Making Computers Wearable
Tutorial: ISWC 2003

Abstract
The future of computer wearables lies in their acceptance by the mass market. One of the main reasons that wearable computers have not been adopted by great numbers of the general public is that the relationship between computer components and apparel has not been adequately addressed. This tutorial provides the basic framework through which participants can address wearability issues for their products and research. It will discuss the traditional functions of clothing, and how electronics may augment or inhibit those functions. Topics include: the use of a modified systems engineering design process to facilitate the generation and selection of novel solutions to existing problems; designing for the human body (issues such as weight distribution of electronic components, mapping variations in pressure sensitivity of the skin, mobility and range of motion, and the effects of added heat stress from electronics); garment structure, construction, and the adaptation of existing garment features (such as padding, fasteners and structural elements) to aid in integration of electronics and to maximize system functionality; and re-conceptualizing wearable computers for mass-market acceptance.
The tutorial will conclude with an overview of resources for prototyping wearable systems, including educational literature, apparel research literature, and sourcing of textiles and notions. There are no prerequisites for this tutorial.

Outline

I. Introduction: Roles and functions of clothing; the functions that clothing traditionally serves, and how electronics can augment or inhibit these functions
   a. Protection: Passive vs. Active
      i. Environmental (Heat/cold, uv/ sun protection, wind protection)
      ii. Situational (extreme weather, chemical protection, force/ballistic protection, safety/visibility, water resistance)
   b. Service: Transport of physical items vs their electronic counterparts
      i. Transport/storage (pockets vs memory and data processing)
   c. Expression: Static vs. dynamic expression
      i. Group identity
      ii. Individual identity

II. Designing for the human body
   a. Weight distribution
      i. Balance and maintaining balance in motion
      ii. Muscle fatigue and repetitive stress
      iii. Suspension points and the effects of suspending hanging weights
   b. Pressure and skin sensitivity
      i. Anatomy of the skin
      ii. Mapping torso sensitivity to pressure
   c. Heat and its effects on the body
      i. Effect of heat stress on performance/concentration/attention
      ii. Dissipating heat in a wearable system
   d. Mobility
      i. Identifying necessary range of motion
      ii. Design considerations for achieving full range of motion
      iii. Ease of manipulation and accessibility of interface components

III. Adapting existing features of clothing for electronic functionality
   a. Use of garment spaces to house electronics
   b. Identifying and monitoring typical human responses to guide the design of user interfaces
   c. Adapting garment features (fastenings, shapes, etc) for electronic functions
   d. Integration of hard components

IV. Designing a *wearable* system (how-to)
   a. Applying Systems Engineering design process to wearable computers
   b. Evaluating the potential of multiple design configurations (C:PE)

V. Re-conceptualizing wearable computers for mass-market acceptance
   a. Re-conceptualizing electronic components for use with apparel
   b. Re-conceptualizing apparel for use with electronic augmentation
   c. Updating apparel production methods for integration of electronics

VI. Resources for prototyping
   a. Educational literature on design, patterning, garment production and ergonomics
   b. Sourcing fabrics/trims/notions
   c. Existing bodies of research on wearability and garment systems

Instructor Qualifications

Susan Watkins, Professor Emeritus at Cornell University and Designer/ Manager of Portable Environments, LLC, and a has been designing, writing, teaching and conducting research in the field of functional clothing for over 30 years. She has worked for industry, governmental agencies and academia on projects for a wide variety of end users — from Navy pilots to hockey players to nursing home residents to Drug Enforcement agents. She has lectured across the country on protective clothing design. In 1991, Watkins was named a Fellow of the International Textiles and Apparel Association for her pioneering work with protective clothing.

Lucy Dunne is a Masters candidate in Apparel Design at Cornell University, and is pursuing an Associates Degree in Electrical Technology at Tompkins Cortland Community College. In her research, she seeks to bridge the gap between designers of technology and designers of apparel. Her previous work in wearable integration of technology has been presented at several conferences and has received widespread media attention. Lucy has worked in fashion design, functional apparel design for the military and intelligent clothing design. She is a Teaching Assistant at Cornell University.

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