Institution: University of Leeds		
Unit of Assessment: D32		
Title of case study: Waterless Technologies and Xeros: saving natural resources through the marketisation of near-waterless washing products		
Period when the underpinning research was undertaken: 2011-2020		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s): Professor Stephen Burkinshaw	**Role(s) (e.g. job title):** Professor	**Period(s) employed by submitting HEI:** 2006 - present
Period when the claimed impact occurred: 2014-2020		
Is this case study continued from a case study submitted in 2014? Y/N		

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

Professor Burkinshaw's research on polymer sphere cleaning led to the creation of spin-out company Xeros (2007-) https://www.xerostech.com/ by the University of Leeds. Xeros was set up to commercially develop Burkinshaw's research on near-waterless washing technologies for industrial and consumer markets. Their technology has made a significant environmental impact, saving over 887,200,000 litres of water from 2014-2019. The company has also had a major impact on the development strategies of washing machine manufacturers and on contemporary debates concerning water usage. [text removed for publication]

2. Underpinning research (indicative maximum 500 words)

Professor Burkinshaw's research led to the innovative development of polymer sphere cleaning technology. His initial research into the manifold roles of water in conventional textile dyeing and finishing processes showed that its functions in processes such as cleaning and dyeing, could be divided into 'bulk' and 'interstitial'. Burkinshaw identified that whilst interstitial water was required for the vital stages of fibre wetting and swelling, the bulk water functions (heating, agitation, rinsing, etc.) could be performed by an alternative non-aqueous medium with suitable physical and chemical attributes. Polymer spheres were found to be an appropriate, readily available, low cost and recyclable alternative. In relation to laundry processes Burkinshaw's research **[1]** discovered that in addition to replacing most of the water used in conventional clothes washing, polymer sphere material also expedites the removal of stains and soils from garments. This resulted in significant savings in the amounts of both chemicals and energy consumed in clothes washing. It also significantly shortened the duration of the washing process.
Given the novelty of polymer sphere cleaning technology, its inventor (Burkinshaw) and the University of Leeds developed and commercialised the product, leading to the spin-out company, Xeros Ltd, being founded in 2007. Whilst Burkinshaw's research outputs relating to the innovative polymer sphere technology are restricted for reasons of commercial confidentiality, they are presented within patents (see **[1-3]**). As the technology is applicable to areas other than cleaning, work has also have been published in the form of peer-reviewed papers that describe the use of polymer spheres in the removal of vagrant dye from dyed fabrics **[4,5,6].** Xeros has published well over 20 new patents since the end of 2014 highlighting the lasting influence of Burkinshaw's initial research.

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

[1] Novel cleaning method, S M Burkinshaw, J Howroyd and University of Leeds, European Patent 2,012,940 (23/05/2012).
Patent describing the use of an alternative medium to replace some of the water employed in conventional clothes washing.
[2] Polymer Treatment Method, S M Burkinshaw, S D Jenkins, F J Kennedy, J E Steele and Xeros Ltd., WO 2012/035342 (22/03/2011) . Patent application which describes the treatment of polymer spheres recovered after use in cleaning processes for soiled substrates.
[3] Burkinshaw, S.M. and Howroyd, J., XEROS Ltd, 2018. *Cleaning method*. U.S. Patent 9,914,901.
[4] The wash-off of dyeings using interstitial water Part 1: initial studies Dyes and Pigments, 90, Aug 2011, 177-190, S M Burkinshaw and A M Negrou. DOI: 10.1016/j.dyepig.2010.11.002. This paper describes, for the first time ever, a universal method for removing vagrant dye from all dye-fibre systems, by the application of polymer sphere technology, offering marked savings in water usage, time and energy compared to conventional methods.
[5] The wash-off of dyeings using interstitial water Part 2: bis(aminochlorotriazine) reactive dyes on cotton Dyes and Pigments, 90, Aug 2011, 134-144, S M Burkinshaw, J Howroyd, N Kumar, O Kubambe. DOI: 10.1016/j.dyepig.2011.03.007. Describes the application of polymer sphere technology to the removal of reactive dyes from cellulosic fibres which enables reductions in time, water and energy usage to be achieved, as well as effluent load to be reduced.
[6] The wash-off of dyeings using interstitial water: Part 3. Disperse dyes on polyester Dyes and Pigments, 91 (2011) 340-349, S M Burkinshaw, J Howroyd, N Kumar, O Kabambe. DOI: 10.1016/j.dyepig.2011.05.001. Describes the application of polymer sphere technology to the removal of disperse dyes from polyester fibres, enabling savings in time, water and energy usage to be achieved.

4. Details of the impact (indicative maximum 750 words)
Burkinshaw's research, through its application in Xeros technologies has impacted on the environment, on industry investment/processes and on contemporary debates concerning water usage.

Impact on the environment and on industry investment / processes
Burkinshaw's scientific research led to the invention of 'Xorbs', small recyclable polymer spheres that are placed in washing machine drums facilitating the need for only a cup full of water with each wash. Xeros, the University spin-out company license the use of this technology.

The Xeros group floated on London's AIM market in March 2014 and raised GBP27,600,000 towards investment in the global marketplace **[A],** which has facilitated their considerable growth. Their near-waterless washing machine technologies reduce water use by up to 80 per cent and are certified an Environmentally Preferable Product. [text removed for publication] In October 2019 Xeros Technology Group was awarded the London Stock Exchange's Green Economy Mark demonstrating that Xeros generates 50% or more of their total annual revenues from products and services that contribute to the global green economy

Xeros owns a number of business units, including Hydrofinity that focuses on services to hotels, laundries and leisure facilities. These units are having a beneficial effect in drought-prone areas such as California **[D],** UAE **[E]** and South Africa **[F].** Hilton Los Angeles – Universal City installed machines in 2014. In 2017 Hilton reported using 76% less water, saving 2,000,000 U.S. gallons of water with use of 3 machines during that 3 year period **[D]**. Steve Thompson, Director Property Operations, Hilton LA/Universal City said *"The Hydrofinity system is a solution many businesses in California need, as it significantly reduces water consumption whilst also improving our customer experience, by providing cleaner linens. It's a win-win situation no matter how you look at it."* **[D]** In 2018, Xeros sold 16 commercial machines to the Cape Province of South Africa which are being utilised to save water in a major drought region. **[F]**

[text removed for publication]

Impact upon broader debates about water usage and sustainability.
In 2019 Xeros presented its technology in a written statement to the UK Parliament's Environmental Audit Committee inquiry into the sustainability of the fashion industry **[H].** They presented UK MPs with evidence about how its technology can be used to significantly reduce the amount of water, energy and chemicals used by textile manufacturers during garment production. Xeros asked MPs to consider whether garment labelling could be amended to include information about water consumption, empowering consumers to make more informed choices. Whilst these activities have not yet informed policy action, they have clearly contributed to national political debate in the area of sustainability. Burkinshaw's underpinning research and resultant outcomes are also utilised by the media to prompt public debate concerning waterless technologies and wider sustainable issues. For instance, Xeros and its technologies receive significant national and international recognition in the media, evidenced by a television feature on CBS Minnesota **[I]** and a press article highlighting Xeros technologies displayed at the Consumer Electronic Show in Las Vegas, 2018 **[J].**

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

[A] Press Article regarding the expansion of the business (PDF available on request): https://www.theguardian.com/business/2015/nov/12/waterless-washing-machine-group-raising-40m-for-expansion
[B] [text removed for publication]
[C] News Item regarding securing the London Stock Exchange Green Economy Mark (PDF available on request): https://www.xerostech.com/news/lsegreenmark
[D] Case Study: Hilton, Los Angeles, California, Unites States of America (PDF available on request): https://cdn2.hubspot.net/hubfs/5986444/PDF/Hydrofinity%20Case%20Study_HiltonLAUniversalCity.pdf
[E] Case Study: Al Easha Laundry Fujairah, United Arab Emirates (PDF available on request): https://cdn2.hubspot.net/hubfs/303944/HF%20-%20Case%20Studies/Hydrofinity%20Case%20Study_Al%20Easha,%20UAE.pdf
[F] Press Article from the Yorkshire Evening Post reporting on South Africa contracts (PDF available on request): https://www.yorkshirepost.co.uk/news/xeros-secures-order-in-south-africa-for-near-waterless-washing-machines-1-9280431
[G] [text removed for publication]
[H] Xeros presentation to the UK Parliament Environmental Audit Committee inquiry into sustainability in the fashion industry, 2019 (PDF available on request): http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/environmental-audit-committee/sustainability-of-the-fashion-industry/written/94500.pdf
[I] CBS News Video Clip, 2014 https://www.youtube.com/watch?v=00GII_Y1tS4
[J] Press Article from Business Green about Xeros and the Consumer Electronic Show, Las Vegas, USA in 2018 (PDF available on request): https://www.businessgreen.com/bg/feature/3024293/evs-at-speed-drones-underwater-and-recycled-digital-gold-ces-2018