Institution: THE UNIVERSITY OF LEEDS

Unit of Assessment: 34B Design

Title of case study: Virtually waterless clothes washing

1. Summary of the impact

We developed technology that uses polymer particles to replace much of the water that is employed in conventional clothes washing. The innovative technology is protected by several international patents and was commercialised in 2006 via the spin-out company Xeros Ltd. In August 2012, Xeros sold its first commercial-scale (25kg capacity) machine in the UK high street market and also installed the commercial-scale machine at a US commercial laundry, enabling typical savings of upto 70% less water, 50% less chemicals and 50% less energy than traditional methods and, hence, significantly reduced carbon footprint; Xeros plans to introduce a domestic-scale washing machine in 2014.

2. Underpinning research

The polymer particle cleaning technology stemmed from the research of **Stephen Burkinshaw** (Professor of Textile Chemistry) into the manifold roles of water in conventional textile dyeing and finishing processes. This research showed that the water used in textile processes, such as dyeing, could be divided into 'bulk' and 'interstitial' in terms of its functionality. As such, whilst interstitial water was required to enable the crucially important stages of fibre wetting and swelling to occur, bulk water functions such as heating, agitation, rinsing, etc. could be undertaken by an alternative, non-aqueous medium which displayed appropriate physical and chemical attributes. A preferred non-aqueous medium was identified (polymer particles) which was low cost, readily available and recyclable.

In the context of laundry processes initial research **[1]** revealed that in addition to replacing the vast majority the water that is used in conventional clothes washing, polymer particle material also expedites the removal of stains and soils from garments, which enables savings to be made in the amounts of both chemicals and energy consumed in clothes washing as well as reducing the duration of the washing process.

As the polymer particle cleaning technology is novel, its inventor (Burkinshaw) and the University of Leeds decided that the clothes washing process merited development and commercial exploitation; in 2007, the spin-out company *Xeros Ltd* was founded.

Although Burkinshaw's research outputs relating to the innovative polymer particle technology have had to be necessarily restricted for reasons of commercial confidentiality, they are described within patents, such as those shown in **[1-3]**. Further outputs are in-process, mostly in the form of patents, as a consequence of the on-going development and commercial exploitation of the polymer particle clothes washing technology.

As the novel technology is applicable to several areas other than the cleaning of clothes, aspects of the research work have been published in the form of peer-reviewed papers which describe use of polymer particles in the removal of vagrant dye from dyed fabrics **[4,5,6]**. Whilst several alternative applications for the polymer particle technology are being explored by Xeros Ltd., their description has had to be restricted owing to commercial confidentiality.

3. References to the research

[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 particles recovered after use in cleaning processes for soiled substrates.

[3] **Novel Cleaning Method**, S M Burkinshaw, S D Jenkins, A J Waddon, J E Steele and Xeros Ltd., WO 2012/035343 (22/03/2011). Patent application which describes further developments of the polymer particle clothes washing process.

[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 particle 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 particle 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 particle 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

The research findings resulted in the founding of the clean-tech company, Xeros Ltd., in 2007. The company's first premises were in Leeds University Business Incubator, with two staff; the company moved to its current location (Advanced Manufacturing Park, Rotherham, South Yorkshire) in 2010 and now employs 27 staff (most of whom are science PhD graduates) housed within a purpose-built R&D/manufacturing facility. Details of impact are given by Xeros Ltd in the attached letter **[A]**.

The research findings that the patented polymer particle technology enables clothes to be cleaned using a fraction of the water, energy and detergent required for conventional cleaning methods, and provides significant cost-saving and environmental benefits, were borne out by results secured from a series of highly successful field trials in 2011. These trials were undertaken at two of the UK's most respected launderers and cleaners namely, *Jeeves of Belgravia*, which specialises in bespoke garment care and *Watford Launderers and Cleaners*, one of the UK's largest independent commercial laundry operators. The field trials showed that the Xeros polymer particle washing system delivered superior cleaning performance to conventional commercial washing systems, as well as significantly reducing energy, detergent and water consumption **[B]**.

Xeros has been successful in raising investment, despite the on-going global financial difficulties,

with the most recent round in 2013 bringing the total investment thus far generated to £16m. In February 2012, Xeros was awarded a £250,000 grant for R&D development by the Technology Strategy Board to accelerate the development of a domestic laundry machine. Xeros received a further grant of £75,000 from the Technology Strategy Board to create a novel way of cleaning leather that will both save water and protect the environment by reducing the polluting toxins in the industry's waste water **[C]**.

The initial focus of Xeros' business model has been the construction of a commercial-scale laundry machine capable of washing up to 25kg of clothes at a time, aimed at the commercial cleaning sector, such as hotels, hospitals and high street cleaners, for launch in 2012. The recent installation of its commercial-scale washing machine at a major US commercial launderer attracted the attention of the Yorkshire Post **[D]**. The company will introduce a domestic-scale machine in 2014 **[E]**.

To optimise the polymer particle technology and prepare products for market, Xeros has established a commercial partnership with the US company *GreenEarth Cleaning*, the world's largest dry cleaning brand, which operates in 42 countries with over 2000 licensed users of its environmentally friendly patented dry cleaning process. The President of *GreenEarth Cleaning* commented that "We had the honour of previewing this exciting new technology to many of our 800 U.S. dry cleaning affiliates over the past two years. We believe Xeros will be embraced by our industry because of the significant cost savings and environmental benefits it brings." **[F]**

The concept of waterless washing has attracted considerable global media interest, having been reported in publications ranging from *The Economist*, *The Times of India*, *Toronto Star*, *Business Weekly*, *Gulf News*, *Physics Today* and *The Sunday Times*. The invention featured on Radio 2's *Drivetime* show, the BBC World Service and Channel 4's *Home of the Future* programme (Feb 19th 2012) **[G]**.

The technology was named as one of WWF's 'Top 20 Global Green Game-Changers' in 2010, voted 2nd in the top 50 '*2010 Best Inventions*' by **TIME** Magazine and was awarded *Best Technological Breakthrough* at the Climate Week Awards 2011. In 2011, Xeros was one of only 25 companies selected from a range of cleantech sub-sectors to present its technology at *The European Cleantech Summit 2011* in Geneva **[H]**.

The Deputy Prime Minister recently toured Xeros' facility in Rotherham, during which he commented "*It takes your breath away. It is such a simple idea, but it is so revolutionary*" adding "*It could save billions and billions of litres of water over time. The implications are profound in terms of water and energy use.*" In the context of the impact of our research, The Deputy Prime Minister commented that "*This is a great example of what we want to see happening in the British economy. It was academics that first came up with the idea and it has been translated, partly thanks to support from the government and private investors, into something that hopefully make its way into the shops fairly soon*" **[I]**. In this context, as the novel, polymer particle clothes washing system saves so much of the water associated with conventional washing, if the US domestic washing market converted to Xeros technology, some 1.2 billion tonnes of water per day could be saved **[J]**.

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

A. Letter from the Director of Xeros Ltd.
B. Links to field trials at Jeeves of Belgravia and Watford Cleaners:
http://www.xerosltd.com/downloads/leading_launderers.pdf (accessed 14-08-2013)
C. Link to Xeros press release article describing £3.5m funding round investment and articles detailing Technology Strategy Board awards to Xeros:
http://www.xerosltd.com/downloads/oct_10_press.pdf (accessed 14-08-2013)
http://www.xeroscleaning.com/xeros-successfully-completes-10-million-funding-round/ (accessed 14-08-2013)
http://www.xerosltd.com/downloads/tsb_award.pdf
http://www.innovateuk.org/content/press-release/testing-the-waters-the-innovative-smes-making-wave.ashx (accessed 14-08-2013)
http://www.xeroscleaning.com/technology-strategy-board-awards-prestigious-grant-to-xeros/ (accessed 12-08-2013)
D. Link to articles regarding installation of commercial-scale machine in US launderer:
http://www.yorkshirepost.co.uk/business/business-news/xeros-goes-for-a-spin-in-the-states-to-help-cut-carbon-footprint-laundry-causes-1-4941334 (accessed 14-08-2013)
http://www.xeroscleaning.com/xeros-expands-its-revolutionary-laundry-cleaning-system-into-the-north-american-dry-cleaning-industry/ (accessed 12-08-2013)
http://www.xeroscleaning.com/xeros-to-showcase-future-of-commercial-laundry-at-clean-show-2013-in-new-orleans/ (accessed 12-08-2013)
E. Link to Xeros machine variants:
http://www.xeroscleaning.com/polymer-bead-cleaning/domestic-laundry/ (accessed 12-08-2013)
F. Link to Green Earth Cleaning partnership information:
http://www.greenearthcleaning.com/ (accessed 12-08-2013)
http://xeroscleaningna.com/partners/ (accessed 12-08-2013)
G. Links to various sources of media interest in waterless washing concept::
http://www.dailymail.co.uk/home/search.html?searchPhrase=Xeros (accessed 12-08-2013)
http://www.xerosltd.com/downloads/press2009.pdf (accessed 14-08-2013)
http://www.xeroscleaning.com/category/press/ (accessed 14-08-2013)
http://www.guardian.co.uk/environment/2010/mar/09/xeros-washing-machine-bills (accessed 14-08-2013)
H. Links to WWF's 'Top 20 Global Green Game-Changers', Time Magazine Best 50 Inventions of 2010 and *Best Technological Breakthrough* at the Climate Week Awards 2011
http://www.wwf.org.uk/wwf_articles.cfm?unewsid=4200 (accessed 14-08-2013)
http://www.time.com/time/specials/packages/article/0,28804,2029497_2030623_2029701,00.html (accessed 14-08-2013)
http://www.climateweek.com/awards/award-categories/best-technological-breakthrough/ (accessed 14-08-2013)
http://www.xerosltd.com/demo/downloads/tech_tour.pdf (accessed 14-08-2013)
I. Link to visit by Deputy Prime Minister to Xeros on September 13th 2012
http://www.thestar.co.uk/news/business/clegg-backs-bid-to-help-save-energy-1-4937173 (accessed 14-08-2013)
J. Link to potential water saving that could accrue from the adoption of our technology in US domestic washing market:
http://www.xeroscleaning.com/polymer-bead-cleaning/environmental-benefits/ (accessed 14-08-2013)