New Nomads: An Exploration of Wearable Electronics by Otago

Rene Smit
Samuel Mann

Otago Polytechnic
Dunedin, New Zealand

rsmit@tekotago.ac.nz

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ABSTRACT

With predictions of the number of computers outside the traditional PC style box soon to outnumber the desktop it is appropriate that we turn our attention to understanding the development processes used in the development of new technologies such as wearable computing. Conceptual designs and technological developments are part of the process used in Otago Polytechnic's SmartApparel developments. This paper examines the development path taken and compares it to that used by other players such as Phillips and MIT.

1. INTRODUCTION

Weiser (1991 p94) stated "the most profound technologies are those that disappear". As wearable computing or "wearware" is the integration of computing power into clothing, it is such a disappearing technology. Kaku (1997) argues that one of the major uses of computing over the next 20 years may be the development of wearable computing. Billinghurst *et al.* (1998) defines wearable computer as "a computer that is subsumed into the personal space of the user, controlled by the wearer, and that is always on and always accessible". Baber (1999) points to rapid development in the field with recent conferences and journals formalising the discipline. In New Zealand wearable computing is of particular interest, straddling two target areas for innovation: ICT and creative industries.

Page (2000) describes wearable computing as a "paradigm shift". What is not clear is the extent to which such a paradigm shift requires a new development methodology. In this paper we explore the need for an appropriate development methodology for wearware.

2. CHARACTERISTICS OF WEARWARE

Bass (1997) describes the essence of wearware as being a computer embedded in clothing:

i. it may be used while the wearer is in motion;
ii. it may be used while one or both hands are free, or occupied with other tasks;
iii. it exists within the corporeal envelope of the user, i.e., it should be not merely attached to the body but becomes an integral part of the person's clothing
iv. it must allow the user to maintain control;
v. it must exhibit constancy, in the sense that it should be constantly available.

Wearware is at the forefront and convergence of many disciplines, from fashion to artificial intelligence and augmented reality (Figure 1). Page (2000) discusses the range of potential applications, he questions “for many years people have wondered what the next big interface is after Windows and mouse pads” and concludes “...the world is the coming interface”. The applications of wearware, therefore, are almost endless.

For the past decade wearable computing has been the domain of large research institutes such as Massachusetts Institute of Technology’s Media lab (MIT, Mann 1994, 1998 - no relation), Carnegie Mellon University (Germperle and Sellars 1998), Washington (Billinghurst 1998), and Birmingham University (Baber 1999). Otago Polytechnic has been actively involved in this area since 1998 with the development of Simon Sees, a head mounted reading device for the visually impaired (Mann *et al.* 1999). In recent years commercial players are becoming increasingly interested in this field. IBM has produced chip sets specifically developed for wearable computing and Philips has explored market potential (New Nomads, Eves *et al.* 2000) resulting in a partnership with Nike to develop smart apparel (Nike press release 11/5/02).

Figure 1: Conceptual designers form an integral part of a multidisciplinary team. This internet communicator is by Aaron Duncan of Otago Polytechnic

2. DEVELOPMENT PARADIGM

There is clearly much effort being placed into the development of wearware. It is timely that we turn our attention to a development process for this emerging discipline. The need for a development approach is recognized in all other endeavours, improving quality of process and product (Sallis *et al.* 1995). Abowd (2001) recognises three challenges in the attempt to push computing into the background, the design, the technology and the construction. We argue that the overriding process, that which holds Abowd’s three challenges together, is a greater challenge.

Perhaps because of its basis in technical labs, a process for the development of wearware has been slow in coming. Gemperle (1998) recognised two forms of development practice for wearware, exploratory design and task centred design. Exploratory design describes the historical precedents of wearware ‘geeks’ playing with hardware, trying to make things work. Websites abound with pictures of young men pretending to look relaxed as they model very heavy backpack computers with space helmets and wires galore. While the developments coming out this pioneering approach are useful in pushing technical boundaries, they do not provide a sound basis for useful and commercially successful personal appliances that gain a general acceptance.

3. METHODOLOGY COMPARISONS

Carnegie Mellon have been exploring wearable computing for some years. Smailagic and Siewiorek (1999) describe a user centred interdisciplinary approach. Teams of electrical engineers, mechanical engineers, computer scientists, industrial designers, and human computer interaction students work with an end-user to generate a complete prototype system during a four-month long course. The methodology is web-based and defines intermediary design products that document the evolution of the design. These products are posted on the web so that even remote designers and end-users can participate in the design activities. The design methodology proceeds through three phases: conceptual design, detailed design, and implementation. At the core of these ideas is the notion that wearable computers should seek to merge the user's information space with his or her work space.

The development at MIT (and the closely associated IBM) has been one of hardware development (eg Mann, 1994). Despite this, they have also raised many theoretical issues. An important question is the degree to which standard concepts can be transferred to the development of wearware. An aspect that has had some attention is that of human computer interface research (Abowd 2001). Do concepts transfer? are new concepts needed such as implicit HCI? (Schmidt *et al.* 2000), or perhaps as Tognazzini argued in 1993: the old set - those of magic. Clearly interface design rules such as those prescribing font size do not apply, but higher level guidelines are more robust (Norman 1989). Mann (1994) presented attributes of wearable computing. Interestingly, these may transfer back to more general computer design, but the reverse is not always true.

- ♦ Unrestrictive
- ♦ Unmonopolising of the user's attention
- ♦ Observable; the output medium is constantly perceptible by the user
- ♦ Controllable; the system should be responsive
- ♦ Attentive to the environment
- ♦ Communicative; the system should act to assist the communication of the wearer.

Baber *et al.* (1999) describe scenario based methodology for wearable computing. This approach "allow us to concentrate on user requirements rather than on technical issues, which means that our initial designs address the needs of potential users rather than the capability of available technology". They describe four stages: requirements specification (both specific and general requirements); scenario generation (context of use scenario); option reduction; and design and evaluation. End users evaluate prototypes. The actual implementation is considered a separate process.

In 1997, Philips Electronics initiated a Vision of the Future Project (Eves *et al.* 2000). They created a multi-disciplinary group bringing together philosophy, humanities and electronics to create Wearware. Eves noted "forcing together such a mix of disciplines generated a creative tension, a tension founded upon a deep-rooted cultural antagonism between engineering and design problem-solving methodologies. Managing this tension in such a way as to harness the creativity inherent in such multi-disciplinary collaboration engendered a new way for working". It is not clear whether Philips actually implemented the designs portrayed in New Nomads, at one point they describe "concept garments", they certainly look most impressive.

Otago Polytechnic recognises the dual role of exploring technology and product development. The School of Information Technology and Electrotechnology maintains an active programme of investigating new technology. Members of the school had been exploring Force Sensitive Resistors for some time (Cleary *at al.* 2001). A 'core technology' was developed that could be applied to a wide range of applications. The Smarttop project was in response to a client who wished to measure force on the rugby field (Sherriff *et al.* 2001). This was recognised as being multidisciplinary from the start and we widely sought advice and collaboration. The client wished to measure impacts on a sports field within a strict set of conditions but the solution however was not specified. We adopted a software development life cycle (SDLC) approach as it was felt that the structure imposed by such a methodology would give a framework for development.

The approach succeeded and prototypes were completed and trialled in the field. Plans are in place to fully implement the wearable system with a major sports team within a few months.

The multidisciplinary team approach used worked well except for some conflicts over process. Other team members did not understand the SDLC or our reasons for following it. Although the electrotechnology members claimed to follow an 'engineering approach' they gave pragmatics a much higher precedence than we did. They mix initial idea development with pragmatics such as 'can we get the components off the shelf?', if they can't then they refine the idea. From a software engineering background we attempted to avoid such considerations, believing that such thinking gets in the way of properly identifying the functional requirements. Our industrial design colleagues on the other hand thought that we were too ready to develop formal functional requirements. They produced many fantastic designs for the look of the system, using these (in software engineering terms) paper based prototypes to explore possibilities. The designers saw the 'how' of the wearable product as the engineers' job. Unfortunately those engineers were not impressed that we had set and adopted functional requirements before we had found out if such things were technically possible (hence some heated discussions about the effect of the human body on radio transmissions). A further conflict was with our fashion colleagues who we did not involve early enough. They describe their process as using techniques such as Harvey card techniques (working with words such as contradict, symbolise, distort etc) to get a vision then transfer that to reality though pattern making, production. We only wanted them as seamstresses - an underestimation we won't be making again!

4. CONCLUSION

Ubiquitous computing, of which wearable computing in part, is clearly a multidisciplinary discipline that is closely involved with the development and application of new technology with a human system focus. None of these characteristics, however, mean we should abandon rigorous development practices. Today, wearable computing is being recognized as an interesting research and product area by a number of commercial entities, small and large. In these developments professionals from different backgrounds are brought together, each having different approaches; a method is needed to tie those together.

This should provide an environment for the generation of new ideas and products; this should be the focus of future research.

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