Institution: University of Derby
Unit of Assessment: 34
Title of case study: Applied Textiles – Architectural Surfaces Research to develop digital relief castings and embossing techniques for precast concrete and glass for exterior architectural decoration.
1. Summary of the impact (indicative maximum 100 words)

The underpinning research was rooted in surface patterning technologies of the textiles industry – from traditional precepts of structuring seamless repeats to the deployment and hybridisation of advanced digital imaging processes to create control data for output devices - from looms to lasers.
The research investigated digital methods for the realisation of high-definition relief formliners for precast and glass reinforced concrete. Bespoke methods were later translated to develop workable low relief moulds.

This research built on earlier investigative research in 2009 into a method for the digital realisation of the high definition photorealistic form liners.

2. Underpinning research (indicative maximum 500 words)

Research Insights

Against a backdrop of long-term textiles-oriented research that focussed on the adoption of digital methods for the fabrication, construction and modification of both flexible and resistant materials, researchers were drawn into a radically different medium – concrete.

The research and the innovation of creating the first High Definition (1200dpi), photorealistic, low relief form liner mould for pre-cast concrete, for use at an industrial scale, has had several impacts. Of these, the full realisation of the vision of the award-winning architects, Caruso St John, is prime. Without the invention and delivery of a true means of relief replication of the rich detail of Valenciennes lace in concrete, the Nottingham Contemporary Arts Centre would have been deprived of a level of finesse that has established its credentials: *"…might be the first masterpiece of British architecture of the twenty-first century"*. Owen Hatherley, A *guide to the New Ruins of Great Britain*, Verso 2010.

The later (2011) project in Glass Reinforced Concrete (GRC) also adopted the concept of using patterned architectural surfaces to reflect residual locational narratives in animating the urban environment. This developed from the previous research to make a strong societal impact, which in this instance was economic in the creation and retailing of 185 premium apartments, totalling approximately £80million. It added to the economic buoyancy both in London and in Yorkshire, where the GRC panels were manufactured.

Key Researchers:
Professor John Goto, Professor of Fine Art, Head of Digital & Material Arts Research Centre, University of Derby (2008 – present).
John Angus, Senior Lecturer Textiles, Digital Form Liner research, University of Derby (1990-present).
Louise West, Textiles Student Researcher, Lace Consultant, University of Derby.
Research Centre researchers – D-Marc.
The collaborating architects at Caruso St John, Stephanie Webs, Bernd Schmutz and Peter King, Production Director at Trent Concrete Ltd.
Industry Collaborators:
Commissioning architects at Caruso St John, Stephanie Webs, Bernd Schmutz.
Manufacturing: Peter King, Production Director at Trent Concrete Ltd.

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

The following materials are evidence of the profile of the research and of the reach of the impact:

1) http://www.architectsjournal.co.uk/story.aspx?storyCode=5210778
"Nottingham Contemporary Art Gallery by Caruso St John Architects"
12 November, 2009, By Kieran Long.

2) http://www.carusostjohn.com/projects/nottingham-contemporary/

3) Nottingham Contemporary, Weekday Cross, Nottingham, Architecture 10, RIBA buildings of the year, 2010.

4) http://www.nottinghamcontemporary.org/our-building
Summary of external reviews.

5) GRC2011 Istanbul Congress of the Glass Reinforced Concrete Association (GRCA).
http://www.grca.org.uk/congress/default.asp
http://www.grca.org.uk/congress/downloads/32%20Project%20in%20the%20UK%20with%20Patterned%20GRC%20Panels.pdf
Item 32: Project in the UK with Patterned GRC panels, Bob Faulding, GRC UK Ltd.

6) Project reportage (Sept. 2012) on website of Steering Group of senior regeneration and economic development practitioners from across London:
http://www.futureoflondon.org.uk/2012/08/30/maple-quays-canada-water/

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

Process

Caruso St John Architects won the commission for the £20m *Nottingham Contemporary Arts Centre*. Their facia design specified the use of a Victorian lace pattern, at an enlargement of 1000%, to be embossed in a seamless vertical repeat into concrete panels around the building. A bobbin lace expert replicated the real - if oversized - lace for the pattern. The research team provided digital 'pricking patterns' at the new scale, together with 3D visualisations - machined in resistant materials - of the required enlarged detail, and bespoke 'giant' yarn to effect the master sample.

The architects intended producing this physical textile artefact for the master repeat formliner in the magnified yarn, aiming to use this scaled-up sample as a 'traditional' direct master mould for the production of the negative silicone 'formliner' mats, that are required in the concrete casting process. These derivative mats were eventually to be produced by Reckli GmbH in Germany. However, it became evident that this approach would be problematic, as silicone poured on the 'positive' textile master would become trapped below the 'equator' of the round profile yarns used, preventing release of the 'negative' formliner. As a hypothetical alternative solution, a digital method of fabricating the lace master was posited by the researchers and developed to output a high-definition mould without undercut regions.

Experimentation was undertaken using a range of software applications, digital prototyping devices & a diverse range of materials to arrive at the lasering method. The research was underpinned by a heritage of 'desk-top manufacturing' methodology that had been sustained through decades of advanced CAD/CAM implementation in innovative prototyping for manufacture, evidenced by Design Residencies and PhD supervision. Bespoke methods were developed to translate the

digital imaging, applied and constructed textile repeat systems and the 'rules' of machine wrought Valenciennes Lace into a workable low relief mould.

Subsequent media coverage prompted the external request for a second architectural collaboration, with new partner companies. Glen Howells Architects who had specified hundreds of large decorative relief panels, depicting fallen layers of stylised maple leaves, in glass reinforced concrete for Barratt East London's Maple Quays Development at Canada Water. Consequently GRCUK Ltd. - a leading GRC manufacturer - required the invention of a digital method to create the high resolution master formliner with the addition of two additional criteria. Firstly, as GRC is sprayed into the mould, the formliner must have a specific angled 'draw' or bevel between each level of pattern. The second challenge was to conceive a method of digitally engineering an irregular tessellating shuttering, around the core repeat, of the same level of detailing as the relief pattern. This demand arose from the obligation to extend the pattern repeat over large panels - up to 5.25 m2.

This Maple Quays project enabled the exploration of new materials and novel methods to arrive at the sculptural requirements in GRC specified by Barratt and the architects at Glenn Howells and Hawkins Brown. The success of this relied on collaboration with GRCUK and their technologists to dovetail the methods effected at the University of Derby and the replication system carried out in-house at GRCUK Ltd. The Maple Quays project was realised over the course of 2010 – 11.

Beneficiaries

The new digital procedures proved effective at the initial prototype stage and were used to secure a major contract for GRCUK Ltd. with Barratt East London. From this, twenty GRCUK employees were engaged for 6 months on production and Barratt East London sold all 180+ apartments, clad in maple leaf concrete. The research focused on a different range of master formliner materials and on the means of subsequently creating large scale (max. 3mtrs x 1.5mtrs) latex formliner matts in endless & seamless repeat for a variety of signature architectural components, such as balcony cladding, ingress facades and roofline headers.

Evidence of Impact

The physical outcome of the research and its impact is evidenced in the public spaces and built environment of the London Docklands regeneration project and on the façade of Nottingham Contemporary Arts Centre, which has attracted international attention since opening in 2009. The lace embossed, fluted facade of 1100 tonnes of green, structural, pre-cast concrete is part of the national visitor attraction, securing a yearly footfall in excess of 300,000 – 40% beyond projections.

The University of Derby and Trent Concrete Ltd. were shortlisted in the Lord Stafford Awards for Innovation Achieved, 2009.

The employment impact lay primarily in the engagement of 200+ workforce of Trent Concrete Ltd over a 6 - 8 month production period.

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

Corroboration

The assertions of this impact statement can be corroborated by the following external contacts and/or by the content of their websites:

1) Managing Director, GRCUK Ltd. of Dinnington, Sheffield and Chair of the Glass Reinforced Concrete Association (GRCA), which represents the global industry and formulates its trading standards.
See: http://www.grcuk.com/grc_trade_associations.htm

2) Barratt London: http://www.barrattlondon.com : any approach should be mediated only through our prime collaborator - GRCUK Ltd.

3) The architects: Glenn Howells and Hawkins Brown – again any approach should be mediated only through our prime collaborator - GRCUK Ltd.

Evidence of Impact
The impact claimed can be corroborated through the following channels:

1) The project was a shortlist winner in 2010 Lord Stafford Award for Innovation Achieved

2) See Project Team listing: http://www.carusostjohn.com/projects/nottingham-contemporary/

3) East Midlands Knowledge Network:
http://s3-eu-west-1.amazonaws.com/www.sustainability.net/emkn/case_study/search/trent_concrete/index.html

4) BBC East Midlands Today footage:
http://news.bbc.co.uk/player/nol/newsid_7250000/newsid_7257400/7257422.stm?bw=bb&mp=wm&news=1&ms3=6&ms_javascript=true&bbcws=2

Media
The work was extensively reviewed in the broad press and also in specialised architectural publications in UK, Germany and France for example 'de Architect', 'D'Architectures', 'Deutsche Bauzeitung', 'Architectural Digest', 'Artforum International' and 'Arkitekten' are indicative examples.

The research was presented as invitations to address symposia and conferences:
Making Architecture series at the University of Nottingham, 2010; *Cutting Edge*: *Lasers and Creativity,* University of Loughborough 2011; *Materiality of the Digital,* East Midlands Universities Association, hosted at the University of Loughborough 2011.