Motion and Embodiment

3D Simulations for Historic Fashion

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***Abstract*— Fashion is an expressive cultural form, involving silhouette, color and texture, enlivening the material culture discourse by its relationship to society, history, economics, and technology. Museums and educational institutions began amassing collections of dress in the wake of the many world expositions, designed to culturally enlighten the masses, of the mid 1800's. This paper describes a best practices project which aims to enhance the museum exhibition experience of dress in new and interactive ways. In particular, through 3D simulations of the fashions and model body types of the 1930's.**

Keywords—3D simulation, historic fashion, body animation, motion capture, historic costume collection, digital collection

I. Historic Fashion as Cultural Heritage

"Images provide narratives of a culture, clues and revelations of the way a social group or indeed a nation envisions itself, particular to time and space [1]." Images of dress have been used to signify cultural practice and relations of power within the social strata as early as the slab stela of the tombs of Old Kingdom Egypt, 2590 BCN. Historic figurative representations infer fashion. Articles of dress become cultural artifacts whose status is conferred by a social configuration of aesthetics, consumption, class, capital and personal identity.

The 1800's brought the many world expositions of the era's art and manufactured goods, textiles, clothing, and displays pertinent to the culture of contemporary dress for the education of the masses and the contemplation of all human cultural endeavors. Benjamin documents the displays of the 19th century French expositions used to enhance the cultural experience in that period, the various "'-oramas", "phantasmagorical and phantasmaparastatic ", in the Arcades Project and analyzes fashion's relationship to modernity, commodity, fetishism, history, and memory [2]. This period saw the development of the camera and photography, and Thomas Cole's educational mandate to the South Kensington Museum (now the V&A) to become a more public enterprise by documenting and disseminating Europe's artistic treasures through photographs and plaster reproductions. This inspired collections in Europe and the United States to follow suit [3]. These reproductions made art accessible to audiences who would never have entered a museum.

II. A New Role for the Image in Representing Fashion

Conventional exhibition does not allow for close examination as vitrines and low light are necessary to protect the historic object. The internet has brought new and interactive ways to present subject matter and integrate diverse media. QuickTime VR has been employed the Drexel Digital Museum Project: Historic Costume Collection to provide the viewer with multiple views and rich details of embellishment and construction, of selections from the Drexel Historic Costume Collection (DHCC). This best practices archive allows the viewer to manipulate the virtual object and to customize access to and experience of the DHCC holdings. http://digimuse.westphal.drexel.edu/publicdrexel/index.php But to fully appreciate the sensuality of a garment we need to wear it or at least see it in motion, impossible as this would stress and eventually destroy these finite objects. Drexel University and Seoul National University are working together to deliver a virtual experience of historic fashion in motion.

The Digital Clothing Center, Seoul National University (SNU) has been advancing technology, the Digital Clothing Suite (DCS), for the realistic simulation of fabric in drape and motion. The physically-based simulation of clothes is readily adaptable to any body type and motion, can construct complex ensembles, and reproduce their dynamic movements with a striking degree of realism. Reproduction of clothing in this work is based on the immediate buckling model proposed in 2002 [4]. The DHCC has been recognized as one of the finest teaching collections for historic fashion in the USA. Drexel and SNU are collaborating to create 3D simulations for selected garments of 1930s period from the DHCC.

III. The Project

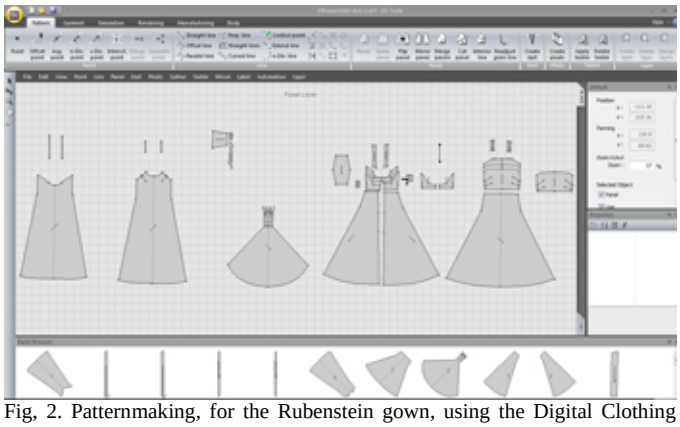
A. The Fashion

The decade of the 1930's was a period of economic and political upheaval in the United States and Europe. In fashion, the "American Look" was born, forged around the identity of the individual and that of America across motifs of modernity, unity and progress [1]. New materials such as Cellulose,

Fig. 1. Chinese parlor, Winterthur Museum. Image courtesy of James Schneck.

Acetate, Viscose Rayon, Cellophane and Bakelite were common elements of dress. Contributing to these advances in fibers and textiles was the DuPont Chemical company [5]. In 1929 H. F. du Pont began construction on a new wing on the DuPont family home, an addition that was the first step towards opening the house to the public as a museum of American Decorative Arts. The decade that followed resounded with activity, taking place against a backdrop of carefully honed interiors designed to show off du Pont's collections and aesthetic. Winterthur makes an excellent stage for our sartorial display of garments of the 1930s and their virtual counterparts (Fig. 1).

Historic accuracy is a prime driver of our project and we aim to create a best practices model throughout the process. Garments for the simulation project are being selected from the Collection's holdings for their historic significance, beauty of design, and appropriateness to the exhibition theme. For the prototype simulation we chose a gown by Helena Rubenstein (Fig.4). Although the DCS currently cannot interpret the complex deforming undergarments of early historic fashion, the body liberating undergarments of the 1930s lend themselves to replication by the software. The girdle was the most constricting garment of the period. Modifications to the human shape created by the undergarments are being considered in the body modeling process. To begin the process measurement specifications are taken from the historic garment. Using the DCS software, patterns are created from the specifications (Fig. 2). Panels for the sections of the garment are constructed to which textile surface and embellishment details, and the physical parameters of the materials (e.g., the tensile stiffness, mass density) and fabric details such as textures, prints, embellishments or textile structures of the original garment are assigned and rendered in DCS. The panels are then draped onto a simulated body, whose size has been customized to the measurement specifications. (Fig.3) Seams are closed and the simulation is executed. After checking the fit of the garment the body is placed into a choice of preset poses and runway walks. A comparison from multiple views can be made between the



Fig, 2. Patternmaking, for the Rubenstein gown, using the Digital Clothing Suite

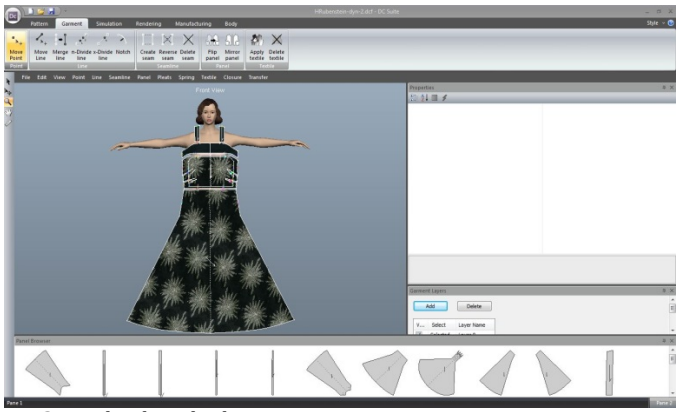


Fig. 3. Panel and textile placement.

physical and the virtual Helena Rubenstein in figures 4 and 5. The DCS has a function to create a video clip of the dynamic simulation. However the resolution of the output is low. We used Camtasia software to create a higher quality movie for presentation. Maya is being used to enhance the realism of fabrics, body, and hair.

B. The Body

To make our replicants historically accurate we must consider how we represent the body as well as the garments. There are limitations to how distinctly the default DCS body can be customized to match our requirements. None of the choices in body type, makeup and hairstyles, nor the preset poses and motion, are of the 1930s era. Drexel faculty and students are creating a virtual human which will look and act appropriately in our virtual 1930s environment. The 1930s was a period when women of all classes emulated Hollywood's stars to find their own modern identity [6]. As we often do not have photographs of the original owners of our historic garments, we are using the iconic 1930s movie star Carole Lombard as our muse. (Fig.6) To create our Virtual Carole Lombard model (VCL) we first needed a model of a human body comprised of a surface mesh and an underlying skeleton, connected in a way that the surface of the body deforms realistically when the model moves. Development of the "physical" attributes of VCL has an added dimension of complexity as VCL will perform a series of choreographed motions and gestures. Topology and edge flow are critical considerations for

Fig. 4. Helena Rubinstein. Evening gown. Black silk organdy and acetate. USA, circa 1932. Gift of Mrs. Larry Stage (64.94.19-Helena_Rubinstein01)

Fig. 5. Simulated Helena Rubenstein gown using the DCS default body.

character models for animation. If not defined correctly, abnormal deformations of the body will occur in motion. This is of concern for exposed areas of the model such as the face, shoulders and arms, and also for areas concealed under the garments. (Fig. 7) The edge flow of VCL's surface topology must take into account both visible surface details as well as how those surfaces will move and deform. Around key joints, for instance, there must be uninterrupted edge flow that runs in parallel with the bend as well as contrasting edge flow that runs perpendicular to the bend, allowing for smooth, predictable collapsing and stretching of the surface. (Fig. 7) This edge flow "net" also will allow for surface twisting such as when the forearm alternates between pronation and supination. To best accentuate surface details such as bony protrusions of the ribs or clavicles, muscles, etc., edge flow must be manipulated. For strategic alterations of edge flow and the resulting 5-poles (vertices that are shared by 5 polygons) we separate prominent details from the rest of the

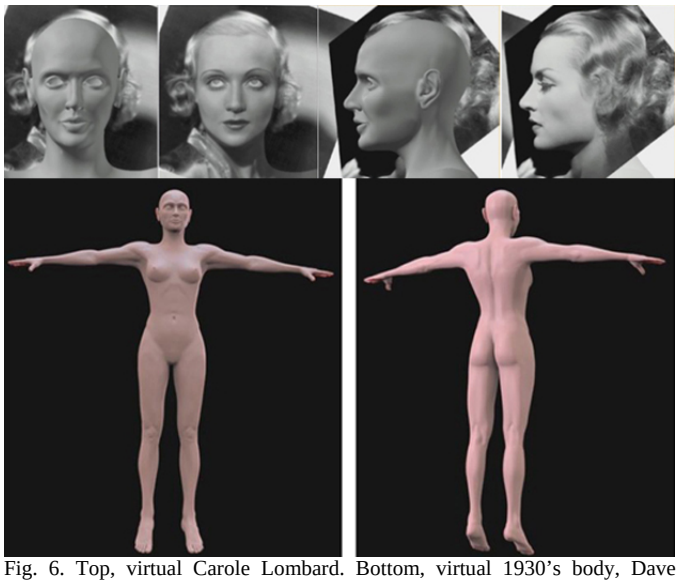


Fig. 6. Top, virtual Carole Lombard. Bottom, virtual 1930's body, Dave Mauriello, artist, modeler.

surface, ensuring accuracy of her physical attributes whether still or in motion. (Fig. 7)

Portraying the nonverbal behavior and personality of a human is a complex task. Realistic performance of the surface motion and deformation of the virtual character in relationship to the skeleton is important but other human qualities need to be considered. [7] Much can be conveyed about personality and emotion by the animation's posture and gait. For the motion capture we chose a model close in girth and stature to the body specifications used in the garment patternmaking. To capture the attributes of posture and gait of a 1930s socialite we studied films of the period and, with the model wearing authentic 1930s undergarments under the motion capture suit, choreographed a script for the movements we wanted to capture. We used a Vicon Blade passive optical system, tracking the movements of reflective markers attached to a non-reflective body suit worn by the model. Each motion capture camera strobes infrared light and records its reflections off the markers 120 times a second. Sixteen synchronized cameras were strategically arranged around the room creating a 20'x20' "capture space" where their fields of

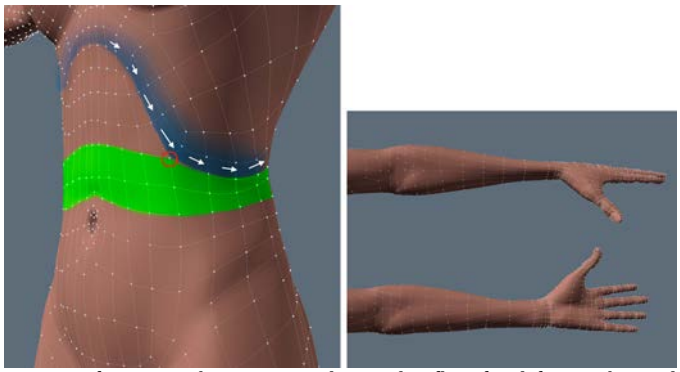


Fig. 7. Left, torso: White arrows indicate edge flow for defining ribs. Red circle indicates 5-pole. Green region is a deformation zone where torso bends. Right, edge flow net, forearm.

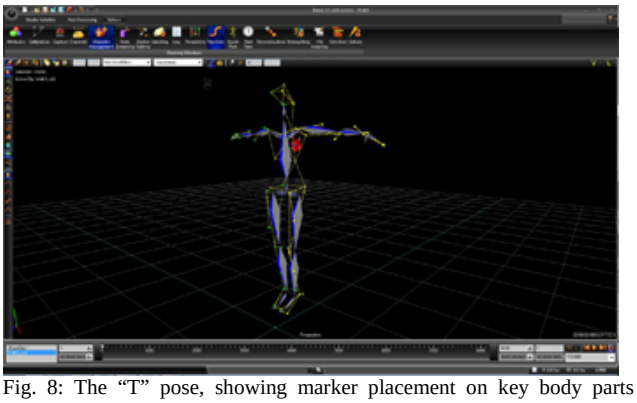


Fig. 8: The "T" pose, showing marker placement on key body parts and skeleton generated by blade software.

view overlap. Translational data of the markers is achieved by triangulating all the camera views to create a 3D reconstruction of all the markers in the software. Marker placement on the human model coincides with key anatomical locations. Blade software generates a skeleton based on the marker locations. The movement of the markers over time is interpolated as both movement and rotation of bones of the skeleton. To ensure the accuracy of this interpolation, the human model begins and ends each movement session in a "T-pose"(Fig. 8). This skeleton, built based on the anatomical landmarks of the human model and articulated by her captured movements, will drive the primary movements of the digital model (Fig. 9). Video reference of the performances were also captured for use when manually animating the digital model's face, hand gestures and secondary actions on top of the captured performance data.

C. *The Exhibition*

On display will be 25 garments from the DHCC. The virtual simulations will populate a 3D panorama created from digital scans of one of the grand rooms of Winterthur. Viewers will enter the 360-degree projection theater, don 3D glasses, and be able to navigate a rich virtual space using gesture to interact with selections of interest. This augmented panorama will be 1:1, real world scale, enabling the viewer to experience the space as if they have stepped "through the looking glass" into the historic space and were invited to the party. This experience should create a dialogue between viewer and object as well as between viewers. This could lead to rich interpretations not apparent in the static, physical object [8].

IV. Conclusion

Digital recreation of historic fashion has been investigated since Jane Harris's *Empress's New Clothes* and the MIRALab experiments with haute couture from the 1950s [9] [10]. Building on past research, we plan, through best practices, to immerse the participant in a historically accurate experience of dress in a way that "creates memories, comparisons, relationships, values" through the inter-actor's lived experience of sensation, aspiration and contemplation [10]. We hope to bring to the audience a new kind of exhibition that mediates between the physical and the virtual, across

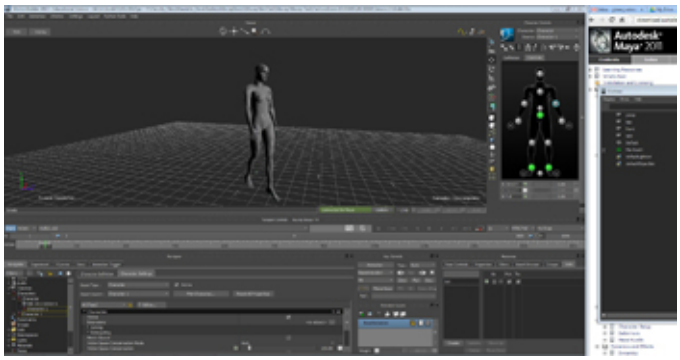


Fig. 9.a, b. Skeleton and animation of the digital model

social, technological and physical architectures, emancipating the objects from the restrictions of conservation and curatorial practice, while interconnecting the material and virtual [12].

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