

# WEARABLE COMPUTERS

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## ABSTRACT

*Wearable computers are essentially computers with the power of a laptop, which are small enough to fit into someone's pocket. They are equipped with display devices that are worn on the head and they are totally mobile. These computers have a long way to go before the majority of computer users switch from their PCs, but the first generations of wearable computers are already on the market. In the future these computers will be helpful supplements to our lives and they will be small enough to be integrated into our clothing without onlookers noticing them. Augmented Reality is one of the most exciting new technologies that are emerging. With this and wearable computers, users will be able to do tasks that only experts were able to do, because computers will guide them step by step. The possibilities of these future computers are exciting and limitless.*

**Keywords :** Wearable Computer, Augmented Reality, GPS Systems

## INTRODUCTION

Computers can be very demanding. They are big, bulky, and use a lot of power. How much longer are we going to have to suffer with desktop systems that get in the way? How soon will it be until we don't have to deal with all the wires? And most importantly, how soon will it be until we can use our computers wherever we are rather than just at the office or home?

Imagine hiking up a steep hill in central Texas. Without any effort of your own, a display screen puts digital Post It® notes in your field of view to show exactly what kind of plant you are brushing up against and whether or not it will irritate your skin. It also tells you which way to go to get to the top of the hill & the best route to conserve your energy. So you are not into hiking? What if you are repairing a complex printer and your personal computer is guiding you, through your field of vision, the proper way to put it back together? This might be helpful since you thought you could do it without writing the correct steps down before putting it back together. Fortunately, this will be reality rather than just a dream. Some of this technology actually already exists. Computers are going to be more than just an accessory; they could become a necessary appendage.

Computers will be part of our daily lives, much like personal assistants. The technology is available to make this happen. There are a few things that still need to transpire for this to happen. In the future it is likely that we will wear our computers rather than sit at them. My children may ask me what a keyboard and a mouse were used for, and I may have a hard time explaining these concepts to them. Clothes will be more than thin cotton coverings. They will be valuable windows into the world of information. We will put on our computers daily, and as things get smaller and more advanced it will be harder and harder to notice that someone is even wearing one.

In a sense we already wear some computers. They are not nearly as powerful as the wearable computer of the future, but they are laying the groundwork for that future technology. Personal Digital Assistants fit in a back pocket and are becoming smaller than a wallet. Phones and mobile assistants are small computers that allow us to access information and even gain access to the web. Soon we will be able to fit the power of a modern laptop in our pocket and use it wherever we go. PDA's and cell phones could be considered an early generation of wearable computers.

### DEFINITION

A wearable computer can be considered a device that can be carried on one's person without the need to be hooked up to any alternate power source or apparatus to aid in its operation. A PDA is a good example, but inadequate for any serious functionality. A cell phone can surf the web, but not much more. The wearable computers currently in existence and in the future that are good examples of this type of technology are small, powerful, and functional.

### BACKGROUND

Computers have been getting smaller and more powerful since the ENIAC. The technology to develop computers small enough to wear started to emerge around 1990. Not until recently have manufacturers actually been able to produce a computer that can be worn comfortably. Augmented Reality, which integrates reality with available information, was first developed at Boeing in 1990. Workers needed a better way to navigate the factory floor, so Tom Caudell and a colleague developed a system that allowed workers to wear computers equipped with a display device that showed them graphically what they needed to know. Though Boeing did not initially accept the implementation of this plan, they (along with IBM) are among the few U.S. firms to use experiment with this technology (2).

“For decades the military has been providing pilots, tank operators, and other fighters with advanced vision systems that overlay real-time combat information on computer-generated analytical data” (2). There are many projects by the U.S. government that have advanced this technology. While an overlay on a glass plate for a fighter pilot is not a wearable computer, it includes some of the technology that helped to develop the current wearable systems. Ditlea states that Land Warrior is a program to equip soldiers with wearable computers that will be field-testing by 2003. The army plans to equip all soldiers with this technology by 2008.

Furthermore, ‘cyborgs’ have been around since the 1990's. These are people equipped with a form of wearable computer. These people wear them all the time. Some of the computers worn by cyborgs are memory aides and are quite bulky. We also cannot forget about fashion. These big computers have all been fashion flops, which is an obstacle that needs to be overcome for this technology to achieve ultimate acceptance. Wearing a brick on your hip and big plastic goggles is not exactly in fashion.

Wearable computers are still rare. Some versions of wearable computers have existed since the early 1990's (2). It is just recently that wearable computers have become a reality rather than just science fiction. Much has been done to advance this type of computing, but much more will have to be done before it becomes part of the mainstream.

## CURRENT AND FUTURE WEARABLE COMPUTERS

The current status of wearable computers varies from rudimentary systems that can perform trivial tasks to advanced systems that actually help workers in the field. The future wearable computers will be incredible, and they may even have their own personalities. Numerous systems are under development at universities, corporate and government institutions around this nation. A few corporations have already put wearable computers into the market place. However, there are many problems that need to be worked out for them to achieve a wider amount of acceptance. Wearable computers currently use four main software technologies.

### Current Implementations

The current uses for wearable computing range from the medical field to customized climate control systems for houses. Ditlea says, "The first clinical medical experiment with augmented reality is being conducted at the University of North Carolina at Chapel Hill" (2). X-ray images are projected directly onto the patient's body in real time so that the doctor can see exactly what is happening inside the body without looking away. The image is projected from the doctor's headgear (2). This type of wearable computer is extremely valuable and is sure to see advancement in the future. Another type of wearable computer exists at the residence of Bill Gates. Visitors wear lapel buttons that signal the home's computer to the preferences the visitor desires. Living conditions such as temperature and lighting preferences can be changed to fit the occupants of the room. It can also be used to allow or deny access to areas of the house (5). Although this is not wearable computing, it is an example of what is being developed.

One of the first corporate uses of this technology can be observed in the daily business routines of workers at Bell Canada. Janick (4), a writer for *Electrical World*, states that they have "Recently completed a large-scale market trial of wearable computers with the Xybernaut Corp". They use this wearable computer to access filed information without having to walk back to the truck to use the laptop. "[Technicians] found the technology easy to use and a valuable way to improve productivity...saving nearly 50 minutes per technician per day with the new devices" (4). Utility workers from different corporations are also using this technology to navigate complex tunnels and to use computers wirelessly while underground. Wearable computers are also being tested in California to help keep the public safer from criminals. Parolees are being fitted with a small computer with a GPS system that will not only track where they are but also where and when they have been while wearing the device (3). The uses for this technology are endless, but many current problems must first be overcome.

### Problems

Many different technologies must go into a project such as this one. Numerous institutions of higher learning, as well as corporate and government entities are involved in different aspects of the present and future of wearable computing. High-tech display devices must be constructed that are practical and not bulky. Power source must be improved, and component size must be decreased down to the size and weight of mere fabric. Then there is the problem of transferring the data and power between devices. This is the future of our computing industry. Regardless of whether or not wearable computers actually come into popular

existence, this technology must be developed. Right now this technology is being applied to wearable computers. Data transfer rates that are wireless and available worldwide must be developed to economically meet the needs of a heavy user. Global positioning systems have already been developed and are being used. Second to reduction in size, is the challenge of developing software that can support information on almost every object in existence. This is no small task, but fortunately many groups are looking into solving this problem.

### **Size & Weight**

The current size and weight of computers are problematic with the success of wearable computers. As new technology emerges, devices get smaller. Nanotechnology may eventually solve this problem, but this technology is currently not applicable. Until then, all devices need to be designed to use less power, be smaller, and weigh almost nothing. One of the largest problems in reducing the size of these computers is the storage device such as the hard drive. It is difficult to make disk storage much smaller. All system devices need to shrink to a size small enough that they can be hidden.

### **Wires**

Copper and gold wiring are both heavy and cumbersome. Wireless is an option, but not, as yet, a practical one. One method that is currently being developed uses human skin to transmit data from one point to another. The data rates are not as fast as gold wire. Another problem with this technology is that devices must be constantly connected with the human skin for them to communicate with each other. This is almost impossible with human movement, and IBM has all but given up on the idea. (7).

### **Power**

Powering these devices is another major problem that must be solved. If wearable computers use no wires, then every device must have its own power source. Battery life needs to improve significantly and the weight of batteries needs to decrease dramatically. A computer's battery needs to last through a full 16-hour day of constant use, if necessary, or at least 8 hours with each user having two batteries.

### **Display**

Cumbersome displays are problems that are being solved in interesting ways. Some of the current technologies use a camera to display reality on a screen in front of the eyes. Some units have permanent displays that can only be removed by taking off the entire head unit, while others have flip down displays. Christina Wood, a writer for Popular Science, states that the next step in display units is using a low power laser to project images into the retina (7). These images would be high resolution and they would not harm the eye. Some of these problems have been worked out with current devices, but not completely solved.

## Products

There are only a few true wearable computers currently on the market. Xybernaut is one of the most common because it is small and extremely powerful. This wearable computer comes with a silver head unit with a flip down display over one eye. It has a PDA sized computer and a thumb-controlled optical mouse (6). It can be combined with many different devices to make it more powerful. The base model comes standard with a 128MHz RISC processor, 32 MB RAM, flash card slot, charger, USB port, headphone jack, lithium-ion battery, color LCD display (640x480), Windows CE, and the optical pointing device. The main computer only weights 10.9 oz. with the battery, and the entire cost is just under \$1,500 (8). Customized units can be purchased with up to a 2 GB hard drive, a 500MHz Intel Celeron processor, and 128-MB RAM. Obviously, the large storage capacity equates into a larger unit. Their base unit is called the Poma and the more advanced unit is called the Mobile Assistant V (MA V). They can be equipped with any operating system and totally customized with software or hardware. These MA V computers are the computers used by Bell Canada in our earlier example (4).

There are other products on the market such as PDA watches by Fossil and other attempts at wearable computers by Panasonic, but the Xybernaut computers are by far the most advanced. They are the only ones that are mass-produced and truly considered a wearable computer.

## Software

Many software systems are in development that will make wearable computers a reality. These programs will fight for global market share, but the first company to develop a mass-produced version will probably become the most popular. One of the software versions currently in use with wearable computers is Diminished Reality. This is not as functional as some other programs, but they all bring excitement to wearable computer users. The possibilities seem endless with systems such as Agents, Personal Awareness Assistants, and Augmented Reality.

### Diminished Reality

Steve Mann of MIT developed this software. It allows the user to replace advertisements with preselected images. This is not extremely valuable, but these types of software change our view of reality with precision. It can replace ads on billboards and busses as well as street signs with other images such as waterfalls (2).

### Agents

Wood explains that an agent is like a servant that keeps track of all your private information. It is not just a storage device for all your personal data. It uses this information to make suggestions on items that you might have an interest. It will also alert you when something conflicts with your schedule, as well as negotiate for the lowest prices for something you may desire. These software programs will be coupled with wearable computers to act like personal servants. Wood also describes how Expert Finders (EF), MIT's advanced version of an agent, will keep a catalog of each user's expertise level on different subject matter. Then if one user who is less knowledgeable about a topic needs to know information about it, the Expert Finder will talk to other EF agents and find out the information desired (7).

## Personal Awareness Assistants

Accenture Technology Labs developed a prototype that is basically a wearable information collection system. This can supplement the human memory at low levels of technicality, or it can give collective intelligence to the user that has been acquired over time by the entire group. It is a personal information system that takes into account the surroundings of the person and offers pertinent information that is useful. The current Personal Awareness Assistants in testing use the Xybernaut computers along with external devices such as GPS (1).

This device constantly records the surroundings through a camera when any recognizable action is taking place. It can be programmed to record after phrases like 'My name is...' so that the user can look back to remember his or her new acquaintance's name. In order to ensure that this not be an invasion of privacy when recording other people or conversations, Accenture has installed a red LED light that blinks when recording. When data is needed from the computer, simple questions can be asked (1). An example of data retrieval would be as easy as asking 'Who was that woman I met at dinner last Sunday?' This is mainly an information collection and retrieval device, but it is a very smart one.

## Augmented Reality (AR)

AR is one of the most exciting examples of the future of wearable computing. Ditlea simply describes Augmented Reality as an information system that effortlessly supplements reality with desired information (2). The only current AR system that can be used outdoors is a twenty-six pound unit that is impractical to wear for longer than a few minutes. Advances in technology this should decrease this size in the very near future. One of the problems with AR is that everything in reality will have to be equipped with some sort of identification. This could be a system of barcodes or radio frequency tags that will identify each device so that the computer knows what it is seeing (2). This is the sort of device that will allow users to accomplish tasks with no prior knowledge of the subject matter. They will be given step-by-step instructions and real time visuals on how to complete the task. All they will have to do is follow instructions.

Ditlea states that an AR system needs to know two things: your location, and where you are looking. Using a GPS and other equipment to determine your field of view, the AR system can superimpose information on a display unit to supplement what you are looking at with pieces of information from a global database. Researchers estimate that it will be at least two more years before a feasible wearable computer equipped with AR technology is developed (2).

This is only the beginning of the software that we might be using in the future. Hardware will have to become smaller and more powerful to allow these programs to be used in a wearable computer.

## Future Implementations

In the future, we will not connect to networks, we will be part of them and we will take them everywhere we go. As new technologies emerge, wearable computers will become commonplace. They will most likely start out as memory aides and communication devices that take the place of cell phones. Others will be advanced versions of PDAs that are interactive. They will then be full-fledged computers constantly connected to the Internet. They will also be equipped with GPS systems as well as most other devices. Instead of having a PC at work and

the house, a navigation system in the car, a PDA, and a cellular phone, each person will have a wearable computer that will be with them no matter what they are doing.

Invasion of privacy will probably be an issue as well as when and where it is proper to bring and use your computer. There is a fine line between a helpful computer and an annoying information system that never seems to let you view reality. At least for a while, we will be able to take these computers off when we get tired of them and just want to appreciate the stars for their magnificence rather than get an astronomy lesson. One day this might not be possible if ways are found to integrate the computer into the human body (and we think that personal privacy is an issue now). We may become walking computers, but for now we are just going to have to concentrate on wearing them.

## CONCLUSION

The future of computers is exciting whether wearable computers are a part of that future or not. Wearable computers present a delightful picture of what our lives may be like in the future. There will be no more bulky units to carry around and all our devices will be integrated into one unit. We will no longer sit at our computers, but rather integrate them into every facet of our lives. They will be more than just places that we can access information and perform tasks. Through the use of software such as Augmented Reality, they will become useful supplements to our lives. A wearable computer might be the digital form of vitamin C to our bodies.

Of course, for this to happen many problems must be solved. The problem of weight and size are currently the most important and difficult to overcome. With many institutions working on different aspects of these problems, we are sure to see advancements in this area soon. If you want to check out the first production versions of true wearable computers, Xybernaut.com is a great place to start. These computers are powerful, yet practical. Wearable computers are advancing rapidly, and we should see new products and prototypes appearing in the next few years.

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