking stick handle, crutch handle and a flexible ferrule. The innovative walking aid, developed for Abianco Holdings Ltd has since sold 1,000 units to the US and Germany. Abianco Holdings Ltd is now planning production of 100,000 units which will deliver further economic impact as a result of the job creation in the companies employed during the prototype manufacturing phase [c].

Similarly the Group used its research techniques and models [5] to user-test a new adaptable underwear range for Adaptawear. Feedback from the usability trial found that the product gave the wearer a greater sense of independence which had significant impact on the health and well-being of arthritis sufferers and their carers. By July 2013 Adaptawear had sold 1,000 of its unique and adaptable brassieres in to this specialist market. The success of this product contributed in turn to the trade sale of Adaptawear to the Senior Clothing Company Ltd.

While most of the Group's work has resulted in the design, testing and launch of products, the group has also achieved an economic impact by providing evidence that a proposed concept will **not** work with the intended user group. Nick Keight of TC Keight stated "they had used the group to test a concept which did not work as expected […] the company saved £50,000 in manufacturing costs by stopping the intended production of the product" [d].

Biomechanical ergonomics research has supported companies to evidence their products' contributions to health and wellbeing [e]. The Group's research is referenced in Vauxhall's international marketing campaign as evidence of the advantages of the company's technology over standard car doors: this is indicative of commercial impact. For example, **Shippen** conducted testing on the FlexDoors, which looked at the effects of lifting an object in and out of the rear seats. He found that, compared with previous models, the FlexDoors reduced back muscle load by up to 58% and leaning and twisting angles by up to 48%. Vauxhall has used this evidence in its international marketing campaign.

The Meriva brochure (2013 Models Edition 2) states that one of the benefits of the FlexDoors is that they are *'easier on the back'* and '*far kinder on your back'* and cites the research done in the Department of Industrial Design at Coventry to support these statements. In addition, Vauxhall released a press release in 2010 about the advantages of the FlexDoors based on **Shippen**'s research. The car is marketed on its appeal to families and the older generation. Martin Lays, Head of Brands at Vauxhall, stated "... that more grandparents rather than parents are buying this car, which ... could be a reflection of the number of grandparents who are childminders" [e].

Health impacts: The Group's research was the first to explore parental views on consent practices with respect to the expanded newborn screening programme in the UK. The exploration of parental needs and resulting re-design of health information contributed to a national pilot expansion of service delivery in relation to newborn screening. The guidelines produced were adopted by the national newborn screening service [D], [2]. There has been a higher than 99% uptake of the screening tests at the six initial centres (Great Ormond Street Hospital, Guy's St Thomas's, Birmingham Children's Hospital, Central Manchester Foundation Trust, Sheffield Hospital and Leeds Hospital). This indicates that the redesigned information for parents is effective and appropriate. Professor Bonham, Clinical Director of Diagnostics, Pharmacy & Genetics, Newborn Screening Project estimates that, by the end of the project, 750,000 new-born babies will have been screened [b]. Eight true positive results for screened conditions have been detected so far during the roll-out. This early detection of a condition has enabled treatment to be started on the child immediately. The Group was subsequently contracted to explore the impact of screening results on parents; follow-on funding of £250,000 has been secured from the National Screening Committee to continue the project until March 2014.

The Group' s health design research supports over 15 NHS Trusts, including Sheffield Teaching Hospitals NHS Foundation Trust, Heartlands and University Hospitals Coventry and Warwickshire

NHS, to research and develop user-centred products, services and guidelines [A]. In 2008, the University signed a collaboration agreement with NHS Innovations South West to facilitate research transfer between the institutions these too.

The Group is a partner in the Department of Health-funded Devices for Dignity Healthcare Technology Co-operative, focusing on the design, development and evaluation of devices to address unmet clinical needs. DevicesforDignity (www.devicesfordignity.org.uk) is a national resource capable of getting new technologies into practice more quickly, thus improving healthcare quality and well-being for patients. The project supports five core NHS Trusts. Since its inception in 2008 the Group has been an academic partner (alongside the University of Cambridge and the University of Sheffield) offering user-centred design expertise. A further four years' funding was awarded in 2013. The relationship has led to the awards of two joint grants for multi-disciplinary design teams to develop products for urinary incontinence. This work has since been taken up by a leading manufacturer of continence products to support the Urology industry and facilitate advising NHS Trusts about patient choice.

The Group also work on the "Warm Neighbourhood" programme which has resulted in the "Warm Neighbourhoods®" (http://ifocus-dallas.com/pub/), "AroundMe™" service and devices developed with the Advanced Digital Institute. This has recently been adopted by a "national channel partner" for distribution to 10,000 homes in the UK to remotely monitor elderly residents in their home.

Impact on User Engagement in Policy Making: The Group's research has addressed the Government's requirement for more user-engagement in policy making by developing VoiceYourView and MyCare applications. VoiceYourView (http://tinyurl.com/ptwmhv8) developed technology which allows people to express their perceptions of safety in public spaces by capturing spontaneous comments from members of the public. These comments can be used to improve the safety of public space designs. VoiceYourView was mentioned in Parliament in the context of discussing software and the digital economy. MyCare (http://tinyurl.com/nosvxrv) is an innovative, usable and reliable patient record system which can be used in both day to day medical consultations but also in emergency situations. MyCare was cited in Parliament as an example of an approach similar to the NHS Spine Service but which could be implemented with less financial investment. (http://systems.hscic.gov.uk/spine).

The Group's unique research expertise has also been recognised by the European Commission, DG SANCO who contracted the team to develop a European Code of Practice for Telehealth Care. The draft Code has been tested in six EU countries (Belgium, Bulgaria, Hungary, Italy, Slovenia and the United Kingdom). The European Commission confirmed that the code the Group developed will provide the framework to guide telehealth service providers in all 27 member states of the European Union. The code can be found at http://www.epractice.eu/en/library/5364841

Conclusion: The Group brings together interdisciplinary research expertise, in combination with the specialist staff and facilities of the HDTI, to tackle health design issues from a user-centred design perspective. This has enabled companies to develop new products and services which improve the health and wellbeing of the population with long-term health conditions, which is growing in numbers. In addition, the Group's research has delivered economic impact to companies and health organisation by designing, creating and testing new products and services which address this growing market. The Group's research expertise has developed EU-wide guidelines which have a policy dimension.

5. Sources to corroborate the impact

a. Dr Jon Arthur, Group Resilience Director, Unilever, UK (information collected by RAND Europe in an interview, see report PR-523-CU).

b. Professor J R Bonham, Clinical Director of Diagnostics, Pharmacy & Genetics, Newborn screening project (information collected by RAND Europe in interview, see report PR-523-CU).

c. Ian Jones, Director of Abianco, UK (information collected by RAND Europe in an interview, see report PR-523-CU).

d. Nick Keight, Director of TC Keight, UK (information collected by RAND Europe in an interview, see report PR-523-CU).

e. Martin Lays, Head of Brands, Vauxhall, UK (information collected by RAND Europe in an interview, see report PR-523-CU.