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How Virtual Fitting Leads to Sustainable Fashion

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Abstract

In fast fashion, a significant problem is that many garments quickly degenerate from being materialized in manufacturing to being tried on, found ill-fitting, and dumped as waste into the environment. These notes from the field present how to scale up clinical evidence on virtual fitting to address this problem. The big-data approach promises to enable a truly circular economy that does away with ill-fitting garments, and thus to significantly lessen industrial waste materialized into the environment.

Keywords

Material waste; clinical evidence; digital fashion; big data; circular economy, sustainability

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Highlights

- Ill-fitting garments tend to end up as industrial material waste.
- Virtual fitting is one way to keep ill-fitting garments from ever materializing.
- Our big-data approach promises to scale up virtual fitting and to scale down waste.

1. Introduction

Ill-fitting garments represent material waste in more ways than one. They tend not to sell. When sold, they are often returned to retailer. If not returned, they lose value due to outdating. The dominant approach in the quest for a cleaner system of production and consumption within the fashion industry has "industrial ecology", searching for ways to reuse byproducts in a process of symbiosis of various kinds of organizations large and small (Armstrong et al., 2015; Yu, Han and Cui, 2015; cf. Gibbs and Deutz, 2007). A complementary but lesser known approach is to avoid from ever materializing waste in the first place (Manring and Moore, 2006). In line with the latter approach is virtual fitting. Bespoke garments are designed on virtual platforms in virtual or immaterial form (Hu and Lamar, 2011), parametric or virtual mannequins function as aids in fitting, (Power, 2013; Chittaro and Corvaglia, 2003), and virtual mannequins and virtual garment design are coevolved (Dorst and Cross, 2001; Clark, 1985; Simon, 1962).

In these notes from the field, we report on our big-data approach to improve garment-consumer fit, to make and keep consumers satisfied, and thus to decrease material garment waste. We specify in this paper how we are working on virtual fitting with the hope in the long run to do away with material waste resulting from ill-fitting garments. The general proposition is that our generic big-data approach ough to be applicable to cutting down on material waste in any industry. What is needed is to build a multi-layer database of clinical evidence and quantitative or quantifiable data. When these can be jointly analyzed as big data, material products can be fashioned to fit their contexts of purchase and use optimally.

2. Materials and methods: Anthropometrics as starting point

Our big-data approach is evolving out of a recombination three approaches: *a)* virtualization of 3D anthrometrics or morphological (i.e. consumer-body) measurements, *b)* virtual garment design, and *c)* analysis and optimization of how "*a)*" and "*b)*", above, interact. It leverages on access to big data on 3D scanning and anthropometrically measuring 500 French female consumers (Tao and Bruniaux, 2013; Hamad, Thomassey and Bruniaux, 2014).

In the case of "a)", we got access to the 500 3D morphologies as two sets of data. The first data set was 478 unsupervised, clustered, and enveloped morphologies (Tao and Bruniaux, 2013), and the second of 485 consumers unsupervised, clustered, and focused on the geometric shape or form of the human torso (Hamad, Thomassey and Bruniaux, 2014). Starting with the first data set, we re-clustered, re-enveloped, and re-optimized the two data sets and their treatment to extract three morphological clusters. We ended up with three parametric or virtual mannequins (Hamad, Thomassey and Bruniaux, 2014) that we propose are proxies of morphotypes or consumer-body shapes of female consumers at large. These mannequins we have calculated and tested to be a more valid approach to obtain information than is to measure the real shape of each and every human body from scratch.

2.1. Theory/calculation: Clinical evidence, draping, and ease allowance

We have worked with a clinical expert (i.e. an experienced tailor based in Hong Kong) to identify key anthropometric contours and appropriate "construction lines" and "sublines" (i.e. correct muscle shapes in a parametric or virtual mannequin (Cichocka, Bruniaux and Frydrych, 2014). Focal background behind the design thinking and experience behind the work of this tailor is Adolf Zeising's "golden ratio" theory of the human body on how to parametrize or virtualize, to determine relations and interactions between the segments and statures of a virtual human body, and thus to work towards an essentially simple, internally a fully harmonious and mathematically oriented ideal-type model of a consumer (Hamad, 2015). The sublines we have taken both as a clinical evidence and as a mathematically ideal-istic model on to approach and measure distances and other relations between positions between body lines and other sublines on which they may be dependent.

Two key constructs extracted out of this clinical evidence are draping and ease allowance. "Draping" refers to anthropometric points of the neck line and are key in how the the garment hangs around a consumer's neck in terms of comfort, style, or both. "Ease allowance" is how the garment affords for movement in the armpits and beyond for good fit, for making and keeping the wearer satisfied and, ultimately, for less material waste. Out of the above starting points, we propose a big-data approach and, more specifically, a champion-challenger model.

2.2. Parametric garment-mannequin fit

Our approach associates anthropometrical body lines (stature, body volume) with garment-construction lines, controlled in the first instance *via* draping and ease allowance. We are developing a "champion-challenger model" to parametrize and iterate in between the above elements of virtual garments design and virtual mannequins design. Systematic iterations in virtual mathematical space work towards ultimately to optimally fitting material garments and real-world consumers, intermediated in a process of unsupervised virtual fitting of bespoke garments. Just as we take draping and ease allowance to matter to a consumer in search of good fit, comfort, and style, we take "grading" (i.e. stages in the process of garment design) to matter to a producer in search of efficiency, as well as to anyone to whom control and avoidance of material industrial waste generally matters.

Our big-data approach is oriented to optimize across all of these vantage points, to leverage successive small improvements in virtual fit for significant impacts in real-world quality, cost, and doing away with of what would otherwise be material environmental waste. Design, construction, and process-control of our parametric virtual and adaptive mannequins in relation to virtual garments design are to become the more robust and malleable the more there are more data, repeated rounds of analysis, and iteration.

3. From supervised towards unsupervised draping and ease allowance

The morphology of our parametric virtual mannequins varies along: *(1)* construction lines, *(2)* stature, *(3)* volume, and *(4)* control parameters (Hamad, 2015). This kind of representation of real-world bodyline types and bodylines of consumers promotes immateriality of grading, good fit of the garment and consumer, avid use, and sound environmental

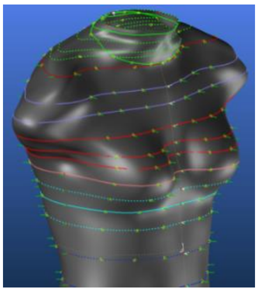

Figure 1. Ease allowance points

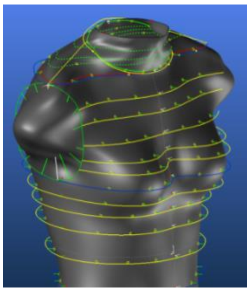

Figure 2. Ease allowance and garment construction lines.

responsibility The link between body and garment in our conceptualization is made and sustained via draping and ease-allowance design. Sets of points on the body contour, independently on each garment contour (front, side, and circumference), are how to control ease allowance (Figure 1).

How points are set and linked determines garment construction lines (Figure 2). This way of creation construction lines provides a necessary link between the parametric mannequin and the garment. Interdependent garment designs are created and supervised as to how they align with one or several mannequin designs. Any change in the stature and volume of the parametric mannequin kicks off the design cascade of the corresponding parametric garment: from neck-line approximation to construction lines to control parameters.

3.1. Method of creating design lines for neckline and armhole line

Apart from body lines, the design and construction of a garment also involves defining lines for the garment. Within this context, the neck line and armhole line in garment design and construction are very special and important lines. Their position is determined by anthropometric points. The anthropometric points determine also the contact area between body and garment.

The points influence but do not determine the body lines. The shape of the lines determines the drape of future garment.

Producing results from applying our champion and challenger models in the first rounds have required much supervision and applying constraints on how the neck and armpits “stabilize” or validate. To briefly point out to next steps, we first provide some details how our clinical evidence can be developed into the “champion model”. We then propose how to compare results of applying this model with those in applying a “challenger model”. Algorithms to be used include found in Python code, R code, fuzzy logic, and vector models. This kind of “soft computing” involves also genetic algorithms. Leveraging on a statistical package for social modeling, we ultimately will “synchronize” (i.e. again, to iterate in between the models), using the Clementine IBM SPSS modeler for this purpose. The goal is that regression and Baysian models in successful loops of analysis advance it towards artificial intelligence.

3.1.1. *Neck line*

The neck line position is determined by two anthropometrical points: A) by the 7th cervical and B) by the clavicle point. The line shaped by the connection of those two points determines the plan on which the neck line will be created. The plan in Figure 3 is tilted with respect to the main horizontal plain. In Figure 4, it is shown how creating landmarks on the neck line and determining ease-allowance creates a construction countour of the neck and provides control of local ease allowance and its value.

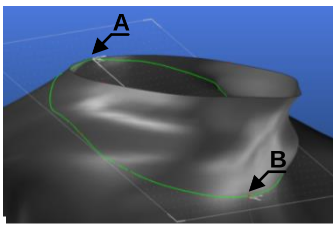

Figure 3. The neck plan.

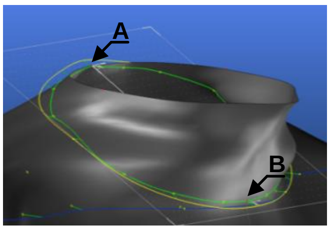

Figure 4. The neck construction line.

Successive additions of data to a line such as the neck line is how we work towards supervised analysis. Iteration in between mannequin design or garment design relates to the new virtual neck line to the virtual garment construction lines, the rest of the virtual garment design, and real-world garment style. Ultimately this promises to result in optimal grading that follows an optimal and unsupervised model. Changing values on other lines produce models to challenge the armhole one.

3.1.2. *Armhole line*

The shape of an armhole as a contour in upper-garment pattern construction is determined by the positions of the acromion point, the armpit point and the mid-armhole points. The acromion point and the armpit point indicate the direction of the armhole plane. Other points are created according to intersection of the body lines and armhole plane with respect of ease allowance. Those steps lead to creation of the garment construction lines (Figure 5).

To obtain desired shape of the armhole line, we may introduce a point "*C"* at the intersection of the line created between acromion point and armpit point and the line created between two mid-armhole points. For example, starting from this point *C*, we may introduce lines, marked in Figure 6 in green color, to control the contour of armhole line. The green lines, along a fixed angle, vary in length depending on armhole line style.

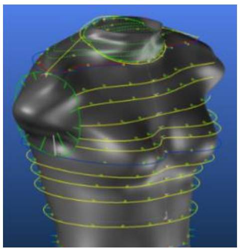

Figure 5. Armhole plans and lines.

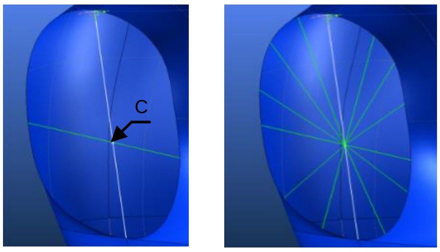

Figure 6. Lines detailing armhole shape.

4. Conclusion and future work

Ill garment-consumer fit is a significant source of environmental waste, difficult to control and keep in check, both because of both heuristic and mathematical complexity. Our big-data approach is designed to lessen environmental waste and treat the complexity by focusing on improving draping and ease allowance on a virtual mannequin, linking the golden-ratio mathematical ideal and clinical evidence as a source of generating models for big-data analysis. Such analysis as comparative analysis between champion and challenger models promises more validly than alternative approaches to control and keep in check the contours, lines and points of consumer bodies, to synchronize across the benefits of allowing for requisite natural diversity.

We believe that this big-data approach, to address draping around a consumer's neck and ease allowance around her armpits before grading around the interests of a producer, is a design strategy superior to conventional grading methodologies that start from scratch. Benefits should accrue in terms of making the entire design process from beginning until end increasingly efficient, selling and using the garments most effectively, and minimizing environmental waste.

In terms of applied and basic research, the logical step to take is to get access the quantitative data behind the visual interface of the software that our tailor uses. Pooling together and working across more than one data set is a complementary route to growing an accumulative data set from clinical evidence. Comparisons between virtual and real tries-on, in the fashion industry and/or in other industries, is the next clinical step to take so as to optimize fit and thus to minimize waste.

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