

Impact case study (REF3)

Institution: University of Northumbria at Newcastle		
Unit of Assessment: 32 (Art and Design: History, Practice and Theory)		
Title of case study: Enabling self-administered healthcare technology through Multiple Perspective Problem Framing		
Period when the underpinning research was undertaken: 2007 – 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:
Stuart English	Senior Lecturer/Associate Professor	1990 – present
Rafiq Elmansy	Lecturer	2017 – present
Sarah Morehead	Senior Lecturer	2004 – present
Period when the claimed impact occurred: 2014 – 2020		
Is this case study continued from a case study submitted in 2014? N		
1. Summary of the impact (indicative maximum 100 words)		
<p>Diabetic retinopathy, a degenerative eye-condition affecting all type 1 diabetics and 60% of type 2, is the leading cause of blindness among working age adults. To support those affected by this condition, Northumbria University's development of a Multiple Perspective Problem Framing (MPPF) approach provides a design-led innovation process to help deliver economically sustainable, self-administered healthcare. Application of the MPPF approach was integral to industrial partner PolyPhotonix Ltd.'s production of the Noctura 400 sleep mask, a new treatment for diabetic retinopathy. This non-invasive home-based treatment has produced substantial improvements in patient sight and wellbeing. The Noctura 400's success has also increased PolyPhotonix's annual turnover [text removed for publication] and enabled the manufacturer to significantly expand operations, creating [text removed for publication] new jobs, and attracting [text removed for publication] investment [text removed for publication]. Noctura 400 has been patented around the world including Europe, China, USA, Mexico, Australia, Japan, South Korea, and Canada. [text removed for publication].</p>		
2. Underpinning research (indicative maximum 500 words)		
<p>Northumbria University research led by Dr Stuart English has demonstrated that an organisation's capacity for innovation is dependent upon the way they perceive problems and opportunities. Organisations are often dominated by pre-conceptions and rely on familiar approaches to innovation, which may be inaccurate or not fit for the emerging challenges they face. This can create a tunnel-vision that excludes alternative potential opportunities or approaches, and thereby limits innovation and growth [R1-R3].</p> <p>Through research conducted with SMEs, multinational businesses, and public sector organisations, English and his collaborators developed and studied how integrated mind-mapping techniques facilitate team-based workshop activities and combine multiple perspectives into one canvas for ease of navigation [R3]. Iteration of these techniques with 80 collaborating organisations resulted in the Multiple Perspective Problem Framing (MPPF) approach to design-led innovation. MPPF involves collecting various datasets which frame issues and opportunities from widely different, singular perspectives in order to evaluate, compare, and determine their commercial potential. MPPF synthesises this onto a single canvas of interrelated factors where the competing benefits and challenges of different perspectives can be seen in an original framing unique to each company. The collaborative process enables a company to visualise and navigate its relationship with technology, intellectual property, and commercialisation, allowing potential strategies to be robustly and holistically evaluated. English's research also indicates how MPPF facilitates organisations in developing or refining their innovation strategy and</p>		

product/service delivery to meet industrial and sectoral trends, ensuring the adoption of an economically sustainable route to internal innovation [R2-R3].

In 2010, English initiated research exploring the potential of creating patient-administered healthcare technology with an industrial partner, PolyPhotonix Ltd - a company based in the North East of England specialising in [text removed for publication] organic light emitting devices (OLEDs). Recognising that innovation in healthcare, and ultimately the patient experience, is traditionally hindered by looking at issues from a single perspective (such as technological novelty or the existing evidence base), English applied MPPF with PolyPhotonix to gain new insights on ways to successfully harness the opportunities of OLEDs in health technology [R4]. The MPPF approach drew together six distinct, context-specific fields of enquiry: 1) current scientific research, 2) technology innovation, 3) human factors, 4) sleep patterns and habits, 5) product stakeholder networks, and 6) change factors [R4]. Through the use of MPPF, the research identified an unmet need for non-invasive and lower-cost treatments for diabetic retinopathy (DR) for which OLED technology could be utilised [R4]. This research informed the claims of a patent granted in specific international jurisdictions from 2015 to 2020 for an OLED sleep mask [R5], known commercially as Noctura 400. Subsequently, Northumbria applied the MPPF process through an incremental and cyclic process of design and materials specification, prototyping and usability testing, to refine the wearability of the Noctura 400 OLED mask. This research facilitated the development of both the light-treatment cartridge and improved the comfort and fit of the mask to produce a more effective, lighter, and more breathable design [R6].

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

R1. Stuart English (2007) 'Creating Universal Form – Using Universals to Describe Design Solution Space' *Design Principles and Practices: An International Journal* 1(4): 21-30
<https://doi.org/10.18848/1833-1874/CGP/v01i04/37864>

R2. Stuart English (2008) 'Integrated Mind Mapping: Multiple Perspective Problem Framing' pp. 35-42 in *Networks of design: Proceedings of the 2008 Annual International Conference of the Design History Society* (Falmouth, January 2008). E-book, Universal Publishers. Available on request

R3. Stuart English, Moor, T., and Jackson, W. (2010) Value innovation modelling: Design thinking as a tool for business analysis and strategy. Design Research Society International Conference, Montreal, Canada, 7-9 July 2010, paper 37
<http://www.drs2010.umontreal.ca/data/PDF/037.pdf>

R4. Stuart English and Rafiq Elmansy (2020) 'Investigating Patient Adherence in the Medical Technology Design Process: Noctura 400 Case Study'. Available on request

R5. Stuart English, Kirk, R., and Holland, M., 'Cartridge, Medical Apparatus and Method'. Patent. (B publication Patents granted: in Europe 2015, China 2016, Australia 2016, Mexico 2016, USA 2017, Japan 2017, South Korea 2019, Canada 2020). Available on request

R6. Sarah Morehead, Stuart English, and Rafiq Elmansy (2019) Portfolio: Face masks to house hard Pod digital light therapy for DR. REF2 ID: 25950047
This portfolio explores the making of a mask to house a medical therapy for diabetic retinopathy. The aim was to experiment with new materials to construct a mask that fitted around the complex anatomical areas of the head and face addressing the issue of non-compliance from patients in wearing the mask due to lack of comfort during sleep that inhibits their ability to receive the therapy. Available on request

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

English and colleagues' research with PolyPhotonix led to four main forms of impact: 1) product development, 2) improving health and wellbeing of individuals living with DR, 3) commercial/economic benefits for PolyPhotonix and 4) economic and infrastructure development in the sustainable healthcare sector.

4.1 Applying MPPF and empathetic design to design of the Noctura 400

Working with Northumbria enabled PolyPhotonix to define the parameters of, and subsequently develop, the Noctura 400 – a sleep mask delivering light therapy via [text removed for publication] OLEDs to treat DR. This product has been granted patents around the world between 2015-2020 as a direct result of the application of MPPF (Europe, China, USA, Mexico, Australia, Japan, South Korea, and Canada) [E1]. Richard Kirk, the CEO of PolyPhotonix, explained the contribution of engaging with English's research and how the 'Noctura 400 improved significantly due to our work with Dr English's research... [we] applied his MPPF model in the development of the Noctura 400' [E2]. Kirk continues, '[a]s a direct result of the MPPF, we gained vital new perspectives on user-needs and new insights into how the product could meet them' [E2]. Embedded collaboration with English enabled PolyPhotonix to address issues with their original product by refining the design of the fabric mask to make it more breathable and low-profile (Fig. 1). The European Patent Specification attests to the innovations of the Noctura 400 and how it meets needs for patient accessibility through a slimmer profile, onboard power rather than cable supply, and easily replaceable cartridge that accords with, and supports, how people best use these devices consistently in their homes [E3, E4]. The Noctura 400 incorporates the treatment pod and the fabric mask design that were developed at Northumbria University to meet the product-needs revealed through application of the MPPF process.

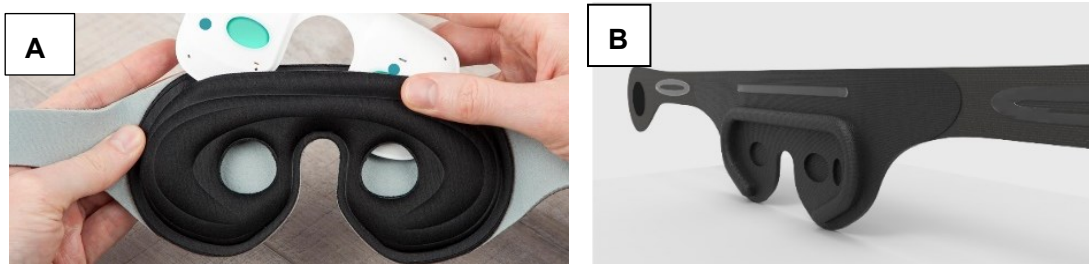


Figure 1: A – the original fabric mask design, B – the final mask design developed at Northumbria University.

4.2 Improving the health and wellbeing of individuals living with DR through the Noctura 400

[text removed for publication] [E5]. A later study from Ashford and St Peter's NHS Hospital saw 98% of patients achieve a beneficial outcome, with 66% enjoying stabilisation of their eyesight (preventing further degeneration) and 32% experiencing measurable improvement in their eyesight [E6, p2]. As a 'non-invasive and monitored home care treatment' the Noctura 400 avoids the patient-discomfort resulting from 'laser treatment and/or injections of anti-VEGF pharmaceuticals directly into the eye' [E5]. Moreover, success with existing treatments is not assured and these procedures carry risks, including damage to the eye [E7]. The Noctura 400 is undergoing clinical trials before it can be prescribed for wide-scale use by the NHS; however, it is already being used by 'private patients in the UK, U.S.A, Belgium, France, [text removed for publication], Brazil, Oman, Portugal' to preserve and/or improve their sight [E2].

In addition to offering a more comfortable and less-invasive treatment, the self-administered nature of the Noctura 400 reduces the burden of treatment for patients and clinics (e.g., substantial clinical time and regular hospital attendance) by facilitating remote use and continued monitoring [E5]. The Covid-19 crisis highlighted the potential individual and public health costs of intensive healthcare infrastructure for patients and clinical staff [E8]. Ashford and St Peter's NHS Hospital, who has patients using the mask, said that 'during the coronavirus pandemic the mask can help diabetic patients, who find it difficult to attend retinopathy screening and eye clinic appointments... it is likely that diabetic patients who cannot attend surgeries and hospitals for

medical treatment – as many clinic appointments are being cancelled – are further risking their eyesight’ [E8].

4.3 Commercial/economic benefits to PolyPhotonix resulting from the Noctura 400

Northumbria’s work with PolyPhotonix, in developing the Noctura 400, had a significant impact on the success and future business strategy of the company. The Noctura 400’s *‘intellectual property has attracted external funds of over GBP 18 million [GBP18,000,000] including a recent £2 million [GBP2,000,000] investment from a New York bank to support business development’ [E2]. [text removed for publication] [E2].*

While the sleep mask is in the early stages of commercialisation, PolyPhotonix has sold 5,000 units to 954 patients and 63 treatment centres, generating a turnover of GBP450,000 [E2]. Due to this success PolyPhotonix altered their business strategy to a sole focus on the Noctura 400, and now this product *‘accounts for all of the company’s sales’* and underpinned its international expansion [E2]. PolyPhotonix has signed license deals in France, Brazil, Argentina, Oman, with further deals being negotiated in Japan and Portugal [E2].

4.4 [text removed for publication]
[text removed for publication]

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

Ref.	Source of corroboration	Link to claimed impact
E1	Granted Patents: English, S. Kirk, R. Holland, M. ‘Cartridge, Medical Apparatus and Method’ Europe: EP2686066 (B1), 2015-09-23 China: CN103596621 (B), 2016-05-18 USA: US9849303 (B2), 2017-12-26 Mexico: MX343529 (B), 2016-11-09 Japan: JP6241878 (B2), 2017-12-06 Australia: AU2012228054 (B2), 2016-07-07 Canada: CA2829816 (C) 2020-05-12 South Korea KR102043313 (B1) 2019-11-11	Proof of innovative nature of the research, global reach, and commercial significance
E2	Testimonial - Richard Kirk, CEO of PolyPhotonix Ltd.	Confirms the contribution of Northumbria research to improving the efficiency of the Noctura 400, with positive results for the company
E3	English, S. Hewitt, I. Kirk, R. Holland, M. European Community Design Registration: 002298729-0001	Proof of innovative nature of the research
E4	European Patent Specification	Confirms innovations of Noctura 400 as original product drawing from English’s research
E5	North East Times - ‘Novel treatment developed at Netpark helping diabetic patients during lockdown’ April 27 th 2020	Benefit for patients of the Noctura 400
E6	Analysis of the RENDER NHS Project – Real-world Evaluation of Noctura 400 sleep mask for Diabetic Retinopathy – presentation August 2020	Benefit for patients of the Noctura 400
E7	Noctura Website Video https://noctura.com/	Provides context on device and patient feedback on the benefits of the device

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E8	The Northern Echo - 'Sedgefield firm's light therapy masks help treat diabetic retinopathy during Covid-19' April 30 th 2020	Benefit for patients of home-based and non-invasive treatment through the Noctura 400 in light of the additional challenges arising from the Covid19 pandemic
E9	Testimonial - Dr Arun Harish, Strategy Director for CPI National Centre of Healthcare Photonics website	Confirming Dr English's and the MPPF technique's role in shaping the early product development processes and securing government investment in the Healthcare Photonics centre