Wearables: Introduction

Wearables (or more properly: wearable computers) are electronic devices integrated into or onto clothing, or carried directly on (and sometimes under) the skin. Wearables are an interesting topic in the context of technology development as they partake in the culture and long history of tool making. The design of cloth (weaving, knitting) involves advanced technologies that were developed over thousands of years and constitute fundamental milestones in the history of mankind's relationship to the environment and the ability to intervene in it. Adding information processing to clothing is thus a 'natural' progression of this ongoing development. The first loincloth was a decisive step in the creation of the cyborg body.

In terms of biosensing, wearables are of particular interest for several reasons: 1)Wearables combine electrical with living systems; 2) Wearables are part of clothing culture; 3) Wearables require cross-disciplinary knowledge; 4) There is a decade-long history of theory and practice in wearable computing.

Wearables combine electrical systems with living systems. As such they share the same fundamental design space as biosensors. The design of wearables requires knowledge from several fields with very different knowledge bases and partially competing interests: design, technology, and sociology all play an important role in the making of a successful wearable object and all have very different foci points. Wearable systems answer to challenges from technical, social, ethical and aesthetic questions. A good-looking, well-fitting rain jacket that allows moisture to leave the body, for example, fulfills requirements that are difficult to combine and draws little attention while doing so. We have become used to expecting clothing to meet such multiple requirements and to do it well in every regard. In short, there is a long history and acute sense of quality and appreciation for clothing; it is a quintessential intimate technology.

There is at least a 10-year history of theory and practice in the design of wearable computers with practical results produced on industrial levels and distributed to the general public. Wearable computers are a mature field, an advanced stage of synthetic-natural system co-design; it should come as no surprise that most cyborg variations have wearable computing systems in one form or another as a common denominator.

First generation wearable computers were plagued by bulky hardware, buggy software and short battery life making any comfortable use impossible. Nonetheless, much of the interesting discussions on the theory of wearables occurred while the hardware was still very much under development. At Georgia Tech, Tad Starner considered the future of wearables in a text on wearable computing, published in 2001[1]. The text discusses wearables in the context of companionship, constant information access, assistance in daily needs, adaptable systems and just-in-time information. The text also discusses interesting power harvesting options such as environment scavenging as well as the challenges of network resources and privacy concerns that have now become much more central in the evaluation and critique of wearables.

[1] Starner, T., "The Challenges of Wearable Computing", IEEE Micro, 21(4), July 2001, pp. 54-67.

Steve Mann, another pioneer of wearable computing, made important early contributions to privacy design and in particular the role of the individual in actively countering surveillance creep of ubiquitous video surveillance. Mann's approach was to actively watch the watchers with reverse surveillance or *souveillance*[2]. In order to operate under cover, souveillance makes use of wearable technologies in head-mounted displays of continuing refinement (until they are indistinguishable from ordinary reading glasses). The premise of souveillance rests on the assumption that the participation of the masses in reverse-surveillance, facilitated through convenient wearable computing, could form a counter force to the uncontrolled surveillance of corporations and government. Furthermore, the approach assumes that visual surveillance is the 'battle ground' where this question can and should be addressed. Both of these premises have turned out to be not quite true. The earlier pivotal role of visual surveillance has now been taken over by data surveillance (surveillance of data transactions of all kinds) without direct visual footprints.

In the field of preventive healthcare, the *Nuvant MCT system*[3], is a good example of state-of-the-art medicinal wearables. The system consists of a waterproof device that is worn on the body (on the skin of the chest) and collects and transmits data on cardiovascular activity to a transmitter, which is connected in turn to a remote monitoring center. The center performs automated checks on the streaming data and contacts a cardiologist as soon as it detects potential anomalies such as arrhythmia or patient-specific pre-specified criteria. The patient can reside anywhere on the planet and be monitored in real time by experts (when all goes well).

This product is interesting in that it demonstrates a closed-loop design that includes an on-body device, a network, a back office that performs analysis and an expert network that intervenes when necessary and interacts directly with the patients, recreating the effect of direct personal care despite multiplexed remote operation.

In the field of fashion and accessories Nike has developed some interesting wearable prototypes. For example, the running shoe *26+*[4] keeps track of the number of miles a runner completes and lights up a set of LEDs integrated into the shoe corresponding in number to the distance travelled. The competing brand Adidas launched the first 'smart shoe' in 2005. The *Adidas1*[5] was designed for the ultimate in fitting comfort and the first shoe to flaunt an integrated microprocessor. The minicomputer automatically adjusted (through a mechanical pulley system) the cushioning level in real time. Both products, plagued by technical defects, are no longer on the market.

Military applications of wearable systems also abound. Here the wish is to expand the abilities of the human mind for battlefield awareness through sensory-expansive perception modalities[6]

[2] Mann, S., Nolan, J., Wellman, B.. „Sousveillance: Inventing and Using Wearable Computing Devices for Data Collection in Surveillance Environments", in Surveillance & Society 1(3), 2003.
[3] www.corventis.com
[4] http://www.nike78.co.uk/michael-robinson/
[5] http://www.engadget.com/2005/03/22/adidas-1-review/
[6] The land warrior: http://dsc.discovery.com/videos/futureweapons-land-warrior.html

(night vision being a well-known common example) and group communication (local wireless and satellite networks). Military wearables also aim to expand the bodily limitations of soldiers and enable exposure to harsh environmental conditions. The newest generation of military fabrics resists mildew, ultraviolet light and offer selectively active cooling and heating. Wearable hydration systems, first developed for military applications, have trickled down into sporting goods stores.

Wearables are also well represented in art and design, ranging from systems with mostly visual aesthetic appeal to concept art. The field of *critical design*, represented amongst others by designer/researchers such as Fiona Raby and Anthony Dunne, has produced some interesting niche wearables. "Risk Watch"[7] is one such example. This wrist-watch like object reports information about current dangers (such as the political stability of the country the wearer is in) as opposed to the current time. Indeed, wearables are mature enough to allow for the old to be new again. This is the case in the work of the *SixthSense* project[8] that created a wearable gestural interface that augments the physical world with digital information (old), but does so in compelling and intuitive ways (new) by focusing on the "seam" between the two disparate domains, and finding clever ways of making the seam disappear.

Wearables have become viable media, so thoroughly that wearables can operate as a conduit through which to investigate issues not directly related to wearables. The *Eduware*[9] project (2006-2008), for example, aimed to harness the appeal of wearable design processes as a way to lure under-represented students into the technology domain. The project included a construction kit and a matching programming environment offered in a workshop environment that stressed a direct and hands-on approach to electronics. The qualitative evaluation of the project showed that even rudimentary wearable computing can be an effective way by which to begin to motivate non-technically inclined students.

Further reading:

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[7] http://exhibitions.cooperhewitt.org/Why-Design-Now/project/risk-watch-do-you-want-to-replace-the-existing-normal-series
[8] http://www.pranavmistry.com/projects/sixthsense/
[9] Katterfeldt, E., Dittert, N., Schelhowe, H., EduWear: smart textiles as ways of relating computing technology to everyday life, IDC '09 Proceedings of the 8th International Conference on Interaction Design and Children, ACM 2009.

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