Wearable Appliances; The Future of Wearable Computing

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The term "Wearable computing" brings to mind an image of a human-computer symbiote with circuitry embedded in his clothing, an electronic monocule for display and a one-handed input device. Although such systems may seem more the realm of science fiction than everyday fact, researchers have demonstrated wearable computers with these characteristics. But is this the future of wearable computing? Just as personal computing is moving away from the beige box desktop, wearable computing will also not be a general-purpose platform. As computing becomes more intimate and individual, one size will not fit all. The wearable interfaces of the future will be based on an appliance-based design whose individual components will be chosen by the user to suit their lifestyle and desired application.

Already we see the evidence of this. At a recent IEEE International Symposium on Wearable Computing (ISWC 2000), of the 350 people in attendance, only a dozen or so attendees were wearing general purpose computers, compared to the more than half who had a cell phone, PDA or similar wearable device. Further evidence is shown in the sales of traditional wearable computers. One of the market leaders, Xybernaut, sold fewer than 2,000 Windows-based wearable computers in the whole of 2001. In contrast Palm Inc, shipped around 1,000 Palm Pilots a week in its first year of sales. Both of these figures are dwarfed by cell phone sales, over a million a week in 2001 according to the Yankee Group. Clearly, while there may be a limited market for general-purpose wearable computers, there will be a far greater number of specialized wearable devices sold for the foreseeable future.

While it may be debatable that a cell phone is a wearable computer, the distinction becomes more uncertain when you consider the combination of devices that a person may be carrying, such as PDA, digital camera, cell phone, heart rate monitor and GPS receiver. These devices are chosen based on their individual attributes yet together they may provide more functionality than a general-purpose wearable machine. In addition they provide the interface customization that is difficult with a generic wearable computer, and so improve usability. Users can choose the individual device that provides the most intuitive interface for them.

In order for this type of "ad-hoc" or "distributed" wearable computer to be developed there are a number of challenges to be overcome. One of the most significant is the ability for seamless ad-hoc networking and wireless data transfer between devices. A user should be able to place various devices on their body and have them all network together to provide the distributed functionality they desire. In addition, the devices should be able to query each other to see what functionality they have for input and output, so the best interface can be assembled on the fly. For example, if the user has a PDA and cellphone, then while he is using the PDA any calls received on the phone should be shown on the bigger PDA screen. This type of networking encompasses the BlueTooth standard for ad-

hoc networking, but moves beyond it by providing interface query functionality. With this type of network capability, distributed wearable systems could be assembled out of the various consumer electronics devices the user is already familiar with.

From a distributed wearable computer it is only a short step to an appliance based wearable computer. In the first issue of Appliance Design Bill Sharpe identified the three key attributes of applianceness; "everyday things, that do one thing well, and work together". Once the ad-hoc networking standards and technology have been developed, it will be easy to develop wearable computers based on individual body worn appliances. This approach with enable a portable appliance that does one thing very well, to be incorporated into a wearable system that is capable of a wide variety of functions.

A key concept in this notion of distributed wearable computer is the realization that just like appliance design the paradigm shift of wearable computing is more about interface than hardware. Steve Mann defines a 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 [1]. In order to develop systems that are always on and always accessible there needs to be a change in the interface metaphors that are traditionally applied in human-computer interaction. Current interfaces are often based on the windows-icons-menus-pointers, or WIMP, metaphor. These interfaces have the inherent assumption that interaction with the device is the primary task. Most interfaces for appliances also share this same assumption. However wearable computers should be designed to support interaction with the real world, rather than distract the user from what is occurring around them. In order to accomplish this, wearable appliances need to be designed based on the concepts of contextual computing and communications, and ambient interfaces. For example, Rhodes advocates using ramping interface that adjust the amount of attentional awareness required to use them based on the user's availability and current perceptual load [2]. Sawhney's Nomadic Radio [3] is an excellent example of a wearable computer/appliance that dynamically changes the interface to match the user's state and enhances their interaction with the real world rather than impeding it.

Although it may seem difficult to apply an appliance based approach to wearable computing the rewards can be great. One of the most successful wearable computing applications developed is Symbol Technologies WS-1000 wrist-mounted scanner [4]. This is a wrist worn 8086 dos-based wearable computer connected to a ring-mounted bar code scanner. The device provides hands free scanning and wireless data transfer for package tracking and identification. Developed in 1996 at a cost of ten million dollars, over 30,000 systems have since been sold to customers such as UPS, Albertsons, FedEx, Wal-Mart, Office Depot, and Sainsburys. This is more than the combined sales of all of the general-purpose wearable computers ever shipped. The success of the WS-1000 was largely due to the application of applicance design principles; the focus on a single function, the integration of familiar objects into an intuitive interface, extensive user testing, and the ability to work together with other systems and applications. With application of these principles into the future wearable devices we can develop products that have similar success.

References

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[3] N. Sawhney. Contextual Awareness, Messaging and Communication in Nomadic Audio Environments. Master's thesis in Media Arts and Sciences, MIT Media Lab, 1998.

[4] Symbol Technologies Website: http://www.symbol.com/