Advances in Performance Apparel

Huiju Park (Ph.D.)
Assistant Professor
Department of Fiber Science & Apparel Design
Cornell University

Research foci
Problem-Solving Design for Human Well-being
Based on Incorporation of Technology

- Comfort
- Thermal Comfort
- Mobility
- Functionality
- Aesthetics

Human Well-being
Topics

- Wearable technologies
- 3D technologies
- Thermal comfort

Wearable Technologies
**Wearable Technologies**

- Real time bio-monitoring
- Posture monitoring and correction
Wearable Technologies

**Smart Firegear**

Develop Tcore prediction model (based on Thermal manikin test)

\[ T_{\text{Core}} = -7.664 + .973 \times T_{\text{Micro-chest}} + .300 \times T_{\text{Micro-back}} \]

Evaluate reliability of the model

Thermal manikin test vs Human subject test

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**Wearable Technologies**

*Listen to Fit* - Erica Hyunji Lee, Emma Wang & Huiju Park
Wearable Technologies

Smart Dress Shoes with Automatically Adjustable Heel Height

David Shi & Huiju Park
Wearable Technologies

*Smart Dress Shoes with Automatically Adjustable Heel Height*

David Shi & Huiju Park

- Patent filed: pending

- Future research direction:
  - Structural stability
  - Incorporation with shoe upper
  - Most effective power source (e.g., Energy harvesting technology)
  - Comfort evaluation based on dynamic plantar pressure measurement
  - Consumer research

Wearable Technologies

*Future directions*

- Practical applications
- Integration vs attachment
- Durability and maintenance: Prototypes vs Products
- Production issues in conventional apparel manufacturing setting
- Unobtrusiveness / Context awareness / Social interactions
- Market acceptability (price vs added value)
- Easy human interaction
3D Technology

3D Technologies

Advance in apparel design based on understanding of human forms, design, comfort and performance

- 3D full body scanner
- 3D foot scanner & 3D head scanner
- 3D motion capture system
- 3D printers
- Optitex and CLO3D 2D/3D Apparel CAD software
3D Scan to 2D Pattern in Active Sportswear

3D scan > 2D pattern making

Kristen Morris, Sandy Flint, Huiju Park, Susan Ashdown, & Youngjin Jeong
Funded by Cornell Council for Art (2012)

3D Scan – Virtual Simulation Technologies

3D scan > 2D pattern making

 IMPLEMENTATION

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Examples of student projects from FSAD2660: Product Development for Activewear

Imported pattern into CLO3D
- Digitized half scale pattern
- Scaled to full size in Optitex
- Exported patterns so that it could be accessed in CLO3D
- Entered measurements into Avatar Editor to match live fit model
  - Used fit model similar to Wolf Mannequin size 8

Examples of student projects from FSAD2660: Product Development for Activewear

Created Colorways
Examples of student projects from FSAD2660: Product Development for Activewear

Examples of student projects from FSAD2660: Product Development for Activewear
3D Foot Scan – Morphology - Comfort

*Change in foot morphology in high-heeled shoes*
Huiju Park

![Image](image1)

*Figure 6. Area of constraint (a), change morphology (b) and foot width (c) in heeled shoes*

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3D Foot Scan – Posture - Gait

*Firemen’s boots fit & gender difference in foot morphology*
Huiju Park

![Image](image2)
3D Motion Capture – Pressure Sensing Technologies

Impact of Firegear on Gait and Body Balance

1) Investigate impacts of wearing each item* on gait
   *: turnout ensemble, SCBA: Self-Contained Breathing Apparatus, and boots

2) Identify contributing factors that affect gait and lower body mobility


Incremental impact of PPE on body balance

- **COP:** The point where all ground reaction forces, acting on the foot when it is in contact with the ground, are balanced (Harris & Smith 2010).

- **Restricted foot motion:** Decreases the anterior-posterior (AP) and the medial-lateral (ML) excursion of COP trajectory
Incremental impact of PPE on body balance

**Figure 13. Gender difference in Q angle**
3D technology moving forward

*Future Direction in Park’s Lab*

**Performance Products & Health Care**
- Rapid prototyping of customized sport equipment, prosthetics and orthotics
- Optimized breathability & structural support using soft and rigid 3D printing
- Evaluation of impact of design on human performance

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**Thermal Comfort**
Thermal Comfort in Performance Apparel

*Body Mapping Approach based on Understanding of Sweat Pattern*

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Thermal Comfort in Performance Apparel

*Development and Evaluation of Cooling/Heating Garments*
Thermal Comfort in Performance Apparel

On-going Projects

• Development and Evaluation of Ebola Protective Clothing

• Development and Evaluation of Outdoor Gear for Improve Thermal Comfort