A case study in persnalised digitally printed jeans

Jeni Bougourd and Philip Delamore

Abstract

The Research Department at the London College of Fashion (LCF) comprises several subject specific research hubs. The authors of this paper are members of the Fashion Science Research Hub, with interests in the convergent disciplines of fashion design, computer science and materials science. This project focuses on the digitisation of the product development process incorporating 3D body scanning, automatic pattern generation, visualisation, digital printing and embroidery. Project partners were LCF, Bodymetrics and Optitex. The aim of the project is to introduce custom print and embroidery to the existing Bodymetrics Digital Couture offer in a London retail store. This is the first in-process report of an ongoing digital fashion product development research programme. There were several stages employed to realise this research project. One male and one female model were scanned to an automatic 2D pattern generation and uploaded to a CAD system in preparation for the engineering of the two selected print designs. The designs were evaluated on a 3D dynamic visualisation system before the colour profile was reviewed on a colour management system prior to being tested on a Mimaki TX2 and lay plans produced for final printing. On completion, prints were steamed and washed and the fabric of the women's jeans was embroidered. The garments were cut and assembled using traditional methods. The project was successfully realised using a range of digital tools, which facilitated each individual stage but failed to provide a continuous integrated workflow. Remaining issues to be addressed, to provide a complete digital throughput for product development, include: File format, CAD workflow, fabric stability, print and post processing and single-ply cutting and registration The issues highlighted are currently being addressed through a continuing

Keywords:
digital print,
made-to-deasure,
bodyscanning

research programme. This paper has not been published elsewhere; transfer of copyright is acknowledged.

Introduction

The University of the Arts London has six constituent colleges, one of which is the London College of Fashion. Research interests at the College are extremely varied but can broadly be placed into six research hubs:

- fashion curation
- fashion mediation
- fashion science
- historical and cultural studies
- object, art, situation
- pedagogic research

The Fashion Science Hub at LCF is built on the dual foundations of the College's key specialisms in fashion design and technology: traditional 3D craftsmanship in tailoring, fashion, footwear and accessories including millinery and 3D digital systems. The authors of this paper are members of this hub with a particular interest in the exploration of three dimensional systems and the extent to which these and other enabling technologies can be used for the fashion industry. As part of the college’s centenary celebrations, this group presented a project developed with Bodymetrics to demonstrate how digital technologies can be used either to support the digitization of traditional processes or to challenge current practices.

Background

During the past 100 years the apparel and footwear industries have almost travelled full circle from traditional bespoke clothing, through mass production to mass customisation. Traditional bespoke clothing has been described as having three factors of convenience: service, selection of a unique design and removal of the need to go shopping.[1] This clothing was made to meet the needs of individuals but it is a labour-intensive, craft-based process, available only to an elite group.

Mass production emerged from the industrial revolution, opening access to ready-to-wear clothing to the wider population. The strategy can be seen as appropriate for a time of economic growth comprising a process of designing new products, making those products in quantity so that customer demand could then be stimulated through marketing. Although the traditional process of mass production is continually being enhanced through the use of new technologies, it is nevertheless being challenged for a variety of reasons:

- Increased competition in the market place
- Designs being replicated by competitor
- Over supply of very similar goods
- A high percentage of returns
- Changing consumer behaviour

Consumers are now better educated, more demanding and discerning. They seek greater variety and immediate, personalised service.[2]

In the same way as mass production replaced bespoke clothing at the turn of the twentieth century, mass customisation is expected to replace mass production in the twenty-first century.

Mass customisation is regarded as a new paradigm, based on creating variety and customisation through flexibility and responsiveness.[3] The advent of new and enabling technologies is bringing the original concepts of mass customisation as defined by Davis[4] and Pine[5] to fruition. It is a strategy that seeks to address the individual needs of the customer and is, perhaps, as Fralix suggests, a practice that combines the best of the craft era with that of the mass production era.[2]

The apparel and footwear industries are seen by Tseng and Piller as being the forerunners on the application of mass customisation. Having the potential to address all three possible dimensions of customization, fit, functionality and aesthetic design.[6]

One of the first retail companies to offer custom clothing using new enabling technologies was Brooks Bros. of New York. Many other retailers in the US, mainland Europe and to a lesser extent the UK, now offer these services, although at present the product types have necessarily been confined to classic styles such as jeans, tailored suits, shirts and some intimate apparel.

A UK company called Bodymetrics has two custom clothing units in London – one set up in Selfridges department store, offering digital personalised jeans, the other in Harrods' department store, specialising in digital bespoke suits for women.

Aim

The aim of this digital bespoke jeans project was to extend the current Bodymetrics jeans range to include opportunities for customers to have digitally printed and embroidered jeans.

Current digital data flow

This section describes the retail custom apparel process used by Bodymetrics. The process typically uses 3D whole body scanners and visualisation systems, has the following stages:

Current data flow is supported by a proprietary data tracking system, where the outcomes of each stage are uploaded and progress monitored from the entry of the customer's details at onset to jeans being delivered to the customer at the end. The progress of the garment can be accessed by retailer or manufacturer at any stage. The current digital data flow has six stages, each of which is discussed below.

Jean design selection

Anderson et al[7] identified four options through which a consumer may collaborate in the design process. Design options with standard sizes, co-design, totally custom and clothes clones. Of those four, co-design most closely resembles the design of the bespoke jeans where a professional sales person guides the customer through a choice of style, style details, fabric weight, colour and personal fit.

Figure 1. Available styles for men and women

The initial jean offer by Bodymetrics was 'best fit' for existing, ready-to-wear ranges of jeans. There are now three options: ready-to-wear; bespoke jeans and couture jeans – all are offered with personal fit. The ready-to-wear and couture jeans have limited style options whilst in the case of bespoke jeans there are two styles: a skinny fit with a shallow yoke and a super skinny fit with a deep yoke and a curved fit. (Figure 1)

These styles can also have three body rise depths, related either to the position of the navel or related to total body depth; three leg shapes – straight, drain pipe and boot cut; and two leg lengths – full and three-quarters. The materials are available in several colours, in two weights (12 and 14 oz) with two percent elastane. In addition, there is a non-stretch fabric range available for men.

Figure 2. Available materials

The trimmings for all styles include contrast stitching, with the exception of self-stitching on black and white. Traditional studs are available, together with crystal on the skinny fit. When all style details of the jeans have been agreed with the customer they are uploaded to the data tracking system.

Size, and shape

The 3D scanning unit is used automatically to capture the point cloud, detect body landmarks and extract measurements. The shape is visible as a point cloud and up to 140 measurements can be extracted, as required. All measurements can be verified visually prior to being uploaded for pattern generation. (At present, where a scan appears less than perfect, supplementary body measurements will be taken using traditional anthropometric methods. However, new software is under development that is intended to obviate this precautionary step.)

Pattern generation

A proprietary system was created for the initial ready-to-wear, best-fit option, using both shape and measurement data. This was later combined with a commercial pattern alteration system, using standard CAD pattern processes.

Virtual try on

An initial proprietary try-on system, (Figure 3) was developed for the ready-to-wear option. The patterns generated were 'wrapped around' the 3D virtual image of the customer so as to verify the fit, shape and style of the garment envisaged. (It is reported that this system is now being developed so as to allow further style variations to be assessed in virtual space.) Following visual evaluation, interim adjustments may be made to style and fit, prior to automatic generation of the final pattern, lay plan and manufacturing specification. Where a customer seeks reassurance, it is possible to offer physical jean block shapes (made up as toiles) in whole and incremental sizes (i.e. 8, 9, 10, 11, etc., up to 18), although it is recognised that block shapes do not accurately represent the size or the shape of the individual customer.

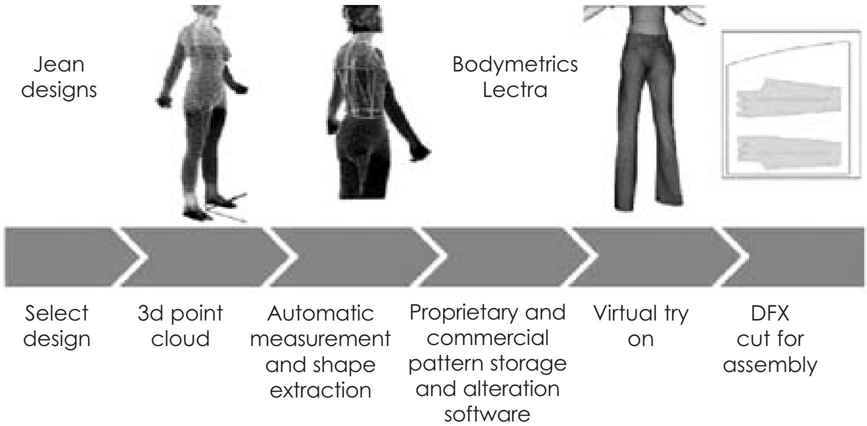


Figure 3. Custom clothing: current digital data flow. Developed from flow process described by David Bruner of TC2

Cutting and manufacture

The final pattern is uploaded to the data tracking system for processing by an automated, single-ply cutter. A flexible, quick-response assembly system is used to manufacture the jeans. All jeans are packed in a proprietary box for despatch, either to the retailer for collection or directly to the customer's home. A data tracking system is used not only to store customer data but also monitor progress through the mass production process.

Personalised, digitally-printed and embroidered jeans

We now turn to the ways in which the processes described above have been extended.

Pattern generation

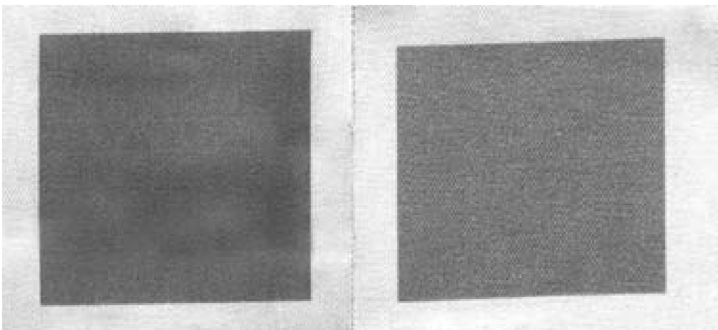
We selected two models, one male and one female, to deputise as customers for the project. Each model was scanned in the Bodymetrics TC2 3D bodyscanner. A slim fit jean was selected for each, so that a suitable non-stretch pattern could be generated for the fabric type selected for the project. In this case a cotton drill, of similar weight and construction to denim, was selected.

Once the patterns were received from Bodymetrics as .dxf files they were imported into Adobe Illustrator for viewing. A preliminary pattern was exported to a plotter so a toile could be cut to check the fit. This would not normally be part of the manufacturing process but was identified as desirable to check fit prior to developing the print.

The Illustrator files were adjusted to remove the seam allowances. At this stage it was identified that in future iterations a pattern could be generated without seam allowances to avoid this additional process.

Shrink testing

Using a textile ink-jet printing system requires that the fabric substrate must be pre-treated in order to fix the colorant permanently and give



Unsteamed 8x8 cm

Washed and steamed
Shrinkage: W 7.8; L 7.5 cm

Figure 4. Pre- and post-shrunk test

good fastness; a series of shrink tests were performed on the fabric prepared for print to establish the dimensional stability. An 8cm square grid was printed across the width of the fabric, steamed and washed. This is necessary as inkjet printing with reactive dyes is liable to cause dimensional change to the fabric[7] due to pre- and post-processing of the fabric. Having repeated the tests three times an average shrinkage formula was calculated, and applied to the final artwork before printing.

Print design selection

Two approaches were employed for the print and embroidery design for the prototypes. For the men's jeans, artwork was selected from a student digital print design project and for the women's jeans a Research Fellow developed the artwork. Following design selection the artwork was imported into Photoshop to be engineered to fit the pattern pieces.

Figure 5.

Engineer print

An engineered print is a design tailored to fit the pattern pieces of a garment in such a way that, when assembled, there is a degree of continuity so that the image flows unbroken around the body. Many historical craft designs for print and embroidery are tailored to fit the garment. Notable designers of the 20th century such as Sonia Delaunay, Emilio Pucci and Gianni Versace favoured engineered screenprinting and more recently, Tristan Webber, Jonathan Saunders and Basso & Brooke have employed the technique using digital textile printing.

None of the existing proprietary fashion/textile software packages allow for the automated matching of a single image through the pattern pieces of a garment, although several existing systems allow check and stripe matching, and the possibility of filling pattern pieces with repeat patterns and motif placement. Subsequently Illustrator and/or Photoshop, or similar systems must be employed to generate suitable artwork for print.


Figure 6. Engineered print by Philip Delamore for Tristan Webber, SS 2002

By importing paths from the pattern pieces with seam allowance removed and shrinkage formula applied to use as a template, the artwork could be rescaled and manipulated to engineer the pattern pieces. An ideal method is to first match the centre fronts and backs, then the side seams are matched for each leg, and then the pockets, yokes and waistband. As leg seams and hips are curved it is not possible to match exactly, and some cloning of the print is necessary after the pieces are offered up to each other.

Embroidery was discussed as an alternative approach to print, but for the prototypes developed it was decided to use it as an embellishment to the print for the women's jeans only.

Print design visualisation

3D Computer animation allows visualisation of the prototype for design (but not colour) assessment and approval prior to committing to print the fabric. This virtual prototyping process can reduce the number of physical prototypes that must be made, and allows for better design communication, potentially reducing the product development time and costs significantly. Existing systems allow a parametric avatar to be created from a fit model by manual measurements or from a body scan. The avatar can then be dressed using the 2D patterns (without seam allowance) that are wrapped around the body and draped using cloth properties selected from a database.

Figure 7.
Optitex 3D Viewer showing jeans on female avator. This approach is currently being used where a UK manufacturer is supplying a major high street retailer to enable virtual prototypes to be used for design communication and fit assessment. A pattern is wrapped around a model avator that is received by the retailer and jointly evaluated. Real-time amendments are made, so that it is only necessary to produce a final sample for approval. This reduces the prototyping process from 13 weeks to four

Optitex supplied a browser based 3D viewer and a 3D animated catwalk visualisation for the purpose of this project, having exported and supplied them with .jpeg files of the engineered pattern pieces and 2D measurements extracted from 3D model scan data for avatar creation. Once the designs were approved, seam allowances were added and a sympathetic background colour was filled so any slight deviance in the construction would not reveal a noticeable white area. A lay plan was then created for the most economical use of fabric and exported for colour management.

Colour management

Colour management systems allow the ink-jet printer to be calibrated to the screen, and a colour profile which is generated for each fabric and ink type used allow for fidelity between the colour on screen and fabric. In this case, using an AVA Colour management system and a Mimaki

TX2 printer a number of swatches were first printed and post-processed for colour approval. Some colour management was necessary for the men's print as the red/green balance was incrementally adjusted and reprinted. The lay plans for both jeans were then printed.

Post processing

Following steaming and washing the fabric was embroidered for the women's jeans. Samples of CADCAM embroidery demonstrating a range of techniques were presented and discussed by the design team, and relevant ideas were explored in relation to both digital print design images. It was identified that simple small blocks of colour could be effective with the digital skyline print and reference the concept of architecture whilst maintaining the abstract quality of the design. The digital image was imported into the embroidery CADCAM Wilcom ES software programme to form a background with small blocks of satin stitch digitised in relation to the print image. A paper printout of the combined design was used to register the embroidery onto the digitally printed textile. The design was embroidered using the Amaya CADCAM computerised embroidery machine.

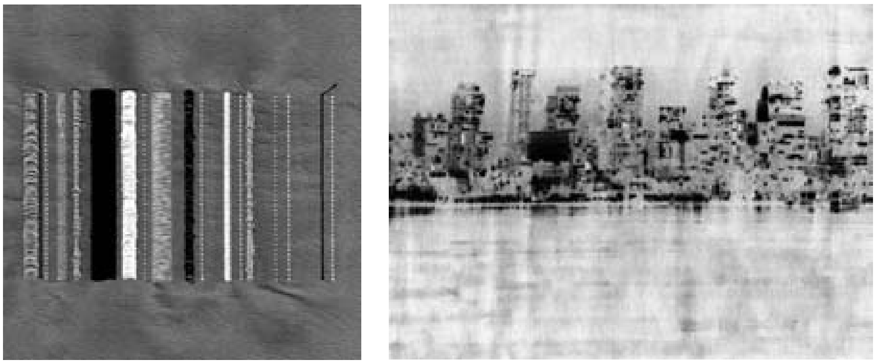


Figure 8.

Cut and assemble

The jeans were manually cut and assembled using traditional methods for the prototype. It is proposed that single-ply cutting could be incorporated into the fully digitised process once suitable registration and optical recognition systems can be employed. Existing systems allow for camera recognition, using edge detection for leather cutting, and stripe and check matching for automated cutting of nested patterns.

The finished prototypes were fitted on models and photographed.

Figure 9.

Recommendations for the next stage of investigation

The main obstacles to mass customisation identified were:

- CAD workflow
- fabric stability, print and post-processing
- registration for single-ply cutting

In order to customise an engineered print to fit the individual, a methodology must be developed to allow the image to be re-proportioned to differently sized patterns, and this should be integrated into the CAD workflow in such a way that, as with current systems, allow a repeat to be flowed into a pattern which may be adjusted in real-time. It is noted that existing 3D CAD systems allow for images to be wrapped or projected onto a surface, and UV mapping techniques currently employed to make a 2D map which represents a 3D model. This map can be associated with a texture and subsequently used to wrap the image onto the 3D surface.

The most significant limitation is the fabric stability in regard to the number of processes in pre-treatment, printing and post-processing. Using reactive dyes requires pre- and -post treatments which have significant effects on colour and shrinkage and require significant time to be taken on testing and processing the fabric. Three approaches to address this limitation have been identified:

1. Pre shrunk fabric treated to receive existing reactive printing system.
2. Pigment systems, including those with nano-scale pigments are now available which may offer a reduction in processing time and increase stability. As pigment systems require no pre-treatment and less rigorous post-treatment they offer the potential for a more cost- and time-effective solution to printing.
3. Flatbed printing systems that allow for whole garment printing. While this may obviate the need for such complex engineering, there are still the issues of registration between printer and garment to be addressed. Similarly, for the use of automated single-ply cutting systems to successfully integrate into the process, the issues of registration must be solved.

Conclusion

While the digital product development process was demonstrated, there were several issues identified within the digital workflow which require manual intervention at this stage and as such, make the process too labour and therefore cost, intensive to be commercially viable for 'mass customisation' at this moment. It would however be suitable for a digital bespoke service as identified at the outset of the project. There are emerging technologies and processes that may address these shortcomings in the near future and are the next stage of investigation for this research project.

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Acknowledgements

Other participants: Ceri Isaac (Research Fellow), Polly Kenny (Senior Lecturer) London College of Fashion, University of the Arts London

The authors would like to thank the following: Suran Goonatilake, Jon Walters, Tania Fauvel, Rachel Du Preez, Anna Sjoberg, Mons Lindstedt, Patricia Matzdorf, Sharon Blackford, Megan McGuire, Rachel Bradburn, Annie Robinson, Sonja Boussou, Oliver Furlong, Abibatu Fofanah, Jason Quaglia.

The authors would also like to acknowledge the co-operation of the following organisations: Bodymetrics, Union Models, Gerber Technology, AVA, Optitex, Fashion Business Resource Studio

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