Tailored but versatile, simple but powerful: Challenges and Insights of Wearable Toolkit Design

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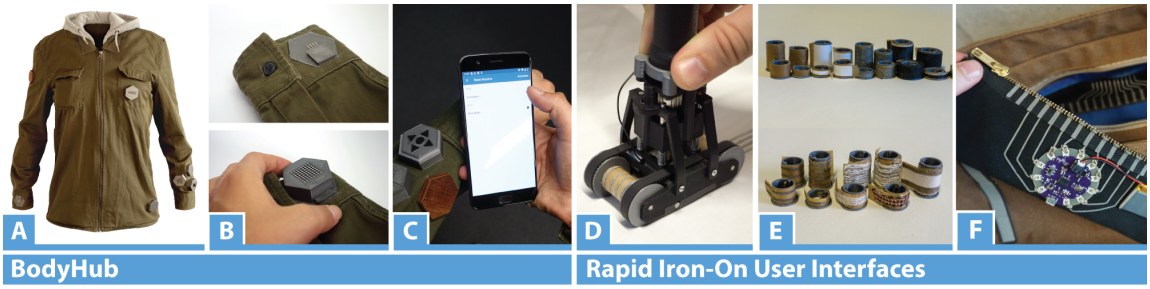

Fig. 1. Our wearable toolkits BodyHub [5] **(A-C)** and Rapid Iron-On User Interfaces [4] **(D-F)**.

Prototyping and exploring novel body-worn user interfaces remains a challenge, as we do not yet know exactly how to collaboratively design, flexibly customize, integrate, and finally reuse or recycle them in a sustainable way. While the next generation of body-worn interfaces should be tailored and simple, but also versatile and powerful, some paradigms even seem contradictory. With this paper, we aim to share hands-on experiences, present demonstrators, and highlight findings from two research projects while discussing current challenges in wearable toolkit development along three research questions.

How do we develop toolkits that support users with different skills and goals?

We think that versatile and easy-to-use toolkits are needed to empower designers, researchers, and technology-enthusiastic people to enable interdisciplinary cooperation. Possible approaches to simplify hardware design are easy-to-use fabrication tools [1, 3]. For this purpose, we developed Rapid Iron-On User Interfaces (RIO) [4] with a hand-held ironing tool and adhesive functional tapes (see Figure 1, D+E). The tapes are made of functional materials layered with iron-on fleece and can be loaded into the tool. To create functional prototypes, the user simply moves the tool along the desired path to apply the functional elements to the textile, which facilitates the fabrication for diverse user groups.

How can we support reconfigurability for designers and end users?

Usage scenarios of body-worn interfaces are diverse and highly context- and user-dependent. To this end, we believe it is necessary to develop toolkits that can be customized by the user both physically and in terms of interaction mapping. Therefore, we developed BodyHub [5] with a 3D-printed socket system integrated into the garment (see Figure 1, A). Attaching modules enables versatile input and output options at different body locations (see Figure 1, B). To realize user-defined interaction mappings, we implemented an accompanying smartphone app (see Figure 1, C) based on

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the *If This Then That* principle [2]. Furthermore, we also investigate how our RIO toolkit could utilize existing textile accessories like zippers as reversible connections (see Figure 1, F) in addition to other state-of-the-art solutions [6]. These examples illustrate that predefined socket systems are easier to use but limited in their flexibility, while more flexible toolkits typically got a higher level of complexity.

What level of integration is appropriate for emerging toolkits?

The level of integration ranges from attached rigid components, to hybrid approaches, to solutions at yarn level. Even though solutions at yarn level are the most integrated, the choice is not solely technologically determined. Factors such as comfort of use, reconfigurability, and sustainability have a considerable influence. To address the long-term sustainability of smart garments, we see great potential in hybrid solutions. Interchangeable modules can be used for different tech-enabled garments, which can be reasonably recycled.

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