

Impact case study (REF3)

Institution: Loughborough University		
Unit of Assessment: D32 Art & Design: History, Practice & Theory		
Title of case study: Giving a voice to and changing the lives of disabled people: Transforming the design process of Assistive Technology products through collaboration with practitioners.		
Period when the underpinning research was undertaken: 2010-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Dr George Edward Torrens Dr Michael Fray	Senior Lecturer Senior Lecturer Human Factors Design	1994-present 2009-present
Period when the claimed impact occurred: 2016-2020		
Is this case study continued from a case study submitted in 2014? No		
1. Summary of the impact		
<p>The UK social care market (which has grown from £2bn in 2012 to £6bn in 2020) is fragmented into Assistive Technology (AT) 'niches' supplied by specialist businesses who only have limited access to R&D investment and lack the ability to optimise their designs for their product users. Mainstream NPD (new product development) also needs to account for the needs of the widest population to ensure social inclusivity. Our research addressed this by developing a novel design process ('LUCAT'), which delivered two key impacts: (1) Enabled niche designers of AT (e.g. Nottingham Rehab Supplies Ltd) and mainstream companies (e.g. Philips, Arup) to use a cost-effective way to elicit user requirements and deliver optimal design solutions, and (2) improved the ability of people with disabilities, and the charities that represent them, to engage with previously inaccessible sports, such as Boccia and independent running.</p>		
2. Underpinning research		
<p>Research led by Dr Torrens, ongoing for the last ten years, aimed to improve the lives of people living with disabilities through developing a process to support new product developers of AT in designing products that truly meet the needs and wants of users in a cost-effective way. Our research approach to developing this design process used novel participatory research design methods and heuristics, underpinned with theory and principles from social psychology and systems engineering. The resulting design process was called LUCAT (The Loughborough User-Centred Assistive Technology process) [R1].</p> <p>The LUCAT process is a streamlined collection of design, engineering, ergonomics and human factors theory and best practice in User-Centred Design (UCD) brought together to enable time-compressed market research and evidence-based design decision-making. The process concept was based on Torrens' experience of working in the field of AT product design since 1986. He then refined the process and through further research studies between 2010-2020, has significantly expanded the methods and heuristics into the current LUCAT process with the support of Fray [R3, R4, R5, R6].</p> <p>LUCAT was developed through a practice-based, bottom-up participatory approach within AT product design, informed by Ergonomics and Human Factors theory. The research programme that underpinned the LUCAT process initially defined a suitable approach [R1, R2]. This was based on the conventions of design innovation, the fast time-compressed and iterative cycle of participatory design, and best practice from small batch production design engineering.</p> <p>These initial methods and heuristics were augmented by additional research into best practice relating to optimum formats of communication to be used by new product developers [R3], principles from social sciences and psychology [R4], and applied within a mixed methods research approach [R2].</p> <p>Some of the novel principles and heuristics added to the LUCAT process included 'social camouflage' (using principles from military camouflage to disguise unusual shapes and profiles within AT products that would be seen as 'different'); 'blacksmith's approach' (a one-to-one dialogue between designer-maker and user that would have been commonplace in pre-industrial design); and, 'technology footprint', (the visual area within the profile of a person with a disability taken up by equipment that affects the viewer's perception of that person's persona). In addition,</p>		

principles used in other disciplines but not conventionally within design development were also employed, such as ‘cultural blindness’, (the differences in how people from different cultures perceive images – important for online sales of AT products) [R1, R4].

The potential for a wider application of the LUCAT process was shown through the review of case studies from other researchers [R1, R2]. The review highlighted the limited number of methods which designers use within new product development, (conventionally four: literature review, task analysis/ usability evaluation, interview, and observation), and the opportunity to apply the LUCAT process whose elements have been sourced from over 200 research and design methods in appropriate communication formats for this market [R2, R3, R6].

3. References to the research

- R1:** Torrens, G., 2011. Universal design: empathy and affinity. IN: Karwowski, W., Soares, M.M. and Stanton, N.A. (eds). Handbook of Human Factors and Ergonomics in Consumer Product Design. Boca Raton, FL: CRC Press, pp. 233 - 248. DOI: [10.1201/9780429143946](https://doi.org/10.1201/9780429143946)
- R2:** Torrens, G.E., 2017. The order and priority of research and design method application within an assistive technology new product development process: a summative content analysis of 20 case studies. Disability and Rehabilitation: Assistive Technology, 13(1), pp.66-77. DOI: [10.1080/17483107.2017.1280547](https://doi.org/10.1080/17483107.2017.1280547)
- R3:** Torrens, G.E., 2018. Dialogue Appropriate to Assistive Technology Product Design: A Taxonomy of Communication Formats in Relation to Modes of Sensory Perception. She Ji: The Journal of Design, Economics, and Innovation, 3(4), pp.262-276. DOI: [10.1016/j.sheji.2018.01.001](https://doi.org/10.1016/j.sheji.2018.01.001)
- R4:** Asghar, S., Torrens, G.E. and Harland, R., 2019. Cultural influences on perception of disability and disabled people: a comparison of opinions from students in the United Kingdom (UK) Pakistan (PAK) about a generic wheelchair using a semantic differential scale. Disability and Rehabilitation: Assistive Technology, 15(3), pp.292-304. DOI: [10.1080/17483107.2019.1568595](https://doi.org/10.1080/17483107.2019.1568595)
- R5:** Torrens, G.E. and Newton, H., 2013. Getting the Most from Working with Higher Education: A review of methods used within a participatory design activity involving KS3 special school pupils and undergraduate and post-graduate industrial design students. Design and Technology Education: an international journal, 18(1), pp.58-71. Available at: <http://ojs.lboro.ac.uk/ojs/index.php/DATE/article/view/1800>
- R6 :** Torrens, G.E. and SMITH, N.C.S., 2012. Evaluation of an assistive technology product design using a paired comparisons method within a mixed methods approach: A case study evaluating preferences for four types of cutlery with 34 upper limb impaired participants. Disability and Rehabilitation: Assistive Technology, 8 (4), pp. 340 - 347. DOI: [10.3109/17483107.2012.735746](https://doi.org/10.3109/17483107.2012.735746)

The underpinning research and commercial development contacts were supported by competitively won funding from UKRI, Sport England, NRS Ltd and other Charities worth over £200,000. The outputs were published in peer-reviewed journals and edited collections in the fields of design, assistive technology, design education and human factors.

4. Details of the impact

The **pathways** to impact for the LUCAT design process have involved collaborative activity instigated many years before its development. For 25 years, Torrens has regularly invited local and national representatives of charities (e.g., Age UK, University of the Third Age, Motor Neurone Disease Association, Arthritis Care, REMAP GB, Vista Blind) to collaborate on network events and student projects, linking their membership directly to student designers and the underpinning research being done by the research team [R4, R5, R6]. This collaboration provided a deep understanding of the assistive technology design needs of industry and charities. LUCAT is made accessible to practitioners via the Usability-NET website (<https://usability-net.lboro.ac.uk/>). This resource developed by Torrens contains a cohesive collection of inspirational and best-practice research case studies to support those applying user-centred design approaches to cost-effectively design products to meet the needs of people

with disabilities. The free resource, used by both practitioners and students, aligns the methods and heuristics with the relevant standards for the New Product Development (NPD) of AT. The LUCAT process has been presented at industry exhibitions and conferences such as NAIDEX and recognised through Industry Awards. It was a finalist in the 2019 Leicestershire LIVE awards for education, and a Graduate Inclusive sports product developer (a recipient of LUCAT training) won the Young Innovator Award at the same event [S5], demonstrating knowledge transfer from education into industrial design practice. Over 500 graduates and postgraduates have been trained in the LUCAT process, many of whom now hold senior positions in consultancies or global brands such as Samsung and JPMorgan Chase & Co. The Senior Usability Designer, Philips Experience Design, has provided evidence of how training in the LUCAT process has impacted on his professional practice [S1]. Together, the research and its pathways have led to the following impacts.

Impact 1: Enabled designers of AT to use a cost-effective way to elicit user requirements and deliver optimal design solutions.

Our research on the underpinning design methods, applied using heuristics and an approach communicated through best practice and exemplars [R1, R2, R3] delivered a better way of doing new product development to designers and businesses within the AT product market. The LUCAT process addressed the need of inventors, start-ups and small businesses to have an effective way of cost-effectively gaining insights from the AT market. This is highlighted through the examples of a student enterprise project, Tap Dash, an inclusive point-to-point running game, and AT equipment development for Visually Impaired (VI) Boccia. The Inventor of the VI Boccia game had attended an event to bring student designers and people with a need for AT products together, organised by Torrens.

For example, the production of **Kura Care cutlery** demonstrates the effectiveness of the LUCAT process in practice (Figure 1). The cutlery was designed for **Nottingham Rehab Supplies Limited (NRS)**. NRS had given invited lectures to our students and were aware of the work of Torrens before commissioning commercial design work. It was produced using the LUCAT process for a small budget and in less than three months from request to production. It followed an earlier research study of cutlery for NRS and applied Gestalt principles of perception (associated with foreground background and applied through military camouflage) to deliver 'social camouflage' for the unusually shaped products to appear more conventional, reducing stigma and associated product abandonment. [R1, R2, R6]



Figure 1. Kura Care cutlery Range, Nottingham Rehab Supplies Ltd. Highlighting application of Social Camouflage, part of the LUCAT process.

The LUCAT process provided New Product Development (NPD) teams with a clear stage-by-stage process for rapid research and design methods including co-design, reducing the time and cost risks within NPD. The Head of New Product Development at **Nottingham Rehab Supplies Ltd (NRS)**, a major manufacturer and supplier of assistive technology products internationally, and regional representative of the British Healthcare Trades Association, stated:

"The Kura Care cutlery range is one of our best-selling cutlery ranges. We sell approximately 30,000 sets and items per year, with increased sales year on year." [S2]

Furthermore, as evidence of the LUCAT process delivering cost-effective solutions, The Senior Design Engineer at NRS, reported:

"The training I had in the LUCAT process enabled me to get my current and previous job. I have introduced elements of the LUCAT process to engineers and healthcare professionals"

in my teams in each new role to more effectively gain insights from end users and stakeholders and deliver commercially viable products.” [S3]

Other beneficiaries of the LUCAT process [R1] report its impact, including the cost-effectiveness and suitability of the process for gaining user and stakeholder needs, ensuring appropriateness for the market. The Senior Usability Designer at **Philips Experience Design** stated:

“A user-centred approach to design is a core aspect of any project I lead. I have introduced much of the LUCAT process as described into our new product development process and to the multi-disciplinary team, which has enhanced our ability to gain consumer insights.” [S1]

Similarly, a Human Factors Consultant at **SYSTRA Scott Lister**, reflected on how he had raised awareness of the process within his multi-disciplinary team during stakeholder consultations, whilst on placement with **Arup Group Ltd**, a major civil engineering company:

“...I knew within the first week of the brief that the elements of the LUCAT process were applicable to the project. ...not having an early codesign intervention, especially for an infrastructure project, would be detrimental... due to the success of using the insights, the organisation was considering adopting the approach for future work.” [S4]

He was referring to the need to gain insights and an affinity from individuals and stakeholder groups, representing people with a wide range of disabilities, at the design stage who would use the transport system to avoid major additional costs due to alterations at the construction stage.

Impact 2: Improved the ability of people with disabilities, and the charities who represent them, to engage in sports.

The underpinning research [R1, R5, R6] was used by Torrens and Fray to gain a better understanding of the needs and aspirations of people with disabilities, and the charities that represent them, engaging them in participatory codesign to produce outcomes with a sense of ownership. [S6, S7] The application internationally of the LUCAT process, is presented in the following examples. These show the reach and impact the approach has had on individuals, communities, organisations, and its usefulness in empowering individuals in different cultures and social groups to have the confidence to change their lives. The examples shown are (i) the **Tactile Boccia Grid** and (ii) **Visually Impaired Running Line**.

(i) Boccia is a Paralympic inclusive sport like French Boules. The LUCAT process was used with the Inventor and Visually Impaired (VI) Boccia players to develop the Tactile Boccia Grid, which enabled players to progress rapidly to an advanced level of tactical play and become competitive against sighted players. (See Figure 3 below). Since 2014, from a few local teams in the East Midlands, the game has expanded to two National competitions and is regularly played in over 30 centres around the country. Over 150 units have been used in 14 countries. [S3] The Director of **Handi Life Sport**, Denmark, the main worldwide distributor of Boccia equipment and products, including the Tactile Boccia Grid, stated:

“...the device serves a great purpose of inclusion of the visually impaired players with the sighted players.” [S6]

Furthermore, the Principal of the **Sense (Formerly RNIB) College** commented on the engagement between College students and University staff and design students on design projects, including the Tactile Boccia grid:

“what's important for them is to be able to be with young people of a similar age to themselves and ... exposed ... to people outside of their usual frame ... to mix with people outside this sphere of knowledge ... that's a really important thing ... to feel that their contributing to something really important.” [S7]

Impact case study (REF3)

(ii) The participatory approach and codesign stages from the LUCAT process were embedded in the research [R6] to produce the **Visually Impaired (VI) Running Line**. This enabled visually impaired and blind people to run independently of a guide runner giving them a sense of control and independence not previously experienced in their life (see Figure 2 right) [S8]. This VI Running Line enabled engagement with many adapted sports groups to deliver a wide range of innovative events, activities and interventions.

Many VI or blind people have never run more than a few steps in their lives, nor competed against other runners. During the sessions the VI Running Line enabled them to race against their VI, blind and sighted peers. The VI Running Line has been demonstrated at nearly 300 events across the UK and used by over 1,600 Blind and Visually Impaired children and adults, most of whom would have never experienced running independently. When parents and carers have also used the running line, it gave them a better understanding of the difficulties faced by those in their care. The Co-Inventor of the VI Running Line and Inclusive Sports Coach, stated:

“The experience gave parents an insight into the level of uncertainty and difficulty their children had in everyday living, moving and travel in their world and opening discussion between them.” [S9]



Figure 2. Left: VI Boccia ‘touch’ grid in use during a codesign session. Right: VI Running line during experience events, (a guide-line with sliding handle between two limit stops)

5. Sources to corroborate the impact

Impact 1: Enabling designers of AT to use a cost-effective way to elicit user requirements and deliver optimal design solutions.

- [S1] Senior Usability Designer, Philips Experience Design, integration of LUCAT to their approach to elicitation of user requirements. (Testimonial).
- [S2] Head of New Product Development, Nottingham Rehab supplies (AT manufacturer) impact financial result of LUCAT process on Kura Care cutlery. (Testimonial).
- [S3] Senior Design Engineer, Nottingham Rehab Supplies Ltd (NRS) effectiveness of LUCAT process. (Testimonial).
- [S4] Human Factors Consultant at SYSTRA Scott Lister, application of LUCAT process to a project within Arup Group Ltd during placement. (Testimonial).
- [S5] Graduate and developer of the Inclusive sports product-Tap Dash, winner of the Andrew Simpson Sports Enabling Trust Award 2019, and Young innovator of the year award, Leicestershire Live Awards 2019. (Testimonial).

Impact 2: Improving the ability of people with disabilities to engage with sports and design.

- [S6] Director, Handi Life sport. Impact of Boccia grid (boccia touch grid), widening participation and engagement through VI Boccia ‘touch’ grid. (Testimonial).
- [S7] Principal of Sense College Loughborough. (Testimonial).
- [S8] VI Running Line Video available at: (https://www.youtube.com/watch?v=PqFk-P1MVxA&feature=emb_logo)
- [S9] Inventor VI Boccia, Inclusive Sports Coach, Co-Inventor VI Running line. Widening participation and engagement. (Testimonial).