Making with Fabric: Foundations of Soft Goods and E-Textiles Fabrication

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ABSTRACT

Wearable technologies afford more pervasive access to the human user: higher bandwidth for communication in multiple modalities, and better context-awareness through sensing the user's body and environment. However, stand-alone devices like wristbands and clip-ons are limited in the body areas they can simultaneously access. Clothing and textiles provide a useful platform for distributed systems, but present unique challenges in design and fabrication. This course provides an introduction to the tools, methods, and techniques of designing and fabricating with soft goods, including patternmaking and construction techniques for different material types at multiple scales, and e-textile methods and materials.

CCS CONCEPTS

• **Human Centered Computing** → **Ubiquitous and mobile computing**; *Ubiquitous and mobile computing design and evaluation methods*
• **Hardware** → **Emerging technologies**; *Flexible and printable circuits*

KEYWORDS

Wearable technology; textiles; soft goods; e-textiles sewing; patternmaking

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1 INTRODUCTION

Soft materials offer the ability to distribute sensors, actuators, and interfaces over the body surface: to situate system elements in the body area where they are needed. However, integrating electronics into soft goods presents unique fabrication and durability challenges, and also requires that the designer carefully consider the wearability and aesthetic expectations of the user. This course provides an overview of the methods, tools, and techniques used to design and fabricate systems based on soft substrates.

2 COURSE TOPIC OUTLINE

The topics covered in this course include:

1. Deriving system geometries: patternmaking techniques
    a. Drafting
    b. Draping with non-stretch fabrics
    c. Draping with stretch fabrics
    d. 2D and 3D CAD systems for pattern development
2. Basic textile fabrication
    a. Weaving
    b. Knitting
    c. Non-wovens and finishing
3. Cutting systems and production workflow
4. Joining techniques
    a. Single-needle sewing operations
    b. Multi-needle sewing operations
    c. Automated and industrial-scale fabrication
5. E-textile techniques
    a. Integrating conductors and traces: weaving, knitting, printing, laminating, and stitching techniques
    b. Interconnects and component attachment
    c. E-textile components: sensors, actuators, antennas
6. Product development and manufacturing of e-textile systems
    a. Workflow integration
    b. Testing and validation

3 COURSE STRUCTURE AND MATERIALS

Concepts will be taught through lecture, video, live demonstration, and targeted experiences/examples. The course design will be adapted to the audience size. It is unlikely that

extensive hands-on experiences can be part of the course due to time and equipment restrictions, but targeted demonstrations and short illustrative experiences will be provided to contextualize the material.

4 INTENDED AUDIENCE AND PREREQUISITES

This course assumes no prior knowledge, although working familiarity with making and fabrication in any domain is useful. It is intended for a broad audience: students, researchers, designers, and practitioners interested in experimenting with textile-based systems, and/or broadening their understanding of wearable technology.

5 BENEFITS AND OUTCOMES

The course is expected to provide for participants:

- Basic working understanding of the product development and fabrication processes used for soft goods
- Key methods technologies used at each stage of the development process
- Understanding of the process changes that happen at different scales and in different contexts
- Resources and communities for further investigation of each sub-area
- Open questions and research/design challenges for textile-based wearable systems

6 INSTRUCTOR BACKGROUND

Lucy E. Dunne is a Professor (academic home: Apparel Design; graduate faculty memberships: Human Factors and Ergonomics, Product Design, Computer Science, Electrical Engineering) at the University of Minnesota, where she directs the Apparel Design program and co-directs the Wearable Technology Lab. She has taught Apparel Design and Human Factors for 15 years, and has been an active researcher in wearable technology since 2001. Dr. Dunne holds degrees in Textiles and Apparel (BS), Apparel Design (MA), Electronic Technology (AAS), and Computer Science (PhD). She co-authored the foundational textbook on human factors and physics of on-body systems, “Functional Clothing Design: from Sportswear to Space Suits” [1]. Prior to joining the faculty at the University of Minnesota, she taught Engineering Design at Olin College. More about Dr. Dunne’s current research can be found at wtl.umn.edu.

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REFERENCES

[1] Susan M. Watkins and Lucy E. Dunne. 2014. Functional Clothing Design: From Sportswear to Space Suits. Bloomsbury, New York, NY.