A Multidisciplinary Approach for Placement and Testing of Electronically Conductive Textiles in a Medical Smart Garment

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The development of wearable electronic clothing for healthcare is a budding field that holds much promise yet is complex and relatively underdeveloped. Advances in medicine and medical technologies have enhanced the life expectancy of the population even though individuals may have health conditions that encroach on their quality of life. Finding solutions to problems related to health and wellbeing through textile products is particularly appropriate due to the potential for garment engineering and design to assess and accommodate needs of individual patients with specific disease/disorders through the design of products that have the potential to make contact with most of the skin surface. The embedding of multiple biomedical sensor systems into functional, durable, comfortable, and aesthetically pleasing garments engineered to fit diverse body types enable patients to maintain dignity while proactively monitoring their health (Park & Jayaraman 2003).

Effective communication is an essential component of successful research teams, and challenging enough when all of the team members share a common expertise. When addressing a problem that requires diverse areas of expertise, effectual communication becomes even more difficult. When developing Wearable Electronic Textile-based Systems (WETS), variables such as the physical distance between researchers, differences in professional training, and interpersonal relationships can pose significant challenges when pursuing the project outcomes (Cummings & Kiesler, 2005). Consequently, one of the primary barriers to electronic apparel development for healthcare, especially, is the need to combine knowledge of textiles and apparel design, electrical and computer engineering and health science.

Researchers at a Midwestern University from each of the three specialty areas, Biomedical Sciences, Electrical and Computer Engineering, and Apparel Design, joined together to research and develop a medical smart garment. At the initiation of the project, establishing a baseline of terms and concepts for communication was essential. Areas of exchange included the body's anatomy and function, electricity, sensors, motherboards and circuits, as well as textiles, pattern-making, construction, aesthetic principles, and consumer behavior. Early on during the team's interaction, we realized that in-depth discipline-specific information tended to confuse and/or burden the researcher from the other specialties. Therefore, during each phase of the project's development the researchers from each specialty area were mindful to communicate adequate information to accomplish the tasks, but not more than necessary.

During the research development process, two key interdisciplinary approaches that were found to be vital to the successful development of a medical smart garment prototype for remote monitoring of patient health. First, each element of the system design was best addressed with academic standards in mind. Clearly establishing a research question and following a scientific method to plan and execute the

research established a common ground familiar to all the researchers, regardless of specialization. Second, information was shared at a rate that allowed each collaborator to adequately achieve the task yet not provide too much in order to avoid attaining confusing or burdensome levels. As a result, frequent and short interactive meetings were a necessity. Adhering to these two concepts allowed our interdisciplinary team to focus on the outcome while fostering creativity and innovation.

The medical application chosen for this WETS was an in-home device for collecting diagnostic data that would enable a doctor to determine a sleep apnea disorder. Medical standard sensor placement varies dramatically for each body signal collection application. For example, the traditional 12-lead electrocardiogram requires 10 electrodes placed at various locations on the human torso while traditional respiratory impedance plethysmography (RIP) requires a stretchable band around the chest and/or abdomen. It would be difficult to place an infinite number of sensors across the body. As a result, careful consideration was given to choosing sensors that yield the maximum amount of information without adding too much complexity to the design. Communication with our medical researchers allowed us to identify essential lead locations for the quality and type of signals required for the specific data needed to diagnose sleep apnea. The Electrical and Computer engineer specialists guided the choice of sensors, the establishment of conductive paths, connectors, and conductive materials while the apparel designer then integrated all of these criteria into a textile-based embodiment and contributed expertise in apparel design and consumer behavior.

In conclusion, the process of collaborating with diverse disciplines provided insight into effective working methods that enable the team to maintain academic standards through calculating the type and quantity of information that needs to be shared in short, interactive meetings to achieve project objectives. In an interdisciplinary environment, efficiency and harmony can be fostered by maintaining mutual respect and enhancing each of the team member's areas of expertise.

References

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