Proceedings Paper:

Scott, J (2016) Programmable Knitting. In: Acadia 2016 Posthuman Frontiers: Data, Designers, and Cognitive Machines: Projects Catalog of the 36th Annual Conference of the Association for Computer Aided Design in Architecture. ACADIA 2016 Posthuman Frontiers: Data, Designers and Cognitive Machines, 27-29 Oct 2016, The University of Michigan, Taubman College of Architecture and Urban Planning, Ann Arbor, Michigan. Acadia Publishing Company , pp. 276-281. ISBN 978-0692770955

Programmable Knitting

Jane Scott
The University of Leeds &
Central Saint Martins, London

1 Programmable Knitting: the knitted surface actuates causing waves of movement along the fabric length. (Scott, 2015 ©)

PRODUCTION NOTES

Designer Jane Scott
Yarn 1/24nm linen 850tpm s/z
Programme Shima Seiki Apex1
Knit Machine: Shima Seiki NSSG122:5g

This project examines the potential for knitted fabric to exhibit environmentally responsive, shape-changing behaviour. Using the examples of two knitted prototypes Flux and Skew, the work demonstrates how the configuration of front bed (FB) and back bed (BB) stitches can be used to program specific shape change behaviours into knitted fabric composed of 100% natural fibres.

The intention has been to develop a passive responsive material system which directly engages with changes in the environment, rather than using material components that require electronic control.

This requires the shape change behaviour to be engineered into the fabric itself, and biomimetic insight derived from the structural organisation of plant materials has been instrumental to design development.


2 Programmable Knitting; fabric before actuation in dry state (Schek, 2015 ©)


3 Programmable Knitting: after actuation fabric forms spiral peaks (Schek, 2015 ©


4 Skew: Detail of knitted surface after actuation in 3D/wet state. (Schek, 2015 ©)

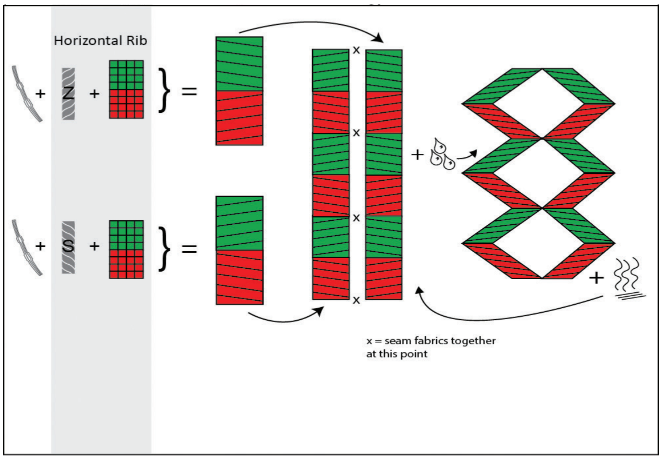
In order to design shape-changing knitted surfaces the constituent materials require the ability to sense and respond to external stimuli. In this research actuation occurs in response to moisture. Natural fibres have exceptional moisture absorption properties. As moisture is absorbed into the fibre there is little change in the fibre length, however the transverse swelling is extensive (up to 45% in flax fibres) (Morton and Hearle, 1986:227).

For shape change to impact at the level of the fabric the transverse swelling caused by moisture absorption needs to be translated into an actuation motion which can generate shape change across the whole fabric. This is achieved using twist, the underlying mechanism which holds fibres together within a yarn (Scott, 2015:90). However in order to generate complex shape change, the directionality inherent to yarn twist direction can be modified through the configuration of knitted stitches demonstrated in the prototypes Flux and Skew (Scott 2015:95).

Knitted stitches are generated with a specific directionality; the yarn is always introduced to the needle in the same way, interlooping through the previous loop from the technical back to the

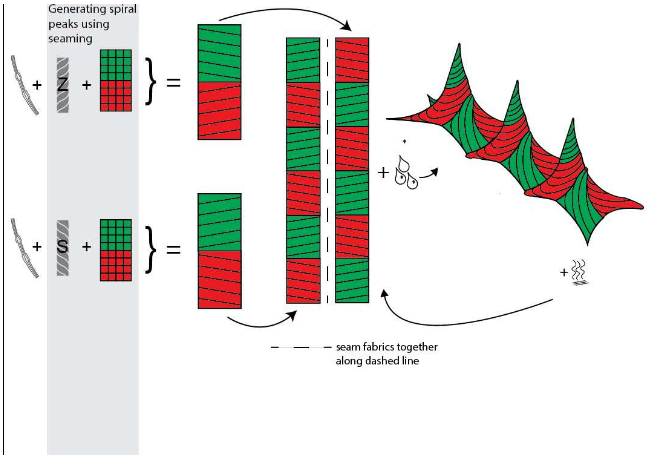
5 Flux: Large scale knitted prototype constructed from multiple shaped panels of horizontal rib. Fabric seamed at particular points to produce different shape changes.

6 **Flux: detail illustrating openings forming in the actuated surface**. (Scott, 2015 ©)



7 Flux: RKS data illustrating directional behaviour of fabric in 6. (Scott, 2015, ©)

8 **Flux: detail illustrating spiral peaks forming in the actuated surface.** (Scott, 2015 ©)



9 Flux: RKS data illustrating directional behaviour of fabric in 8. (Scott, 2015, ©)

In order to programme the shape change behaviour a new illustrative approach has been developed; RKS (the responsive knit system) (Scott, 2105:119). Analysis of RKS representation of Skew in comparison to Shima knit data for Skew (images 11&12) illustrates how incorporating the directionality of the fabric structure and yarn in combination (the resultant active twist) enables the design of shape-changing knitting.

Flux demonstrates shape change behaviour using a horizontal rib configuration. The underlying shape change is from a rectangle to a chevron and repeating units generate a zigzag on actuation. Flux however is an assembly of individual fabrics, extending the scope of programmable knitting to create alternative geometries where fabric structures interact, including peaks and spirals, and sections that open and close. RKS representation of two individual details are illustrated above.

What this project demonstrates is the potential of natural textile materials to exhibit behaviours conventionally associated with smart synthetics or e-textiles. Through the use of a hierarchical approach derived from biomimicry a new class of smart-natural knitted surfaces has been established.

11 Fabric actuated using cold water spay (Schek, 2015 ©)

REFERENCES

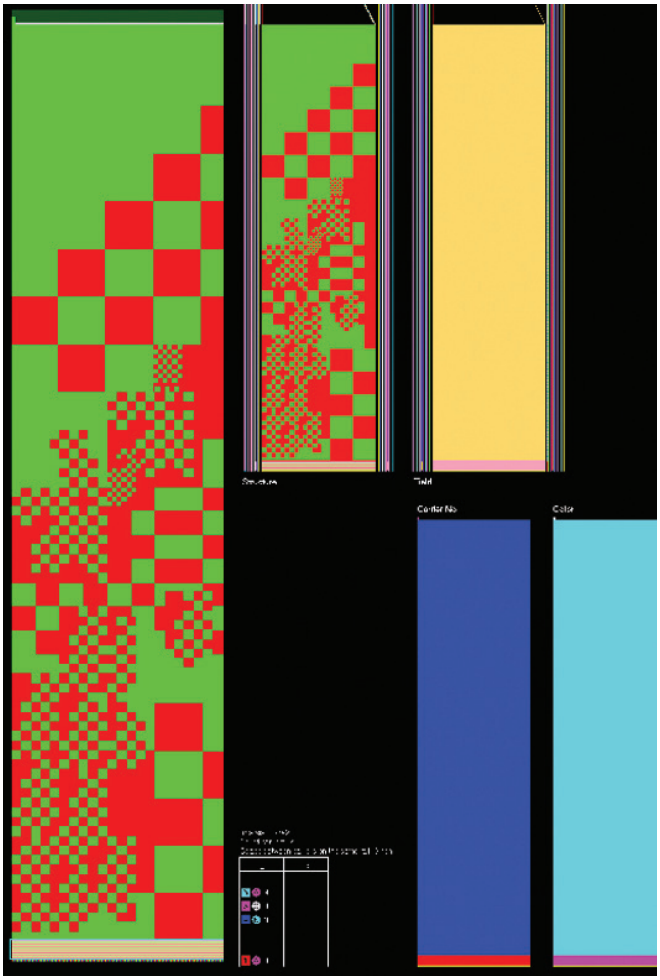
Morton, W.E and J.W.S Hearle. 1986. Physical Properties of Textile Fibres. Manchester: Textile Insitute.

Scott, Jane. 2015. Programmable Knitting: An Environmentally Responsive, Shape-changing Textile System Informed by Biomimicry and Costructed from 100% Natural Materials. PhD Thesis. University of the Arts London.

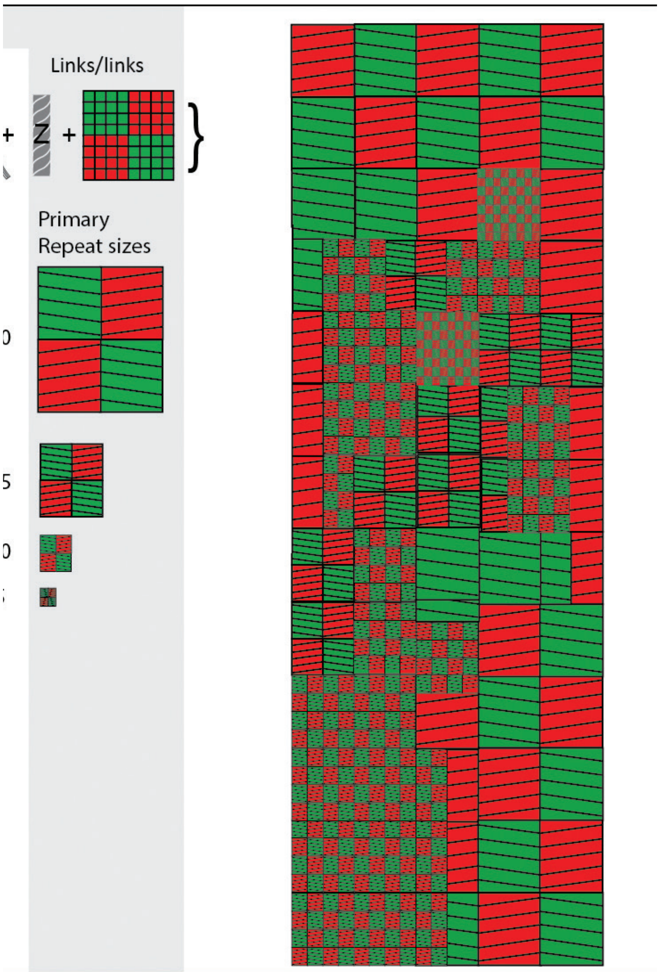
Spencer, David. 1997. Knitting Technology. Cambridge: Woodhead.

Jane Scott's research incorporates programmable and responsive textile systems, knitted fabric design, knit technology and biomimicry. Using a biomimicry methodology her work re-examines the constituent components of knit fabrics in order to engineer smart behaviours into knitted textiles without electronics or smart synthetic materials. She has recently completed a PhD through The Textiles Futures Research Centre, Central Saint Martins at The University of the Arts London.

Jane works as a Senior Teaching Fellow at The University of Leeds. Her role incorporates the design and delivery of both studio practice and lecture programmes in BA Textile Design.



11 Skew SDS1 Apex Programming Data illustrating knit stitch configuration.



12 Skew: RKS data shows the directional behaviour of knit structure. (Scott, 2015