Innovative Explorations in Apparel Design to Create Engineered Outfits with Lighting Technologies

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Abstract
The future of innovation in clothing lies within wearable technologies, advanced design development processes and advanced construction techniques. The integration of functional apparel design and engineering has attracted a lot of attention in the last decade. The objective of our work is to explore new avenues that connect design and technology, and to improve upon traditional techniques in apparel product development and construction. We will discuss the techniques used in our research project to explore fast prototyping techniques including laser cutting, 3D body scanning, draping on a half scale mannequin, 3D printing, and the inclusion of wearable electronics. The use of these fast prototyping techniques can reduce the cost in production and simplify the development process [1].

Author Keywords
Fast prototyping techniques; 3D body scanner; 3D printing; Electroluminiscent tape.

Introduction
One of the most important technological developments in the last decade is the integration of technology and functional design. The new approaches explored here utilize the emerging techniques to study the abstraction

of human body muscular system and their synergy with apparel design. In this project we are presenting two different garments: a male and female look. The male look is a tight-fitting body suit with an attached outer layer of neoprene. For the female look a tight-fitting body suit was made using mesh and spandex. For these bodysuits we wanted to attain an ideal fit [2]. The use of new technologies for apparel design and development to create better fitted garments is one of the most challenging endeavors in apparel design and construction.

A body scanner (Human Solutions VITUS XXL) with 8 laser sensor heads was used in the development of the male garment. The model was scanned, and a half scale mannequin was created from the scan. First the body scan was made symmetrical by slicing into left and right halves with a sagittal plane, choosing one half of the body, mirroring it, and reassembling the scan using Geomagic™. The scan was then scaled down to exactly half size, sliced horizontally into ½ inch increments, and small registration holes were created on each slice. Subsequently, the sliced pieces were cut from ½ inch thick polyurethane foam, using a commercial laser cutter (KER52100-G150 HSE). The foam pieces were assembled by threading onto a dowel through the registration holes (see figure 1). Once the half scale mannequin was assembled, patterns were draped on it to create prototypes of the body suit to be fitted on our model. The half scale model allows the designer to experiment with a simulated human body and create prototypes using minimal material before creating the final garment. Pattern pieces prototyped on the half scale model can be scaled up to full-scale by digitizing them into an apparel patternmaking system (Optitex™), scaling them to full size, and printing the pattern for cutting[1].

As an additional step, the pattern was digitized into Optitex™ and then the garment was virtually fitted on the original 3D body scan, which was imported into the software (see figure 1). After the proper fit was attained, the final pieces were cut from the spandex and neoprene using the commercial laser cutter machine.

The integration of flexible electroluminescent (EL) material devices such as EL tape and EL wire into the garments was explored, as can be observed in figures 2 and 3. One of the main applications of these lighting garments could be futuristic law enforcement. The wearer would be able to "light-up" when a situation occurred, much like a modern-day police car. Both the EL tape, in the male look, and the EL wire, in the female look, give this effect. Through integration of lighting and construction materials, the aesthetic features of the human body were enhanced. The female body suit was constructed from both a thicker and a thinner fabric. These fabrics were used to emphasize the hourglass figure using traditional activewear design lines. The lighting was then placed to further emphasize the ideal body shape. The inner layer of the male bodysuit was made using a thin spandex, which supported the external technical layer made from a 4 mm thick neoprene. Both layers were designed to exaggerate muscular structure using anatomical design lines[3, 4].

The use of 3D Printed objects in Apparel Design for the creation of accessories is a popular trend in the industry. The addition of 3D printed glasses completed

the looks. A simplified 3D model of the accessory was created using the SolidWorks CAD program. These glasses were printed using a rapid prototyping system (Makerbot 2X). The printed accessory was then functionalized with a flexible EL tape. The glasses reflect our perception of futuristic eyewear.

Figure 1. Images showing the half scale mannequin, the body scan, and the virtual fit process used to develop the pattern.

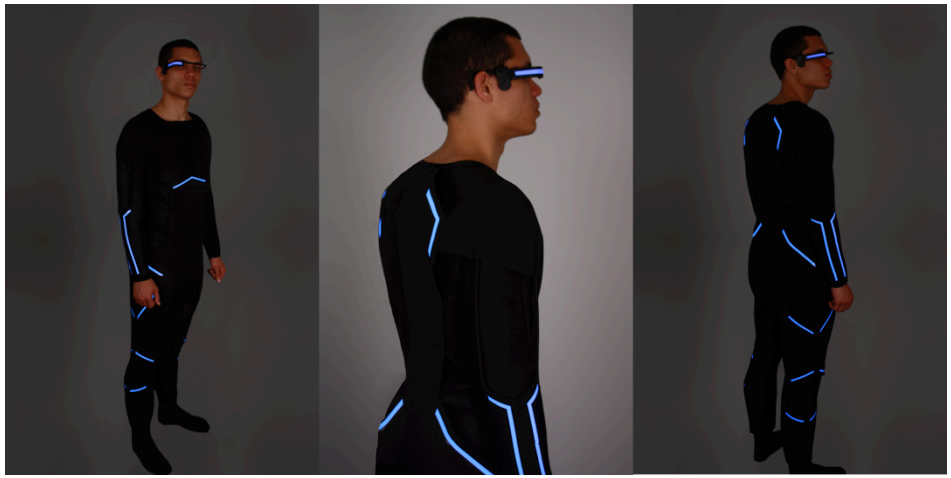

Figure 2. Male garment bodysuit. The design relies on the exaggerated muscular male body shape. The technology used is flexible EL tape, from Myant Capital Partners Inc. and AIA

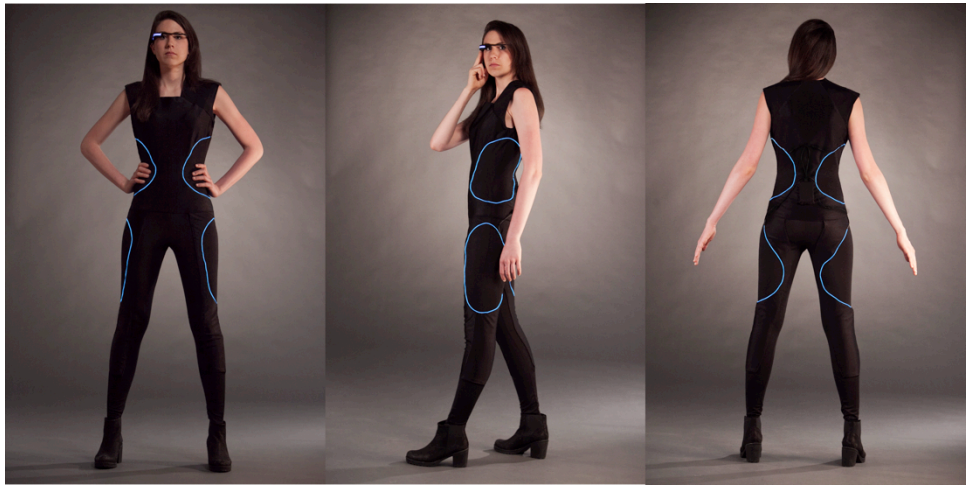

Figure 3. Female bodysuit. The design emphasizes the female hourglass form shape. The technology used is flexible EL wire.

Figure 4. (a) Virtual prototype of the glasses in SolidWorks. (b,c) prototype 3D printed using a Makerbot replicator 2X. The technology used is flexible EL tape, Myant Capital Partners Inc. and AIA.

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