Custom Fit Model Avatars: 3D Body Scanning Workflows for Digital Fashion

Kyra GIBSON *, Penelope NORMAN, Jonathan BURGESS, Sarah DICK.
Arts University Bournemouth, Poole, UK

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Abstract

As the fashion industry increasingly integrates 3D garment design software such as CLO3D, highly accurate digital avatars that replicate in house fit models has become essential. Standardised avatars are widely available but often fail to accurately align with a brand's legacy sizing systems, which are typically based on specific fit models and bespoke measurements. British performance wear brand ThruDark's dedicated consumer base is accustomed to a consistent garment fit, therefore, transitioning to digital sampling with software stock avatars would risk significant inconsistency in sizing and customer experience. Maintaining continuity with the existing fit model is critical, prompting the need for an accurate, efficient avatar creation process that supports ongoing production without disruption. For brands to fully leverage digital workflows and reduce reliance on physical sampling, accurate brand specific avatars are crucial.

This research - conducted in partnership with ThruDark - explores the creation and implementation of bespoke digital avatars. A comparison study includes manual anthropometric and 3D body scanning technologies which are evaluated for the creation of bespoke fit model avatars. A new avatar creation process pilot study allows critical insights into functionality and scalability. Based on this research a commercially viable workflow for generating digital avatars from brand-specific fit model data has been implemented at ThruDark.

Keywords:
3D Body Scanning, Digital Fitting, Fashion Technology, CLO3D, Virtual Sampling, Knowledge Transfer Partnership, Bespoke Avatar, Digital Workflow.

1. Introduction

As the fashion industry undergoes a digital transformation [1], 3D body scanning and 3D garment design tools such as CLO3D are playing a central role in reshaping how garments are prototyped and brought to market. Integration of digital avatar libraries enable digital on-screen fitting without the need for physical samples, allowing brands to streamline workflows, reduce sampling costs, and accelerate design timelines [2]. As a result, highly accurate digital avatars that replicate in-house fit models have become essential for maximising virtual fitting capabilities within digital garment software.

As a continuation of previous research on legacy sizing systems [3], this paper investigates new ways to overcome the limitations of standardised avatars from 3D design platforms and evaluates the role of in-house digital avatar development in preserving fit consistency. It further examines how integrated avatar creation tools, alongside 3D body scanning can support scalable, brand-aligned virtual sampling processes with the creation and implementation of bespoke digital avatars [4].

1.1 Garment fit

Achieving consistent and accurate garment fit has long posed a significant challenge within the fashion industry. Despite ongoing technological advances, poor fit remains a leading cause of product returns in both physical and online retail environments, contributing significantly to financial losses and environmental waste. A substantial proportion of returns, particularly in e-commerce, are due to garments not meeting customer expectations in terms of fit [5], [6].

As brands transition to digital design and sampling workflows, maintaining consistency with in-house legacy sizing systems becomes increasingly important to preserve brand identity and consumer trust. These legacy systems are often based on selected fit models and developed over time to ensure consistent sizing across product lines. Failure to replicate this in digital environments can lead to size discrepancies between virtual and physical prototypes, causing miscommunication between design and technical teams, delays in production, and consumer dissatisfaction.

*kgibson@aub.ac.uk; +441202533011; www.aub.ac.uk

1.2 Digital fashion

Digital workflows are becoming increasingly integrated in fashion industry development processes. Digital sampling, facilitated through software platforms such as CLO3D, enables rapid garment prototyping by leveraging virtual simulation technologies [2]. The ability to make fit adjustments and design modifications directly on screen reduces the reliance on physical samples. Digital prototypes and visual design decisions can be transmitted electronically to suppliers, streamlining communication across the supply chain and further accelerating product development timelines. This aligns with broader industry efforts to reduce overproduction and promote more sustainable fashion practices.

Initially introduced as a digital alternative for physical mannequins, digital avatars have emerged to support virtual fitting workflows and reduce reliance on traditional sampling methods [6]. Their integration into 3D garment design platforms coincides with the digital transformation of the fashion industry, aiming to accelerate product development [8]. The use of brand-specific digital avatars have the potential to accurately replicate the anthropometric characteristics of in-house fit models, ensuring that garments designed and tested in virtual environments continue to meet existing fit standards. These avatars serve as critical digital assets, enabling brands to simulate garment fit with greater fidelity [7], maintain consistency across channels, and safeguard the integrity of their sizing systems as they transition to digital workflows.

1.3 Brand legacy sizing systems

Whilst standardised avatars are widely available within most 3D design platforms, these often fail to align with a brand's legacy sizing systems, which are typically based on brand specific fit models and bespoke measurements [3]. Digital mannequin libraries, such as Alvanon Alvaforms, provide digital forms available in regional standards, however fashion brands with legacy fit model sizing are therefore limited to custom digital avatar development options.

Consumers are accustomed to a consistent garment fit, therefore, transitioning to digital sampling with software stock avatars would risk significant inconsistency in sizing and customer experience. It is therefore critical for businesses with brand-specific size specifications to maintain continuity with the existing fit model, prompting the need for an accurate, efficient avatar creation process that supports ongoing production without disruption.

1.4 Avatar creation using 3D body scanning

The process of creating brand specific avatars remains technically complex. Issues of compatibility between scanning hardware, software platforms, and legacy brand systems highlight broader systemic challenges in the industry's adoption of digital workflows. Despite these limitations, bespoke avatars are gaining traction across the sector due to the increasing demand for personalisation and customisation [9]. 3D body scanning technologies have played a central role in the development of digital avatar creation processes, offering a pathway to digitise individuals for the formation of custom avatars [10]. As consumers increasingly engage with fashion digitally, the potential for individuals to scan themselves at home with mobile applications such as Me360 [11] offer promising possibilities for the future of avatar development for both businesses and consumers. Custom avatars enable brands to simulate garments on virtual bodies that more accurately reflect their intended customer profiles or in-house fit models.

A persistent challenge lies in the lack of alignment between available digital avatars and the highly specific body dimensions used in brand legacy sizing systems. This misalignment risks undermining the reliability of digital sampling, particularly when accurate fit is central to consumer trust and brand identity. For brands to fully leverage digital workflows and reduce reliance on physical sampling, accurate brand specific avatars need to be created and maintained as digital assets.

2. Methodology

This empirical research explores different 3D body scanning technologies for the creation and implementation of bespoke digital avatars.

An initial comparative study evaluates the process and accuracy of a variety of 3D body scanning methods [12] for avatar creation. A pilot study then trials a novel process for in-house avatar creation, with the outcomes offering critical insights into the usability and viability of each approach. These insights provide a foundation for evaluating the potential of each process to be scaled and integrated into commercial practice. The findings are then applied to inform a commercial workflow for the creation of digital avatars derived from brand-specific fit model data.

2.1 Industry partner and participants

This research was conducted collaboratively between the higher education research institution, Arts University Bournemouth and industry partner ThruDark to explore new transformative digital technologies. This study forms part of a wider initiative to develop and embed advanced, digital product development processes at ThruDark. This performance clothing brand use a typical garment sizing system consisting of size charts and brand specific fit models.

A single ThruDark menswear fit model was used throughout this study. Using a single fit model participant allows comparisons to be made across the measurement systems. This participant was used for both the manual measurements and the 3D body scanning in this research.

2.2 Quantitative fit model measurements for avatar creation

A comparative study evaluates the accuracy of multiple 3D scanning technologies for data collection. Further analysis of these 3D body scanning data sets, compares both proportion accuracy and measurement translation in digital avatar creation workflows. Four data sets were gathered for comparison:

1. *Manual anthropometric measurements* - Manual measurements were taken using a measuring tape following standard industry practice. To mitigate the risk of human error, all participant measurements were conducted with two individuals present, one to take the measurements and the other to verify their accuracy
2. *Mobile optical scanning with Me360* - The Me360 body scanning app collects a limited set of anthropometric measurements. The app's scanning process relies primarily on front and side images, with an algorithm estimating anatomical features in areas not fully captured [4].
3. *Infrared 3D body scanning with Size Stream* - The Size Stream SS20 is a static booth scanner. The scanner has integrated infrared depth sensors positioned within the corners of an enclosed scanning booth to capture full-body anthropometric data.
4. *Structured-light scanning using PEEL 3D* - The Peel 3D scanner is a handheld scanner [13]. The PEEL operates by projecting structured light beams onto the surface of the participant’s body, with data captured by integrated sensors to generate a high-resolution 3D model.

The participant, who is the core in-house fit model, had measures captured utilising all four methods. The participant was scanned and manually measured in fitted underwear to allow body shape to be accurately captured and reduce measurement errors from clothing layers. The data presented in this paper has been limited to 16 typical points of measure.

Digital 3D fashion design software such as CLO3D offer integrated avatar creation systems, ‘powered by real body scan data to help you create realistic body shapes whether you have a complete size specification or not’ [14]. These avatar development technologies, enable users to create measurement specific avatars from in-house data. This study explores manual measurement input and auto conversion from body scans, to evaluate accuracy in avatar creation processes and propose suitable avatar creation methods for in-house avatar creation.

2.3 Pilot study

This research uses a pilot study methodology to propose evaluated avatar creation methods in industry. Traditional manual anthropometric measurements were captured and a comparative analysis to 3D body scanning data was performed. This comparative analysis includes direct measurement analysis derived from scan data, overlaying scan data, evaluating surface geometry, and testing garment simulation outcomes to determine practical utility in real world design processes.

The quantitative 3D body scan data was fed into digital avatar conversion systems to assess the accuracy, functionality and practicality of body scanning for digital avatar creation. These digital avatar outputs were assessed for functionality with digital garment simulation in 3D software and the practicality of the avatar creation process for in-house digital teams.

3. Results

This study investigates the differences between measurement data collection methods of a brand fit-model participant. The comparison will highlight any inaccuracies in the scan data, along with exploring the benefits and constraints of the scanning method. A secondary analysis of a pilot study will review the creation and implementation of bespoke digital avatar processes, including the use of 3D body scanning methods.

3.1 Quantitative fit model measurements for avatar creation

The measurements presented in Table 1 are key data sets for comprehensive avatar creation. Manual anthropometric measurements were taken of the ThruDark fit model, providing a baseline for comparison. Three forms of body scanning technologies were utilised to capture scan data from the participant. This quantitative data demonstrates the differences and variation within the data collection method outputs. The results of the initial measurement comparison study are displayed in Table 1.

Table 1, Participant Measurement Data

Measures (CM)	Manual Anthropometric	Mobile Scanning (Me360)	Size Stream	PEEL 3D
Neck Base	40	-	39	40.96
Across Shoulder	47	-	40.5	44.13
CB Neck to Wrist	87.5	-	78.5	86.66
Chest*	102	103.7	95.5	96.52
HSP to Apex	27	-	25.5	26.7
Bicep	35	-	30.0	32.39
Waist*	82	90.5	83.5	82.55
CF Neck to Waist	42.5	-	41.5	43.55
CB Neck to Waist	49	-	47.0	49.40
High Hip*	84	-	89.0	88.26
Low Hip*	100	99.5	95.5	95.25
Inseam*	84	-	78.0	86.36
Total Rise	72.5	-	72.5	73.65
Thigh	52	55.7	55.0	55.88
Calf	38	37.9	36.0	36.67
Total Height	178	-	176.0	187.96

*Key points of measure used for garment fitting.

Table 1 provides a comparative overview of extensive body measurements, essential for achieving greater precision in digital avatar development, through the inclusion of detailed anthropometric data. These measurements serve as foundational inputs in digital avatar creation systems, which can support varying levels of data input, depending on the capabilities of the platform and the specific objectives of the project. The level of discrepancy between manual, consumer mobile app scanning and industry standard 3D body scanning systems are apparent in the data – for example the 8cm variation across inseam measures. Manual Anthropometric measures represent traditional industry data collection practices, where desirable data can be accessibly obtained. Mobile scanning offered limited results and key measurements such as High Hip were not recorded. In contrast, Size Stream and Peel 3D systems can provide expansive results, which have been limited to measures within this table.

Table 2 provides a comparative overview of the measurement collection methods in practice.

Table 2, Summary of methods

	Manual Anthropometric	Mobile Scanning (Me360)	Size Stream	PEEL 3D
Accuracy	Medium – reliable for basic dimensions	Low - not detailed and dependent on camera resolution	High – produces consistent and repeatable measurements	High – captures fine anatomical detail
Scan Completion Time*	10 minutes	3 minutes	2 minutes	10 minutes
Operator Expertise	Professional fit experience	Ability to use a mobile app (low)	Simple operation and process	Highly trained
System Functionality	Moderate – requires skilled individual and manual operation	Intuitive – Offers privacy with minimal user interaction	Intuitive – automated, minimal user input	Complex – requires manual operation
Accessibility	Available – Portable, requires low cost tools	Available – Widely accessible and user friendly mobile app	Limited - Requires infrastructure and stationary location	Moderate – Portable, requires hardware and software

*Timings are for the full scan and data collection process

3.1.1 Scan accuracy and tolerance

Size Stream has been demonstrated as accurate to 0.5cm [15]. The accuracy of mobile scanning appears to be variable and dependant on the phone used and the source image quality. The accuracy of this technology is clearly lower than the other methods tested and results have been presented to the nearest centimetre.

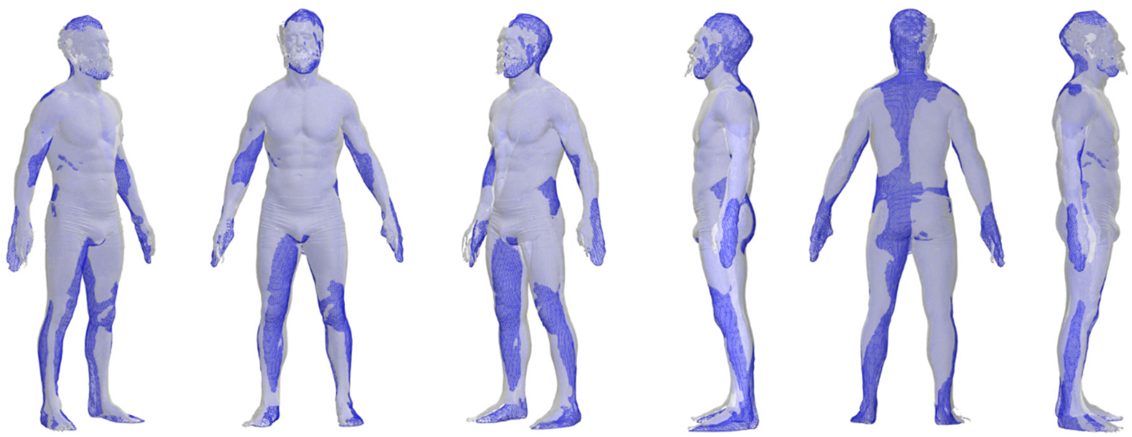

Fig. 1. Visual avatar mesh comparison, Size Stream (shown in blue) and Peel 3D (shown in white)

An overlay of the Size Stream and Peel 3D scans in figure 1 visually demonstrates differences between the two 3D body scans. The scan data clearly demonstrates differences between measurements, highlighting discrepancies within data collection methods. The fine detail captured by the PEEL 3D scan demonstrates the high fidelity of this technology.

3.1.2 Manual anthropomorphic measurement process

Manual anthropometric measuring requires a high level of precision to ensure that each point of measurement is correctly located and consistently followed. This process is not constrained by equipment accessibility and can instead be utilised as a portable and flexible method of measurement data collection.

3.1.3 Me360 scanning app process

The Me360 app provides five measurement data points. The reliance on image-based reconstruction introduces the potential for inaccuracies, especially where the algorithm must infer undefined angles or areas. This method differs from equipment-dependent alternatives, leveraging the widespread availability and daily presence of mobile phone technology in modern society. The app also facilitates rapid scan updates in the privacy of the participant's home, reinforcing its practicality as a quick and user friendly approach to body data collection. However, the Me360 app restricts the number of scans that can be stored, and there are currently no features that allow for manual modification or export of measurement data to programs such as CLO3D.

3.1.4 Size Stream SS20 scanning

This scanning booth is housed in a stationary location, requiring the availability of both the equipment and the fit model to collect data. While this system provides rapid 3D body capture, certain limitations have been identified in the accuracy of scan outputs due to sensor placement. Notably, a potential blind spot occurs at the side and underarm regions of the body, where sensor occlusion can result in mesh anomalies or distortions within the 3D scan. These irregularities can affect the reliability of measurements taken from those specific anatomical areas. To address this issue, participants were scanned multiple times, and only scans with minimal mesh distortion, particularly under the arms were selected for analysis. The SS20's fast data capture capabilities facilitated this process, allowing for several full-body scans to be completed in quick succession. This iterative scanning approach ensured the selection of the most accurate and complete 3D model available within the practical constraints of the equipment and environment.

3.1.5 Peel 3D scanning

While portable, the handheld scanner necessitates continuous operation by an individual for the duration of the scan. This individual should be of an appropriate height in comparison to the model being scanned and have means to maneuverer around the participant during the scanning process, to achieve full-body coverage.

This scanning system offers enhanced surface detail compared to infrared-based or image-based methods, making it well suited for applications requiring fine anatomical accuracy. The scanner's ability to capture small surface variations contributes to a more detailed and precise digital representation. The Peel 3D scan required the longest scanning time for data collection, requiring the participant remain completely still throughout the scanning process. For optimal results, the participant needed to be positioned in a manner that allowed the operator to achieve full body coverage with the handheld device, while also remaining completely still; any misalignment during this process risked a loss of tracking. Whilst tracking dots can be utilised to assist in data alignment, minor involuntary movements still negatively impact the scan, creating gaps and additional mesh layers which necessitated further post-processing. Obscure regions such as the bottoms of the feet and top of the head resulted in incomplete mesh capture, which likely compromised measurement accuracy due to missing or distorted surface data. This poses a challenge, as even minor involuntary movements, such as shifting weight or subtle posture adjustments could introduce distortions or misalignments within the resulting scan. To minimise such errors, tracking markers were applied to the participant's body to assist the scanner in maintaining consistent data positioning and alignment throughout the scan. While this method improves accuracy, the potential influence of participant motion remains a limiting factor in the reliability of single-scan outputs.

3.2 Pilot study

The measurement data of the ThruDark fit model formed the basis of the proposed bespoke brand digital fit avatar. This was achieved using CLO3D. This creation and implementation of bespoke digital avatars improves efficiency by enabling the business to digitally design, sample and prototype using their digitised in-house fit models.

3.2.1 Manual creation of avatars using measurement input

Avatars can be created using digital fashion software CLO3D, with manual manipulation of the standard avatar rigging, to align points of measure with in-house measurement data. This is described in figure 2.

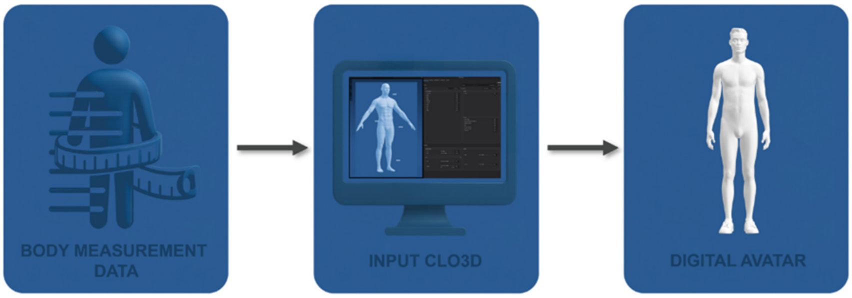

Fig. 2. Process stages for manual measurement input in CLO3D

Participant's manual anthropometric measures were inputted into the edit avatar function in CLO3D. This function enables the stock avatars measurements to be adjusted in accordance with in-house measurement data, shown in figure 3. This offers a quick customisation option, aligning key points of measure with the brands fit-model.

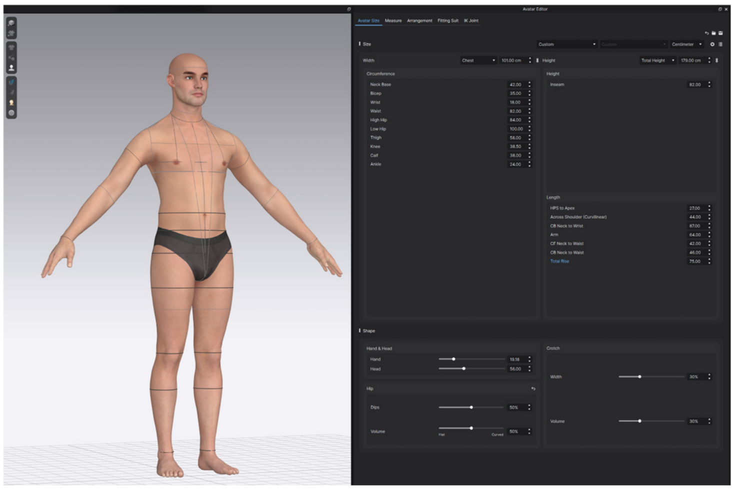

Fig. 3. Example of manual anthropometric measurement input in CLO3D

Within this pilot study, is it noted this fit-models physique is of a muscular build. Stock avatars do not enable physique customisation, therefore achieving the correct build proved difficult. This was noted within longer centre front and centre back neck to waist measurements, where measure distribution seemed to negatively affect posture of the avatar. Some physiques outside the typical industry standard body shape therefore may encounter these issues.

3.2.2 Creation of avatars using body scans

CLO3D's Auto Convert function was utilised to translate body scanned data into digital avatars, suitable for digital garment software, as shown in figure 4.

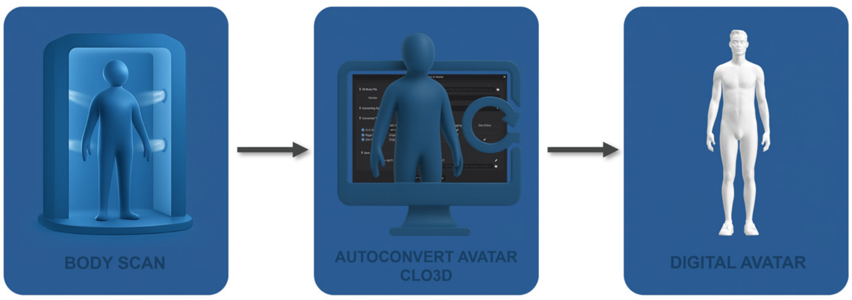

Fig. 4. Process stages for Auto Convert avatar in CLO3D

The fit model participant data collected from Size Stream SS20 and Peel 3D scanners was uploaded within CLO3D auto convert avatar function, which produces an avatar based on the provided data.

These outputs include 3 avatar forms:

1. CLO Skin Type
2. Rigging Only
3. Size Editable

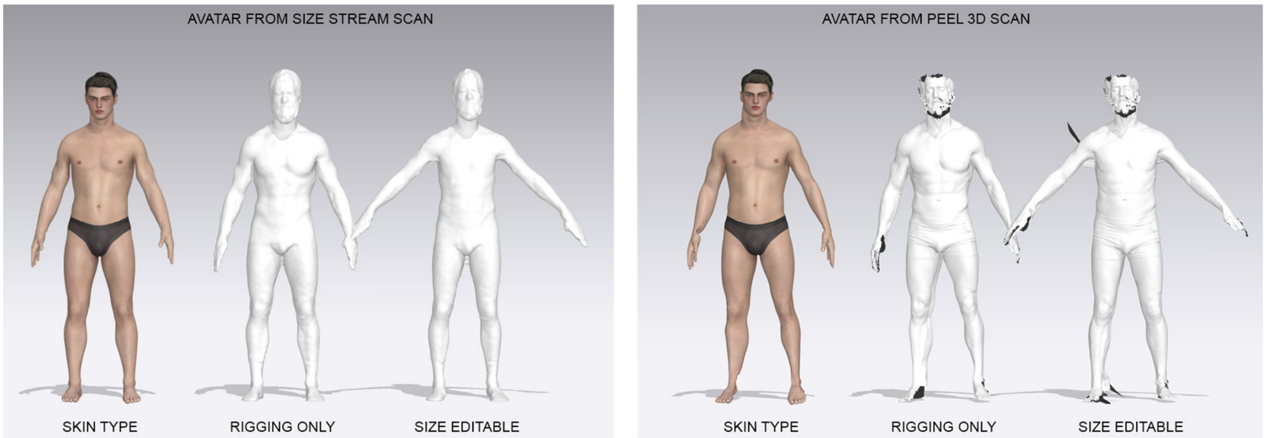

Fig. 5. body scans from Size Stream (left) and PEEL 3D (right) were processed using 'Auto Convert' function in CLO3D for Avatar creation.

Figure 5 presents the outcomes of each avatar produced by CLO3D Auto Convert using Size Stream and Peel 3D scans. The use of body scan data in this process provided a more realistic depiction of form and physique than manual measurement input alone.

The results show some discrepancies in avatar form between the different body scanned avatar creation methods. The avatar generated using the Size Stream scan data exhibits visible anomalies in the underarm region, resulting in distortion of the upper arm geometry. This issue is likely related to sensor occlusion or blind spots from the scanner's fixed infrared sensor configuration. The scan produced by the Peel 3D scan had noticeable holes within the mesh, including the feet, inner hands, chin and top of the head. These empty areas have likely resulted in the distortions noted within the CLO Skin Style and Rigging only avatar at the lower leg and wrists. Anomalies are also present in the size editable output, where more extreme implications with the mesh are observed. Distortion was observed around the neck area of each CLO Skin style output, which may be attributed to interference caused by the participant's facial hair (beard), potentially impacting the auto convert function's ability to accurately identify surface contours in this region.

Each output produces varying degrees of customisability. When converting to the avatar, size editing is not possible. Therefore a 'Size Editable' avatar is created, which fits to a realistic body shape based on CLO software scanned data - this function cannot retain the precise body shape of the original scan file. To keep the native data from the scan 'Rigging Only' avatars were opted for focused in the continuation of this study.

3.2.3 Garment simulation using body scanned avatars

Garment simulation outcomes were tested to determine practical utility in real world design processes. ThruDark product patterns were built in CLO3D and simulated onto the avatars created using body scans. Functionality and fit was assessed. These insights provide a foundation for evaluating the scalable potential of each process and integration into commercial practice.

The 'Rigging Only' avatar was selected from both outputs for a comparison of garment simulation outcomes. ThruDark products from the HeriTech range, known to fit the participant were selected. The fit of these garments were reviewed within CLO3D, using the software's integrated fit maps, for accuracy assessment for physical to digital channels.

Fig. 6. Garment simulation CLO3D (Size Stream Auto Convert Avatar)

The Size Stream Auto Convert avatar provided a good digital representation of product fit. Less definition within the avatar is exhibited in this output, however a clean and watertight mesh has enabled smooth simulation outcomes. Despite some mesh distortion around the underarm and upper arm, appropriate space is still allocated for an armpit region, and the digital garment armhole position is unaffected.

Fig. 7. Garment simulation CLO3D (PEEL 3D Auto Convert Avatar)

The Peel 3D Auto Convert avatar mesh caused interference when garment simulation took place. This was especially evident around the lower leg and ankle areas, where the trouser leg continued to wrap into the gap within the foot mesh, rather than sit naturally as if over an ankle. This made it difficult to review the trouser leg length accurately against leg proportions. Dragging was also noted at the sides of the shirt, from the back and underarm regions, which was not exhibited within the physical product. The avatar mesh at the underarm has joined to the side of the body, removing any allocated space for an armpit region where the garment should naturally sit. The product armhole is therefore forced into a lower position than where it should naturally sit, which has implications on surrounding areas.

4. Discussion

Findings from the study have informed recommended workflows for avatar creation using Size Stream body scanning, now integrated into ThruDark's product lifecycle management system. These workflows enable the brand, and potentially others, to digitise fit models accurately and affordably without extensive in-house testing and disruption to ongoing production. Utilising digital avatars that accurately replicate the brand's core fit models, businesses can preserve sizing integrity across digital and physical channels, supporting efficient digital transformation strategies.

4.1 Measurement data collection analysis

The measurement data collected provided valuable insights into the suitability of tools and methods for use in accurate digital avatar creation.

4.1.1 Physical to digital measurement methods

Manual anthropometric measurements require a high level of precision to ensure that each point of measure is correctly located and consistently followed. Despite attention to detail in aligning the points of measure precisely during the manual measurement collection process, the position of measurement points can be a source of discrepancy with CLO3D. Variations can occur due to differences in interpretation between physical and digital environments, even when best practices are followed. Digital methods typically reference consistent anatomical landmarks, which enhances accuracy and facilitates the reliable replication of results with the use of fixed reference points. These methods offer an alternative approach for tracking fit-model measurements, using digital techniques to ensure that digital avatars remain accurate and consistency is preserved through physical and digital channels. To provide consistency of measurement points, a fully digital measurement process is recommended.

4.1.2 Functionality of data collection tools

The functionality of digital data collection tools was analysed across methods. While the Me360 app may offer a convenient solution for portable and accessible general body tracking, creation of brand-specific digital avatars for garment fitting requires measurements with high levels of detail and accuracy. The Me360 app has a number of limitations regarding data collection and exporting. These restrictions impact technical tasks requiring high-fidelity, customisable, and transferable anthropometric data within professional workflows as the Me360 app not currently tailored to avatar creation. These constraints limit the flexibility and integration of Me360 with digital design or product development systems currently available for digital avatar creation.

The Size Stream body scanner demonstrated high functionality by capturing a comprehensive set of body measurement data. While constrained by its fixed location, the scanner’s six second scan duration allows for multiple iterations to be conducted within a short timeframe, enhancing efficiency and producing comparable data for checking accuracy. The process is also intuitive for both the operator and the fit model, supported by user-friendly automatic scanning systems and designated markers within the booth to guide stance and maintain arm stability. The scanner outputs a complete digital mesh, enabling versatile application across multiple software environments.

The Peel 3D scanner required a higher level of technical proficiency in 3D scanning processes, and continuous operation by an individual throughout the duration of the scan. The handheld scanning provided the participant with freedom with regards to scanning pose. The scanning pose required a balance between obtaining a complete data set and holding position for the duration of the scan. The complexities and time requirement for using the handheld scanner hinder the PEEL 3D’s use for creating custom avatars.

4.2 Creating digital avatars

Each measurement method requires a different approach to creating functional digital avatars that could be used within a fashion industry workflow.

Th variety of measurement methods used highlighted the potential for human error – especially where the time-consuming process of manual input is required. It also posed limitations on the customisation of body shape and physique to emulate that of the fit model. Whilst this method is accessible and intuitive for inputting measurements manually and forming an avatar with custom key points of measure, the use of body scan data in this process resulted in more precise and realistic depictions of anatomical form and proportion.

4.2.1 Functionality of 3D body scanning for avatar creation methods

To produce a useful operable workflow for adoption by the fashion industry, accuracy and ease of use are critical. The Auto Convert avatar function in CLO3D offers an intuitive method for converting body scans into digital avatars. Once the scan has taken place and been uploaded to the CLO3D system, the software will automatically carry out the conversion process, providing three outputs with varying levels of customisability.

Incomplete meshes generated by the Peel 3D scan resulted in functionality issues within CLO3D, limiting the accuracy of garment review. Although the mesh could undergo further refinement through post-processing software to achieve a watertight structure, bridging gaps to fill incomplete regions risks reducing the accuracy of the captured measurements. The participant's pose during scanning also potentially influenced anatomical accuracy, particularly in the armpit region. The Peel 3D system demonstrated an enhanced capacity for capturing fine surface detail compared to the Size Stream scanner, however both methods provided sufficient level of form and proportion capture to meet the requirements for digital fit avatar creation. While this method produces a refined visual scan, issues with operability, post-processing requirements and the potential influence of participant motion remains a limiting factor in the reliability of these single-scan outputs.

The Size Stream scan also exhibited mesh distortion in the upper bicep and armpit region, however a digital garment was still able to be positioned naturally in this region. The conversion produced a complete avatar mesh without conflicting mesh zones during garment simulation. In both the PEEL and Size Stream scans the presence of the participants beard was a source of errors when using the 'Auto Convert' avatar creation in CLO3D, this demonstrates where care needs to be taken during physical to digital transformation. Eliminating interference through the removal of extensive facial hair could enable more accurate measurement capture and improve conversion fidelity, where precision in these regions may be project critical.

4.2.2 Improved garment fit

Embedding digital fit models into product development pipelines improves efficiency for businesses, enabling initial fittings to be conducted digitally, even in the absence of the physical model. This facilitates the early identification of fit-related issues in early prototype stages and allows amendments and alterations to be implemented more rapidly, accelerating product development cycles. The avatars generated from body scans in this study highlighted the critical importance of accurately capturing the entire body during the scanning process. Incomplete or distorted regions can introduce false fit issues within digital design software, as seen with the absence of a correctly positioned armpit region in the Peel 3D scan avatar, which compromised garment evaluation accuracy.

5. Conclusion

This paper addresses a critical need in the fashion industry, bridging the gap between traditional physical sizing practices and the emerging digital garment development landscape. The outcomes of this study demonstrate a scalable, real-world methodology for brands seeking to create bespoke, fit model avatars in house and transition confidently into digital workflows without compromising brand identity or consumer expectations.

5.1 Fashion industry impact

This research has successfully digitised ThruDarks in-house fit models by employing the Size Stream SS20 booth scanner in combination with the auto-convert function in CLO3D to create digital avatars. This integration represents a significant step forward in embedding digital tools within the product development pipeline. By enabling new developments to be visualised in 3D at the early stages of the design process, silhouette and fit can be evaluated against the brand's established fit model before the production of physical samples. Potential fit issues can be identified and resolved within the digital environment, ensuring that once physical prototypes are produced, only minor refinements are required. This transition reduces reliance on physical sampling, minimises material waste, and shortens lead times, contributing to more agile product development cycles and accelerating time to market. The adoption of brand specific digital avatars enhances consistency with legacy sizing systems, safeguarding both fit accuracy and consumer trust. As digital workflows continue to mature, this pilot study at ThruDark highlights the value of integrating body scanning and avatar creation technologies as scalable, sustainable solutions for the fashion industry.

5.2 Future recommendations

Mobile body scanning applications hold significant potential for enhancing the accessibility and frequency of fit-model data collection. Developments in these applications, such as the inclusion of expanded measurement sets and the ability to export data in compatible formats could enable fit models to conduct scans independently within their home environment. By removing the need for in-person scanning, this would facilitate the remote sharing of measurements and further streamline the creation of accurate digital fit model avatars.

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