Institution: University of the West of England, Bristol		
Unit of Assessment: 32		
Title of case study: Transforming heritage printing industries for the 21st century		
Period when the underpinning research was undertaken: 2000 - 2019		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed:**
Prof Stephen Hoskins	Founding Director, CFPR	1994 – present
Prof Carinna Parraman	Director, CFPR	1998 – present
Mr David Huson	Senior Research Fellow	2000 – present
Dr Susanne Klein	Associate Professor	2018 – present
Period when the claimed impact occurred: 2013 - 2020		
Is this case study continued from a case study submitted in 2014? No		

1. Summary of the impact

Research by Professors Hoskins, Parraman and colleagues at the UWE Centre for Fine Print Research (CFPR) has focused on colour, inks and print processes, leading to technical innovation, new processes and materials, and their commercial application. This has included industrial collaboration with businesses including Burleigh Potteries and John Purcell Papers, on revitalising the ink chemistry and methods of underglaze ceramic printing, and with Cranfield Colours and Pulse Roll Products on the performance of inks and substrates. Work on effect pigments with Merck Chemicals has led to work with artists, notably Sir Peter Blake, and practical application of print technologies has led to new markets in security printing with Tagsmart. The work of the CFPR has also impacted widely, through exhibitions, CPD and practical workshops, on artists, practitioners and public audiences, museum curators and historians of print contributing to knowledge, understanding and innovative practice.

2. Underpinning research

Research by the CFPR has focused on the historical, artistic and industrial significance of creative print practices, processes and technologies. Research on colour, bespoke inks and application of colour to surface materials has included work on photomechanical print methods, new applications of inkjet printing and continuous tone colour printing. Detailed research into the history of print and colour processes has enabled their reinvention in innovative techniques and applications.

Reinventing photomechanical print methods

19th-century photomechanical print research by Hoskins and Huson has led to a re-evaluation of historic Woodburytype, collotype, and reinvention of methods for 21st-century applications (**R1**, **R2**). Combining screen-printing methods (**R3**) and research on water-based screen printing onto ceramics (**R4**), and contemporary flexographic printing processes, has led to continuous-tone photographic imagery (**R1**) for 19th-century underglaze tissue printing (**R1**). Research outputs included a patented method for screen-printed transfers for underglaze printing, and a lead-free reformulation of the inks. AHRC-funded research collaboration with Burleigh Pottery (**G1**), built on earlier work to recreate traditional rollers and plates for transfer printing with digital, flexographic rollers and plates. Working from Burleigh's archive collection, benchmarks were established comparing results with the new process, ensuring historical veracity and commercial standards. The new method significantly reduced the time to produce the digital equivalent of a traditional hand-engraved roller, whilst retaining the image's quality. AHRC funding was followed by a Knowledge Transfer Partnership (2015-17) (**G2**) to support the application of the technology in a practical context to Burleigh Pottery's commercial production, described below.

Underpinning research: Inks and inkjet printing

Early underpinning research by Hoskins and Parraman, part-funded through a KTP with Cranfield Colours (2000-03), focused on the formulation of artists' pigments as water-soluble and free from volatile compounds. This included inks specific to 19th-century collotype

processes reinvented by CFPR (**R4**)**.** Related research by Parraman through a KTP with John Purcell Paper (2002-04) led to the development of inkjet technologies compatible with artist-quality papers and the development of coated paper for inkjet printing. AHRC-funded research by Paramann (2004-05) developed inkjet technology for artists through the historical study of screenprinting, based on the Tate Modern collections. The project investigated colour-mixing, layering, translucency and opacity, and how traditional print processes, such as lithography and screenprinting could inform digital colour printing. The research led to commercial applications in collaboration with Pulse Roll Products (**G1**)**,** security printing with Tagsmart (**S4**) to protect the provenance of artworks, and new methods for Red Green Blue (RGB) printing structural colour from colourless inks (**G3**, **R5**), which contributed to the *Ways of Making* collaboration with Sir Peter Blake.

Novel printing and continuous tone methods

Recent improvements in print-head technology and software have increased the potential to inkjet-print a wider range of inks onto a wider variety of materials. Work on 19th-century continuous-tone printing led the team to recognise the potential of multiple layered additive printing (inkjet, UV-curing, direct-write printing) and the importance of an expanded tonal range instead of a reliance on half-tone black and white printing. This led to expanding the existing Cyan Magenta Yellow Key (CMYK) process colours for bespoke colour palettes that match artists' pigments. This introduced new pigments and decorative inks (metallic, mica, gloss) and novel colourants (fluorescent, colour changing effects). This research has taken commercial halftoning and CMYK process colour printing towards developing custom pigments, and decorative inks to obtain new colour mixtures and print applications. Examples include the recreation of full-colour Woodburytypes, exploring UV printing and specialist inks for security printing, and RGB printing to address new ways of colour reproduction.

19th century Woodburytype was restricted to one colour. CFPR were able to create full-colour Woodburytype images using both CMY inks and RGB inks, using computer controlled cutting (CNC) technology and a range of translucent carriers instead of the traditional gelatine (**R1**, **R2**). In 2015, Parraman worked with Tagsmart on a prototype DNA tag – a specialist security tag for the provenance, tracking and identification of prints, paintings and photographs. Parraman prototyped a UV printing method using archival materials. These tags are between nine and 30 microns in thickness. The finished tag contains security components that create an individual profile for each artwork including synthetic DNA and other compounds, all linked via a unique ID to a certificate of authenticity and a digital provenance record.

Working with Merck Chemicals (**G3**), Parraman and Klein developed new printing methods using RGB special effect pigments. RGB printing is an additive printing method onto black paper that uses colourless red, green and blue pigments, emulating the appearance of structural-colour as generated in butterflies and beetles (**R5**). The process is demonstrated in the *Ways of Making* collaboration with Sir Peter Blake. Building on these achievements, Klein secured a five-year EPSRC Manufacturing Fellowship on new approaches to printing based on historic techniques (GBP1,200,000, 2018-23) (**G4, G3**), and CFPR was awarded a GBP7,700,000 Research England grant under the 'Expanding Excellence in England' initiative (2019-25) (**G5**).

3. References to the research

R1 Hoskins S and McCallion P (2013) 'Continuous Tone Colour Printing in Two and a Half Dimensions through a Combination of 19th Century Analogue Methodologies and 3D printing' in F. Masahiko, & B. Lozo (Eds.), NIP29 29th *International Conference on Digital Printing Technologies Digital Fabrication 2013 Technical Programme and Proceedings*, 244-248. Society for Imaging Science and Technology. Available on request: https://uwe-repository.worktribe.com/output/938605/continuous-tone-colour-printing-in-two-and-a-half-dimensions-through-a-combination-of-19th-century-analogue-methodologies-and-3d-printing

R2 Parraman, C., Ortiz Segovia, M. V., (2018) 2.5D Printing Bridging the Gap Between 2D and 3D Applications, Wiley-IS&T, Imaging Science and Technology. Available on request: https://uwe-repository.worktribe.com/output/845974/25d-printing-bridging-the-gap-between-2d-and-3d-applications
R3 Hoskins S (2019) Screen Printing as a 20th Century Graphic Medium: *Journal of the Print Historical Society*. New Series No 30 Summer 2019 pp 69- 87 https://uwe-repository.worktribe.com/output/874504/screen-printing-as-a-20th-century-graphic-medium
R4 Hoskins S (2007) *Water-Based Screenprinting,* A&C Black Visual Arts. London: Bloomsbury. Available on request: https://www.bloomsbury.com/uk/water-based-screenprinting-9781408101377/
R5 Klein, S., Parraman, C., & Voges, L. (2019). How to print a rainbow. Available on request: https://doi.org/10.2352/ISSN.2169-4451.2019.35.52
R6 Huson D and Hoskins S (2014) Underglaze Tissue Printing for Ceramic Artists, a collaborative project to re-appraise 19th Century Printing Skills: *Key Engineering Materials* Vol. 608 pp. 335-340. Available on request: https://uwe-repository.worktribe.com/output/819666/underglaze-tissue-printing-for-ceramic-artists-a-collaborative-project-to-re-appraise-19th-century-printing-skills

Evidence of the quality of the supporting research

G1 Parraman, C: The Development of Novel Inkjet Inks, AHRC, 2014-2015, £99,993
G2 Huson, D: *Knowledge Transfer Partnership*, Denby Holdings Ltd/ Burgess and Leigh Ltd, 2015-2017, £129,650
G3 Merck Chemicals – funding in kind: Effect pigments + Merck expertise
G4 Klein, S: Manufacturing Fellowship Woodbury and Lippmann: A new approach to continuous tone and full colour non-impact printing, EPSRC, 2018 – 2023, £1,238,329
G5 Parraman, C: *Expanding Excellence in England,* Research England*,* 2019, £,7,718,713
G6 Hoskins, S., Knowledge Transfer Partnerships, 2002-04, John Purcell Paper
G7 Hoskins, S: *Hewlett Packard Chair of Fine Print*, Hewlett Packard, 2003-14, £80,000
G8 Hoskins, S: *Combining digital print technologies with 18th century underglaze ceramic printing to retain an industrial heritage process*, AHRC, 2012-13, £95,943

4. Details of the impact

Impact underpinned by CFPR research has included: industrial collaboration leading to technical innovation; new processes and products; commercial application; artistic collaboration and production; knowledge dissemination; understanding and practice promoted through exhibitions, events, and practice-based workshops. This has built detailed historical research, conceptual and technical development, and tacit and empirical understanding of colour and print processes.

Industry collaboration

Burleigh Pottery in Stoke on Trent is the only commercial pottery in the world still using underglaze tissue printing. Burleigh was saved from imminent closure by the Princes' Regeneration Trust. The now preserved historic buildings, machinery, and moulds are part of a UNESCO World Heritage Site. Burleigh had to continue as a commercial pottery producer. Producing and maintaining traditionally hand-engraved rollers and plates for transfer printing onto ceramics was a significant challenge and cost to its continued operation. Skilled engravers were in short supply, and fragile plates needed frequent re-engraving. AHRC-funded collaborative research with Burleigh Pottery (**G1**) proved new methods of creating rollers and plates using digital technology. Time taken to produce traditional rollers was reduced from several months to a week, to make the digital equivalent at a much-reduced cost.


Example of underglaze printed transfer on Burleigh's cow-creamers.

A KTP with Burleigh (2015-17) (**G2**) then supported technological and commercial development and practical application, allowing Burleigh to significantly reduce its overall costs and develop its product range. This included resurrecting historic patterns, shortening lead-times, allowing smaller production runs, increasing marketability, and expanding its global customer base; with a reported 15% increased yield. Application of UWE research contributed to the viability and long-term sustainability of Burleigh as an employer and commercial concern, and the retention of historic skills. It also contributed to the company's sustainability as a vital part of the local community and the country's industrial heritage - preserving historical processes but reinventing them for the 21st Century. Burleigh's Design and Development Manager noted that collaboration with UWE had:

> *'Secured the future for its classic and timeless tableware, transformed Burleigh's production, and paved the way for sustainable sales growth and innovation, including the generation of new patterns, shapes and limited editions'* (**S1**, **S2**).

The collaboration was 'Highly Commended' in the 2018 Times Higher Awards for the 'Most innovative contribution to business-university collaboration' (**S3**).

The research, led by Parraman, has also had industrial and commercial impacts on inkjet technologies and led to an AHRC funded project (2014-2015) with Pulse Roll Label Products, a privately-owned specialist producer of specialist inks for the global market. Developments in colour separation, methods for direct-write applications and UV-curable pigments, enabled the team to develop innovative products for commercial 2.5D print applications, thus giving them an advantage in the field (**R3**). Working on security printing with Tagsmart delivered unforeseen drivers to create customised and unique identification markers applied to artworks to reduce counterfeiting and trace provenance, and led its director to praise '*experts at the CFPR*' for having created:

> *'a permanent security marker for the fine art market. This demonstrates, both to academia and industry, the benefit of an interdisciplinary approach that reappraises the historic context to devise new approaches to physical problems in the current technological age'* (**S4**).

Demonstrating the legacy of early KTPs with Cranfield and John Purcell Paper (2000-2005) and the specialist research generated, these products remain market leaders. The water-washable ink is a significant product in Cranfield's range:

> *'With continued input from UWE from 2013 until the present day, Steve and the team have so influenced our product portfolio (including introducing the world's first oil-based ink that can be washed up with soap and water) that artists' inks and paints now account for 100% of our £1 million turnover'* (**S5**).

UWE continues to hold a patent for an 'On-glaze, screen-printed ceramic transfer process', derived from earlier collaborative work with John Purcell Paper including an earlier KTP (**S6**) – John Purcell continues to supply, commercially, 'UWET' paper for ceramic transfers, created by CFPR.

Artistic collaboration

Led by Parraman, CFPR drew on their wide-ranging knowledge and practical experience of multiple forms of print technology in collaboration with Sir Peter Blake, one of the most significant and best known pop artists of the 20th century, and Worton Hall Studios. This resulted in a new portfolio of editioned prints by Blake - *Ways of Making* (**S7**). Based on art school studio tradition, using one image of a primrose by Blake, the project sought to reproduce the image using as many different print processes as possible. CFPR's direct knowledge of inks, historic and 21st Century disruptive printing processes, contributed

approximately 20 new ways of printing to the project. The aim was to include over 50 processes from traditional lithography or silkscreen through to robotic printing. For example, 3D printed ceramic, underglaze tissue with Burleigh, Woodburytype, laser-engraving, 2.5D glazed tile, 3D printed lace, Merck RGB pigments on black paper (**S8**, **G3**).

The CCA galleries launched the portfolio at the Original Print Fair, Royal Academy London (above) in 2019 (**S9**). This event included a keynote discussion between Parraman, Sir Peter and Helen Roslyn. This project builds on extensive collaborations with major international artists including Richard Hamilton, Do Ho Suh and craftspeople such as Richard Slee and Peter Ting, drawing on the CFPR's expertise in colour and novel print technologies including continuous tone colour printing. Commissions typically draw on CFPR's underpinning research, disseminating to the print and artistic communities and public audiences, through editions, exhibitions or symposia. For example, CFPR co-hosted the Crafts Council/CFPR Symposium *Touch: Reflections on Making* (9th-10th December 2020). Presented online, it attracted 100 plus delegates, including speakers and workshops, recorded and archival material, and a digital exhibition of innovative work from CFPR (**S10**).

Knowledge dissemination, understanding and practice

Drawing on wide-ranging research and practical application of colour and print technologies, CFPR has had a far-reaching impact by disseminating and sharing knowledge and practice. Parraman is Chair of the IMPACT international conference series for printmakers and artists. The last event, IMPACT 10 in Santander attracted 450 delegates from 40 countries. The previous event was in Hangzhou, China (2015). Hoskins and Huson were lead contributors to the *Beyond Blue* symposium at the Victoria and Albert Museum in 2014, based on their collaboration with Burleigh Pottery on underglaze ceramic printing.

CFPR hosts workshops and CPD events, including bookbinding, photogravure, textile design and printing https://cfpr.uwe.ac.uk/courses/history-of-cpd-short-courses/. Attendance in 2020 dramatically increased as CPD was held on-line. *A Summer of Prints and Books Festival* in partnership with Arnolfini Bristol (**S11**), was shared across social platforms and YouTube, gaining 4,861 attendees worldwide attending 27 different activities.

5. Sources to corroborate the impact

S1 Testimonial from the Design Development Manager: Burleigh Pottery
S2 Burleigh Pottery and UWE: Printing partnership success
S3 Times Higher Education Awards, Highly Commended in the University Business collaboration 2018 - Available through UWE
S4 Testimonial from the Director, Tagsmart Certification Ltd.
S5 Testimonial from the Managing Director, Cranfield Colours
S6 Testimonial from Founder and Owner, John Purcell Paper
S7 'Ways of making' - a collaboration between Sir Peter Blake, Worton Hall and the CFPR
S8 Testimonial from the Account Manager, Merck Performance Materials Ltd.
S9 Artist in conversation: Sir Peter Blake, London Original Print Fair 2019, Royal Academy of Arts
S10 Crafts Council/CFPR Symposium Touch: Reflections on Making 9th-10th Dec 2020
S11 CFPR Continuing Professional Development and Dissemination with Arnolfini Bristol, Summer of Books and Prints Festival 2020