Size matters, and big brands in the sports and activewear sector need to take it more seriously. In this article, Dr. Penelope Watkins, research fellow at the London College of Fashion, explains new research she has carried out, which shows that stretch-garments require special considerations at the design and pattern-making stage. She argues that better design and better fit will help wearers improve their performance.

Brands ignore special qualities of stretch-garments

What does the size on a label mean? Size designations and measurement pictograms give no indication of the garment-to-body fit relationship or any clue as to the intended shape, proportions or posture of the target consumer. This means that garments stating an actual body measurement for a specific size are impossible for the consumer to relate to. Therefore the acceptance of garments of dubious fit—particularly stretch-garments—appears to be almost obligatory. However sizing systems are only a part of problematic fit.

Garment pattern development

There is a consensus in current texts over adapting conventional pattern-construction co-ordinates for developing body-contouring stretch-garments, but I question that consensus. These co-ordinates are reduced because of arbitrary stretch factors. And then there's the question of a specific fit for women. How can garment patterns constructed initially for men and adapted for women (and then made smaller) be expected to fit a woman's bodyshape?

I am one of a number of researchers in the Fashion Science Hub (FSH) at London College of Fashion, headed by Prof. Sandy Black, and part of the University of the Arts. We are dedicated to collaborative research integrating craft skills with science and new technology, driving forward inclusive design for health and well-being in all areas of fashion and clothing products, including clothes for sports

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and activewear.

I also practise as a designer specialising in garment fit for enhanced movement. No matter what the clothing application, my passion is the importance of garment fit in enhancing psychological and physical comfort which is crucial for self-esteem.

The focus of my research has been in developing a pattern that I call 'form fit'. It was not constructed by modifying the closest standard pattern, but from a body measurement set that captures bodyshape and proportions. As an aid to the objective evaluation of stretch-fit, a 25mm grid system has been printed on the analysis body suit. To further assist objectivity I have developed a hand-held stretch testing instrument with a PCT international patent application pending.

The 3D garment fit was evaluated then reverse-engineered, using what I refer to as 'nip and tuck' algorithms, (haptic to digital), accumulated over years of experience in designing garments for movement and comfort. A true test of custom fit should be a direct correlation between the 3D body, the pattern geometry and the fabric parameters. Adopting a parametric approach to pattern profiling enabled other variables to be considered, including fabric stretch and recovery, radius of curvature and pressure implications. These factors in a dynamic CAD/CAM technology have exciting implications for further research, which should be of interest to brand managers and designers throughout the activewear industry.

CAD technology

Over the past decade or so a lot of emphasis has been placed on interactive fashion design, developing 2D pattern pieces from virtual 3D images.

Currently most software systems offering virtual 3D design and fit cannot change the pattern in real time, although it has been suggested otherwise. It takes expertise in pattern-cutting to achieve the virtual 2D-to-3D fit. For physical sample production and manufacture, 3D virtual garment-design, incorporating pattern-construction, is still some way off.

Both body-scanning and virtual fit are being promoted as ways of solving the dilemma. All that is required is to access a virtual fitting room such as the ones provided by Browzwear, DressingSim, Fitme, MIRALab or OptiTex. All offer virtual fit to customers' own body measurements, scanned in a booth in a matter of moments. Customers can input their preferences, choose an outfit, view the virtual try-on from different angles and while moving around. Then, if they like what you see, they can buy the real thing.

Companies such as OptiTex offer graphic-rich 3D design software

OptiTex

The discerning buyer will even, in future, be able to assess the tactile quality of fabric on a virtual mannequin. Professor Nadia Magnenat-Thalmann, director of Miralab, is heading a project, Haptex 2007, to develop a prototype haptic glove, which makes virtual fabric feel just like the real thing.

The prospect of not having to spend time endlessly trying on garments in a cramped fitting room is very seductive, although the technology is still developing. One limiting factor is the accuracy of the scan, particularly in difficult areas such as the shoulder, underarm, breast and crutch. At first glance these packages appear to offer the potential to produce custom-fitting garments but, in reality, the closest standard pattern is modified using a few circumferential and length measurements, resulting in a coincidental fit. Therefore, in this context, can custom-fit be fit for the customer?

Stretch-garments and fit

The use of stretch-fabrics is becoming more significant as the benefits of comfort, mobility and shape retention are increasingly in demand for sportswear, cosmetic body shaping and medical applications. Dissatisfaction with the fit and comfort of stretch-garments is exacerbated through movement. Customised or not, examples of ill-fitting stretch-garments are numerous, including sportswear, exercise shorts, leggings, and underwear that rides up or down. It's frustrating hearing the often repeated phrase, 'I'm just the wrong shape for the garment!'

The unexamined view of some manufacturers is that stretch-garments will automatically stretch in the right places to give an acceptable fit. Relatively, stretch-pattern technology is in its infancy. Applying traditional techniques to generate patterns for stretch-fabrics can be successful, but it is often at a cost. Whilst loose fitting garments are more accommodating of different body shapes, allowing for a degree of creative licence, close-fitting garments are not. This is not always apparent when observing stretch-garments (without visualising the curvilinear distortion of the stretch-fabric as it contours the body) as some inconsistencies can be absorbed within the stretch-fabric parameters.

Garment fit satisfaction is subjective, encompassing physical and psychological factors. Fit generally relates to the garment design and style and it is then left to subjective interpretation as to how closely the garment should conform to the body. Extremes of compressive stretch-fit designed for a specific fit model can be uncomfortable and unflattering on a different bodyshape of the same size.

Garment-fit definition

For stretch-garments, fit is paramount in terms of relating the garment to body contours, pattern co-ordinates and fabric stretch parameters to determine fabric tension and predict garment pressure. For this parametric approach to pattern design, garment-fit describes the proximity of the garment to the body.

For clarity I have introduced two anatomical terms, distal and proximal fit. Distal is away from the centre of the body and proximal is towards the epicentre of the body. On a distal proximal fit continuum, the body contour becomes the zero proximal reference point.

Garments along the distal continuum, away from the proximal fit, describe garments that are constructed from fabrics that are either non-stretch or have minimal stretch to enhance comfort. These garments are essentially an external structure, ranging from a 'loose fit', through 'semi-fitted' to 'fitted'.

The proximal fit describes body-contouring garments constructed in a stretch-knit fabric. The increasing positive proximal fit is related to the garment pattern reduction ratio, influenced by the force exerted on the body, through the modulus or compressive retracting power of the stretch-fabric.

The zero proximal reference point, or 'form fit', describes garments that have few wrinkles and no stretch other than tare stretch (a minimal amount) in specific areas, to allow the fabric to smoothly contour the body. The stretch-fabric exerts no pressure on the body and the stretch does not impede mobility.

There are different fit levels. 'Cling fit', where the stretch-fabric clings to the body's curves but does not significantly compress or alter the body contour. 'Action fit' describes most sports and exercise garments where the retracting stretch

A 25mm grid system printed on the analysis body suit is an important aid in evaluating stretch-fit.

DR. PENELOPE WATKINS

effectively grips the body contour. 'Power fit' refers either to the garment as a whole or to specific zones where the force exerted by the stretch holds and compresses the flesh, changing the body form.

Stretch-fabric extension

Stretch-fabrics are produced in a range of fibre contents and weights with a stretch-extension capacity for numerous applications. Information on stretch-fabrics and the way stretch-extension is quantified in the process of constructing a stretch-pattern is not straightforward.

To quantify stretch-extension for pattern reduction, current texts recommend the hand-stretch test method, whereby samples of fabric are pulled until a reasonable resistance to stretch is felt, or until they are visually unacceptable. Electronic tensile testing instruments, as used in most quality assurance and textile research, are not generally available or appropriate to stretch-pattern development.

Information on fabric-stretch is subjective and produces inconsistent results, which inhibits the visibility of the design process. Therefore a simple device is required to measure the degree of fabric-extension objectively. A consistent and verifiable test method, resulting in industry standards, has engendered its own common language between fabric and garment technologists. The same level of integration between stretch-fabric producers and pattern technologists and designers is needed to introduce objectivity into the stretch-pattern design process.

Body-contour fit

Fabric-stretch significantly alters the profile geometry in areas such as the arm, shoulder, breast, leg, hip, buttocks and stomach, and this can result in a garment-to-body fit disparity.

Movement exacerbates fit disparities that are not always apparent when observing garments on a static body. The pattern profile becomes increasingly distorted as the fabric is stretched around the body contours. Anchor- or grip-points, which restrain the fabric, affect the fit and any movement impacts on this. Without visualising the curvilinear distortion of the stretch fabric as it contours the body, fabric stress is not always apparent, as some inconsistencies can be absorbed within the stretch fabric parameters.

Upper body and sleeves

The crucial areas for fit in the upper part of the body are the shoulder angle, breast, armhole and sleeve. The shoulder angle is determined by posture and elevation of the shoulders. A conventional set-in sleeve reflects the shape of an arm hanging in a relaxed position by the side of the body.The head-height and shape of the sleeve and the torso-angle affect the degree of freedom-of-arm movement and have a significant influence on the fit and comfort of a garment.

When a set-in sleeve is constructed in a stretch-fabric, movement is restricted, as it is impossible to lift up the arm without the fabric straining. A prime example that many will be familiar with is the 'cling fit' stretch T-shirt. When the arm is raised, the fabric adjusts to the new body position and the underarm seam will automatically reposition at the anchor- or grip-point under the arm. Subsequently when the arm is lowered, a fold of fabric (producing the effect of an unwanted shoulder pad) appears at the apex of the sleeve crown. A fold of fabric also appears across the chest above the breasts. The T-shirt comfort- and fit-factor is only maintained by constant rearrangement after movement. This can lead to a negative body cathexis (LaBat and DeLong 1990) but it is the pattern profile that is at fault and not the inadequacy of the wearer's bodyshape.

The dynamic crown angle

For the 'proximal fit' pattern profile I have introduced the 'dynamic crown angle', which is calculated from the shoulder point at the top of the crown to the intersection between the arm and chest. This depth becomes shallower as the geometry of the pattern profile changes to utilise the fabric's stretch characteristics. The bodice-to-sleeve angle relationship and the shallow crown shape in the bodysuit analysis garment approximates a subject standing with the arms abducted at 45 degrees.

'Proximal form' fit

The geometry of the stretch-block pattern profile can only be developed successfully through understanding the complex relationship between the dynamic form, the stretch-fabric behaviour and the two dimensional pattern profiles. Through many years' professional experience in designing for movement, I have been able to visually identify pattern pieces that didn't fit, and analyse the reasons why.

Replicating the size and shape of a person in the pattern profile is the key. Good fit is dependent on the pattern drafting co-ordinates co-operating with the stretch characteristics conforming to the shape of a person. My research has enabled me to develop a 'form fit' block-pattern using a personally extended set of traditional measurements.

An optimised contour fit pattern, for all fit levels, should produce a garment that has no wrinkles, minimal stretch distortion and conforms to the body, rather like a second skin. Body heat affects the fibres in fabric causing them to relax and mould to the body. On cessation of movement, the fabric adjusts to reach equilibrium in contouring the body. The fit is not displaced during movement.

Summary

Garments that constantly have to be rearranged in order to feel more comfortable only add to dissatisfaction with the fit. A high proportion of poor garment-fit is brought about by unconsidered pattern design. Better fitting, comfortable garments that enhance well-being and self-esteem, will improve performance.

A true test of distal and proximal fit should be a direct correlation between the 3D body, pattern geometry and the fabric parameters. This can be visualised by printing a grid pattern on the stretch garment for objective analysis and evaluation (another element of the solution). There is also a need for a simple, objective, fabric stretch test method for stretch pattern reduction and the introduction of an industry standard.

It may be argued that because of the increasing sophistication of virtual garment design, stretch pattern-construction and fabric simulation should be confined to the virtual realm and that haptic practices are becoming redundant. However, the development of form-fitting stretch-garment technology has a vital contribution to make in allowing designers and technicians to build on their craft skills, to comprehend and articulate the technical processes that will enable them to link more effectively with emerging technology, and to offer garments that really are fit for the customer.