Wearable Intelligent Devices
An Investigation

The Special [illegible]

"Wearable intellig[illegible]

by Munindra [illegible]

is approved in [illegible]

Guide

Examiner

special project by Munindra Nath Chakravarty 97613004 *guide* Prof. R. Poovaiah
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APPROVAL

The Special Project entitled

"Wearable Intelligent Devices-An Investigation"

by Munindra Nath Chakravarty, 97613004

is approved in the partial fulfilment of the requirement for Masters Degree in Industrial Design of IIT Bombay.

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ABSTRACT

The objective of this project was to document current research going on, in this field, analysis of WCs in terms of its functionalities, hypothesising devices for our own needs and situations and scenario building for one of the possible devices. The approach taken was to collect the related information keeping in mind the interaction of the device with a user. A tabulation of the available wearable computers has been done. Apart from this a brief history of wearable computers has also been given. To hypothesise on a device, a study of the sociological as well as psychological conditions has been done. The first concept is directly based on the augmented memory approach of the wearable computers. The second concept is an abstraction of the augmented ~~memory~~ reality approach and is woven around an Indian scenario.

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1.0 INTRODUCTION

Though we surround ourselves with external support systems indoors and out, we all venture out of our habitats and operate as nomads, independent of these systems, for some portion of each day. Our clothing is a portable environment that can regulate body temperature, afford security and privacy, and express individual identity. Our possessions inform, sustain, and entertain us, as well as provide symbolic or physical access to valued resources.
The ambiguous zone somewhere between clothing and the things people carry is where the prospect lies for portable and wearable devices that extend the human mobile nature.

1.1 WHAT ARE WEARABLE COMPUTERS?

To date, personal computers have not lived up to their name. Most machines sit on the desk and interact with their owners for only a small fraction of the day. Smaller and faster notebook computers have made mobility less of an issue, but the same staid user paradigm persists. Wearable computing hopes to shatter this myth of how a computer should be used. A person's computer should be worn, much as eyeglasses or clothing are worn, and interact with the user based on the context of the situation. With heads-up displays, unobtrusive input devices, personal wireless local area networks, and a host of other context sensing and communication tools, the wearable computer can act as an intelligent assistant, whether it be through a Remembrance Agent, augmented reality, or intellectual collectives.

Bass (1997) suggests five characteristics of a wearable computer:

- it may be used while the wearer is in motion;
- it may be used while one or both hands are free, or occupied with other tasks;
- 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
- it must allow the user to maintain control;
- it must exhibit constancy, in the sense that it should be constantly available.

1.2 AN EARLY PERCEPTION OF WEARABLE COMPUTERS

Wearable computer' is a data processing system attached to the body, with one or more output devices (typically comprising a visual display to one or both eyes that's capable in both text and graphics), where the output is perceptible constantly despite the particular task or body position, and input means (typically comprising pushbutton switches operable with one hand) where the input means allows the functionality of the data processing system (e.g. instruction set) to be modified.

In other words, there are three characteristics; the apparatus is:

1) **Wearable**: The apparatus is within the prosthetic territory of the individual. This facilitates use of the apparatus while engaged in other activities. In this way, the apparatus differs from desktop computing in the sense that computing can become a secondary activity (or task), while one or more other primary activities can be performed at the same time. Implicit here is also the notion of "personal" computing in the most extreme sense; that is, the apparatus exists within the personal space of the user, not only from the user's perspective, but also from the perspective of others. This contributes to the true power of a

long-term synergy with the apparatus in which human and computer become inextricably intertwined.
2) Observable Always (or "almost always"): The apparatus provides an output perceptible to the wearer at all (or nearly all) times. In this way, the apparatus differs from a laptop computer carried in a briefcase, as well as from a pocket calculator (even though the latter is worn, and hence meets characteristic (1) Strictly speaking the output may not "always"" be visible but is nevertheless "almost always" observable. This kind of Augmented Reality (AR) experience in which material is added to the real world is not possible with a screen that is not "almost always" observable. Moreover, with a camera system as input, such an apparatus may be used to augment, deliberately diminish, or otherwise alter the visual perception of reality. This more general framework called Mediated Reality (MR) has AR as a special case. Clearly MR, which involves "life through the screen", is not possible unless there is a screen in view constantly. Extra material inserted into the field of view may derive from the computer itself, or may derive from the computer acting as a communications mediation device. This "computer supported co-operative living" is also quite different from a telephone call, in the sense that it is not answered, but, rather, it is more like having a telephone "conversation" running constantly. Thus implicit in "almost always observability" is the notion that the system will be running constantly.
3) Controllable Anytime ("infinitely often"): The apparatus is responsive to user input at any time. Not that the user need be controlling it at all times, but that the user could control it at any time. This can be called "infinitely often controllability" to convey the spirit of one or more always-ready input modalities, even though these may be discrete-time-sampled in actual practice (e.g. limited to a finite time-sampling lattice). The general spirit of "controllable anytime" is that the time--sampling lattice is sufficiently fine as to be perceived as continuous, and that the delay between cause and effect be also sufficiently small to appear perceptually as always-ready. An example of "controllable anytime" is a system with a collection of pushbutton switches held in one hand to control the wearable computing apparatus. Such a device replaces the keyboard and mouse that we think of in the context of desktop computing, and the collection of switches is sometimes even called a keyboard. In the spirit of "Wearable" (1), this collection of switches must be arranged so that it can be let go of and stowed quickly and retrieved quickly, so that using the apparatus can become a secondary "hands free" task. For example, some of the early 1980s embodiments had Velcro on the back of the collection of switches so that it could be quickly stowed by sticking it to a Velcro patch on a jacket when not in use. Thus, to climb a ladder or rope running up the side of a building for installation of a new antenna, one can stow the collection of switches in a fraction of a second, begin climbing, and then perhaps consult material on the way up by pulling the collection of switches off momentarily. Alternatively, the switches were sometimes sewn right into the jacket, so that commands could be issued by reaching to the jacket with one hand. This always-ready characteristic is in the true existential spirit of self-determination and mastery over one's own destiny.

Constancy is both interactional and operational. Constancy of interaction implies the existence and constant accessibility of data observation and data entry means (e.g. that there be a screen over one or both eyes at all times and a keypad or the like conveniently accessible at any time). Constancy of operation implies that the apparatus will be always ready. It may have "sleep modes" but it is never "dead". Operational constancy means that the apparatus responds quickly to user-input, to, for example, make it amenable to ephemeral bursts of thought, or other activity (such as an offhand reference to a word in a dictionary, or a sudden urge to grab a snapshot picture of something seen in the last 30 seconds). In this way, it differs strongly from the laptop computer, which must be taken out, turned on, and booted up before interacting with it.

A fourth optional criterion, which is typical of many embodiments of wearable computing, is that it be multimodal. There are typically many input modalities. For example, some 1970s and early 1980s embodiments typically included cameras, and some of the 1980s embodiments included miniature wearable radar and sonar systems, together with biosensors, microphones, etc. In this way the device takes its input from both the wearer and the environment. Similarly, output modalities of many of the early embodiments included sound output, vibrotactile output, direct electrical stimulus (e.g. "electric shock" output explored beginning around 1974 to 1975), etc., in addition to the typical video (text and graphics) output.

1.3 Categories of Wearable Computers

A Personal Assistant (PA)
This defines a wearable computer, which has been designed to assist a user in achieving a task.
A Personal Enhancement (PE)
This defines a wearable computer, which has been designed to provide some kind of enhancement.

1.4 Applications of Wearables

- Augmented Memory: The Remembrance Agent
- Augmented Reality
- Desktop applications ported to wearables
- Wearable Audio Computing
- Collective Intelligence

1.5 Desirable Characteristics of a Wearable Computer

Portable while operational: The most distinguishing feature of a wearable is that it can be used while walking or otherwise moving around. This distinguishes wearables from both desktop and laptop computers.

Hands-free use: Military and industrial applications for wearables especially emphasise their hands-free aspect, and concentrate on speech input and heads-up display or voice output. Other wearables might also use chording keyboards, dials, and joysticks to minimise the tying up of a user's hands

Sensors: In addition to user-inputs, a wearable should have sensors for the physical environment. Such sensors might include wireless communications, GPS, cameras, or microphones.

"Attention-getting": A wearable should be able to convey information to its user even when not actively being used. For example, if your computer wants to let you know you have new email and whom it's from; it should be able to communicate this information to you immediately.

Always on: By default a wearable is always on and working, sensing, and acting. This is opposed to the normal use of pen-based "Personal Digital Assistants," which normally sit in one's pocket and are only woken up when a task needs to be done.[Brad Rhodes]

1.6 Physical Aspects of a Wearable Computer

The head mounted display along with the aspect of augmented reality (the seamless integration of real and virtual worlds) enables one to take the

advantage of both the real world and the virtual world at the same time.
People using a wearable computer wear it for about 16 hours a day, seven days a week.

Inputs for a wearable computer:
Text: The standard text input device is the Twiddler, a one-handed chorded keyboard and mouses combination. It allows fairly rapid typing (up to 60 words a minute) in any body position.
Video: Video input has been accomplished through a wide range of video capture devices. For still images, the Colour QuickCam has been used with a great deal of success. It also works well for low frame-rate movie.
Audio: Multiple types of microphones have been used for both speech and musical input.
Other: A very diverse set of input devices have been attached to the wearables: GPS locators, Affective sensors (blood pressure, GSR, heart beat, EMG), infrared positional beacons and probes, Digital cellular modems, Pilots & other PDAs, etc.

Outputs for a wearable computer
Display: The Private Eye, made by Reflection Technology, is our primary display, able to handle 720x280 monochrome video.
Audio: We have a SoundBlaster compatible PC104 board, and a variety of speakers.
Other: Tons of other output devices are being played with: Pilots, tactile feedback, speech, just to name a few.

Display Information
Private Eye The Private Eye, manufactured by Reflection Technology, is an LED based display that can produce a monochrome image at 720-280 resolution. It uses a vibrating mirror to create this image.

Input Information
The Twiddler, made by Handikey, is a one-handed chorded keyboard and mouse combination. It allows fairly rapid typing (up to 60 words a minute) in any body position. It takes around 5 minutes to learn the alphabet, an hour to touch type and a weekend to reach 10 words a minute. The entire keymap is completely configurable, giving the user the ability to add as little as a few extra macros to redefining the entire mapping of all the keys. The Twiddler is a chorded keyboard - that is, it uses a combination of keys pressed at the same time to produce a given string for input. There are over 4000 such combinations available, allowing for a great variety of strings to be encoded. The standard key mapping on the Twiddler includes chords for common letter combinations: 'ing', 'ed', 'the', 'ion', etc. This can be expanded to allow a simple combination of keys to return common words, your entire email address, or the URL for your web page.

In addition to the shortcuts built into the Twiddler key mapping, many good text editing programs allow for macro and abbreviation expansion. Most of the text input done on our systems is done through emacs, which supports word completion (from the first few letters of a typed word) and arbitrary length abbreviations (abb expands to abbreviation, or WHome expands to http://wearables.www.media.mit.edu/projects/wearables). Taken together, this allows one-handed typing that is fast.

1.7 Comparison of a PC and Wearable Computer

1.7.1 Components Common to PCs

- 100 MHz 486 DX4 processor
- 16MB RAM
- 2 serial, 1 parallel port
- Flash memory capable
- 2 IDE disk capability
- 1.35 GB 2.5" HD
- Clock battery backup
- Private eye heads up display

- 10 hr. battery life

1.7.2 Components Specific to Wearable Computer

Fabric: Metallic silk organza
Input devices: Twiddlers
Output devices: Head mounted display
Earphone speaker/microphone
PC104 circuit board
PC104 VGA cards
Analog I/O boards
Power supply: Standard computer clock batteries. Main batteries used are lead or lithium batteries.
Case: A tough and rugged case for holding the main unit
Software: Linux because it comes for free and drivers are available for most of the hardware.

1.8 Operational Modes of Wearable Computing

There are three operational modes in this new interaction between human and computer:
Constancy: The computer runs continuously, and is "always ready" to interact with the user. Unlike a hand-held device, laptop computer, or PDA, it does not need to be opened up and turned on prior to use. The signal flow from human to computer, and computer to human, runs continuously to provide a constant user-interface.
Augmentation: Traditional computing paradigms are based on the notion that computing is the primary task. Wearable computing, however, is based on the notion that computing is NOT the primary task. The assumption of wearable computing is that the user will be doing something else at the same time as doing the computing. Thus the computer should serve to augment the intellect, or augment the senses.
Mediation: Unlike hand held devices, laptop computers, and PDAs, the wearable computer can encapsulate the user. It doesn't necessarily need to completely enclose the user, but the concept allows for a greater degree of encapsulation than traditional portable computers. There are following aspects to this encapsulation:

Solitude: It can function as an information filter, and allow the user to block out material he might not wish to experience, whether it be offensive advertising, or simply a desire to replace existing media with different media.
In less severe manifestations, it may simply allow us to alter our perception of reality in a very mild sort of way.

Privacy: Mediation allows us to block or modify information leaving our encapsulated space. In the same way that ordinary clothing prevents others from seeing naked bodies, the wearable computer may, for example, serve as an intermediary for interacting with untrusted systems, such as third party digital anonymous cash "cyberwallets". In the same way that martial artists, especially stick fighters, wear a long black robe that comes right down to the ground, in order to hide the placement of their feet from their opponent, wearable computing can also be used to clothe the user's otherwise transparent movements in cyberspace. Although other technologies, like desktop computers, can help the user protect his privacy with programs like Pretty Good Privacy (PGP), the Achilles' tendon of these systems is the space between the user and them. It is generally far easier for an attacker to compromise the link between the user and the computer (perhaps through a so-called Trojan horse or other planted virus) than it is to compromise the link between wearable computer and other computers. Thus wearable computing can be used to create a new level of personal privacy because it can be made much more personal, e.g. so that it is always worn, except perhaps during showering, and therefore less likely to fall prey to covert attacks upon the hardware itself.
Moreover, the close synergy between the human and computers makes it harder to attack directly,

e.g. as one might peek over a person's shoulder while they are typing, or hide a video camera in the ceiling above their keyboard. Furthermore, the wearable computer can take the form of undergarments that are encapsulated in an outer covering or outerwear of fine conductive fabric to protect from an attacker looking at radio frequency emissions. The actual communications between the wearer and other computers (and thus other people) can be done by way of outer garments, which contain conformal antennas, or the like, and convey an encrypted bitstream.

Because of its ability to encapsulate, e.g. in embodiments of wearable computing that are actually articles of clothing in direct contact with the body, it may also be able to make measurements of various physiological quantities.

The six attributes (six signal paths) of wearable computing

There are six informational flow paths associated with this new human--machine synergy. These signal flow paths are, in fact, attributes of wearable computing, and are described, in what follows, from the human's point of view. Two additional attributes follow from these six, and are also associated with wearable computing. The six attributes of wearable computing are as follows:

1. ***Unrestrictive to the user***: ambulatory, mobile, roving, "you can do other things while using it", e.g. you can type while jogging, etc.

2. ***Unmonopolizing of the user's attention:*** it does not cut the user off from the outside world like a virtual reality game or the like. The user can attend to other matters while using the apparatus. It is built with the assumption that computing will be a secondary activity, rather than a primary focus of attention. In fact, ideally, it will provide enhanced sensory capabilities. It may, however, mediate (augment, alter, or deliberately diminish) the sensory capabilities.

3. ***Observable by the user***: It can get the user's attention continuously if he wants it to.

Almost-always-observable: within reasonable limitations (e.g. that the user might not see the screen while he blinks or look away momentarily) the output medium is constantly perceptible by the wearer.

4. ***Controllable by the user***: Responsive. The user can grab control of it at any time he wishes. Even in automated processes the user can manually override to break open the control loop and become part of the loop at any time he wants to.

Infinitely-often-controllable: the constancy of user-interface results from almost-always observability and infinitely-often controllability in the sense that there is always a potential for manual override which need not be always exercised.

5. ***Attentive to the environment:*** Environmentally aware, multimodal, multisensory. (As a result this ultimately gives the user increased situational awareness).

6. ***Communicative to others:*** Can be used as a communications medium when the user wants it to.

Expressive: allows the wearer to be expressive through the medium, whether as a direct communications medium to others or as means of assisting the production of expressive media (artistic or otherwise).

The additional properties that follow from the above are:

Constant: Always ready. May have "sleep modes" but never ``dead". Unlike a laptop computer which must be opened up, switched on, and booted up before use, it is always on and always running.

Personal: Human and computer are inextricably intertwined.

Prosthetic: One can adapt to it so that it acts as a true extension of mind and body; after time he forget that he is wearing it.

Assertive: Can have barrier to prohibition or to requests by others for removal during times when one wishes such a barrier. This is in contrast to laptop computer in briefcase or bag that could be separated from one by a "please leave all bags and

briefcases at the counter" policy of a department store, library, or similar establishment.
Private: Others can't observe or control it unless you let them. Others can't determine system status unless one wants them to. E.g. clerk at refund counter in department store where photography is prohibited can't tell whether or not one is transmitting wireless video to a spouse for remote advice, in contrast to camcorder technology where it is obvious
Note that a computer mediation device with sufficient bandwidth can synthesise or even heighten the augmentational aspects.
For example a sufficiently ATTENTIVE computer can sustain a sufficient illusion of being UNMONOPOLIZING that it could encapsulate the user and still provide the same experience as system running in the augmentational mode of operation. Similarly, a sufficiently COMMUNICATIVE machine, especially if ``machine" is broadened to include mechanical mediation devices such as motorised exoskeletons, can synthesise the UNRESTRICTIVE attribute.

1.9 Aspects of wearable computing and personal empowerment

There are several aspects and affordances of wearable computing. These are:
Photographic memory: Perfect recall of previously collected information.

Shared memory: In a collective sense, two or more individuals may share in their collective consciousness, so that one may have a recall of information that one need not have experienced personally.
Connected collective humanistic intelligence: In a collective sense, two or more individuals may collaborate while one or more of them are doing another primary task.
Personal safety: In contrast to a centralised surveillance network built into the architecture of the city, a personal safety system is built into the architecture (clothing) of the individual.
Tetherless operation: Wearable computing affords and requires mobility, and the freedom from the need to be connected by wire to an electrical outlet, or communications line.
Synergy: Rather than attempting to emulate human intelligence in the computer, as is a common goal of research in Artificial Intelligence (AI), the goal of wearable computing is to produce a synergistic combination of human and machine, in which the human performs tasks that it is better at, while the computer performs tasks that it is better at.

Over an extended period of time, the wearable computer begins to function as a true extension of the mind and body, and no longer feels as if it is a separate entity. In fact, the user will often adapt to the apparatus to such a degree, that when taking it off, its absence will feel uncomfortable, in the same way that we adapt to shoes and clothing to such a degree that being without them most of us would feel extremely uncomfortable whether in a public setting, or in an environment in which we have come to be accustomed to the protection that shoes and clothing provide. This intimate and constant bonding is such that the combined capabilities of the resulting synergistic whole far exceed the sum of either. Synergy, in which the human being and computer become elements of each other's feedback loop, is often called Humanistic Intelligence (HI).
Quality of life: Wearable computing is capable of enhancing day--to--day experiences, not just in the workplace, but in all facets of daily life. It has the capability to enhance the quality of life for many people.

1.10 A Brief History of Wearables

Foundations (F): Thinkers, innovations, and experiments that helped pave the way for wearable computers.
Complete Systems (C): Complete wearable computers (general or special purpose)

1268 (F) Earliest recorded mention of eyeglasses
Roger Bacon made the first recorded comment on the use of lenses for optical purposes. However, by that time reading glasses made out of transparent quartz or beryl were already in use in both China and Europe.
1665 (F) Robert Hooke calls for augmented senses
Micrographia preface 1665: "The next care to be taken, in respect of the Senses, is a supplying of their infirmities with Instruments, and as it were, the adding of artificial Organs to the natural... and as Glasses have highly promoted our seeing, so 'tis not improbable, but that there may be found many mechanical inventions to improve our other senses of hearing, smelling, tasting, and touching."
1762 (F) John Harrison invents the pocket-watch
Harrison invented the first practical marine chronometer; a highly accurate and reliable clock needed to determine the longitude of a ship.
1907 (F) Aviator Alberto Santos-Dumont commissions the creation of the first wristwatch
Alberto Santos-Dumont, one of the early experimenters in heavier-than-air flying machines, commissioned the famous jeweller Louis Cartier to manufacture a small timepiece with a wristband to his specifications. The wristwatch allowed him to keep his hands free for piloting.
1945 (F) Vannevar Bush proposes the idea of a "memex" in his article "As We May Think" [MIT]
While Bush thought the memex would be desk-sized rather than wearable, it is an early mention of the augmented memory. "Consider a future device for individual use, which is a sort of mechanised private file and library. It needs a name, and to coin one at random, "memex" will do. A memex is a device in which an individual stores all his books, records, and communications, and which is mechanised so that it may be consulted with exceeding speed and flexibility. It is an enlarged intimate supplement to his memory."
1960 (F) Heilig patents the Sensorama, a Head-Mounted Display (HMD) with olfactory output
The Sensorama was designed to provide the ultimate cinema experience. The system included handlebars, binocular display, vibrating seat, stereophonic speakers, cold air blower, and a device close to the nose that would generate odours that fit the action in the film.
1960 (F) Manfred Clynes coins the word "Cyborg"
Manfred Clynes and co-author Nathan Kline first coined the phrase "Cyborg" in a story called "Cyborgs and Space" published in Astronautics (September 1960). The term was used to describe a human being augmented with technological "attachments". The story has since been reprinted in "The Cyborg Handbook" edited by Chris Hables Gray.
1966 (C) Ed Thorp and Claude Shannon reveal their invention of the first wearable computer, used to predict roulette wheels [MIT]
The system was a cigarette-pack-sized analog computer with 4 push buttons. A data-taker would use the buttons to indicate the speed of the roulette wheel, and the computer would then send tones via radio to a bettor's hearing aid. Though the system was invented in 1961, it was first mentioned in E. Thorp, Beat the Dealer, revised ed. in 1966. The details of the system were later published in Review of the International Statistical Institute, V. 37:3, 1969. Thorp also disclosed a similar system for beating the Wheel of Fortune gambling game in LIFE Magazine, March 27, 1964, pp. 80-91.
1966 (F) Sutherland creates first computer-based head-mounted display [MIT]

Sutherland created a tethered HMD using two CRTs mounted beside each of a wearer's ears, with half-silvered mirrors reflecting the images to the user's eyes. Another system determined where the user was looking and projected a monoscopic wireframe image such that it looked like a cube was floating in mid-air. The bulk of the system was attached to the ceiling above the wearer's head, earning the system the nickname "Sword of Damocles." See
http://www.sun.com/960710/feature3/alice.html

1967 (F) Bell Helicopter experiments with HMDs with input from servo-controlled cameras [Bell Helicopter]

Bell Helicopter Company performed several early camera-based augmented-reality systems. In one, the head-mounted display was coupled with an infrared camera that would give military helicopter pilots the ability to land at night in rough terrain. An infrared camera, which moved as the pilot's head moved, was mounted on the bottom of a helicopter. The pilot's field of view was that of the camera. See
http://www.sun.com/960710/feature3/alice.html

1967 (C) Hubert Upton invents analogue wearable computer with eyeglass-mounted display to aid lip-reading [Bell Helicopter]

Hubert Upton designed an analogue wearable computer as an aid for lip-reading. Using high and low-pass filters, the system would determine if a spoken phoneme was a fricative, stop, voiced-fricative, voiced stop, or simply voiced. An LED mounted on ordinary eyeglasses illuminated to indicate the phoneme type. The LEDs were positioned to enable a simple form of augmented reality; for example, when a phoneme was voiced the LED at the bottom of the glass illuminated, making it seem as if the speaker's throat was glowing. The work was presented at the Conference on Speech-Analysing Aids for the Deaf, June 14-17, 1967, and was subsequently published in Upton, H, "Wearable Eyeglass Speechreading Aid," American Annals of the Deaf, V113, 2 March 1968, pp. 222-229.

1968 (F) Douglas Engelbart demonstrates one-handed chording keyboard in NLS (oN Line System) [SRI]

At the Fall Joint Computer Conference, Dec 8, 1968, Engelbart demonstrated the NLS system, one of the first personal computer that paved the way for both the interactive personal computer and GroupWare. The system included one-handed keyboard, word processing, outline processing, split windows, hypermedia, mouse, shared documents, e-mail filtering, desktop conferencing, annotation of shared documents, interactive sharing, quarter sized video sharing, turn taking, and network information.

1972 (C) Alan Lewis invents a digital camera-case computer to predict roulette wheels [Cal Tech]

Like Thorp and Shannon's system, Lewis used a radio link between data taker and bettor. The data-taker used the computer to predict the roulette wheel, then whispered the prediction via radio link to the bettor's hearing-aid radio-receiver.

1977 (C) CC Collins develops wearable camera-to-tactile vest for the blind [Smith-Kettlewell]

The result of ten years research, C.C. Collins of the Smith-Kettlewell Institute of Visual Sciences developed a five pound wearable with a head-mounted camera that converted images into a 1024-point, 10" square tactile grid on a vest. The system was tested as a visual prosthetic for the blind. See "Mobile Studies with a Tactile Imaging Device," C.C. Collins, L.A. Scadden, and A.B. Alden, Fourth Conference on Systems & Devices For The Disabled, June 1-3, 1977, Seattle WA.

1978 (C) Eudaemonic Enterprises invents a digital wearable computer in a shoe to predict roulette wheels [Eudaemonic Enterprises]

Using a CMOS 6502 microprocessor with 5K RAM, Eudaemonic Enterprises (Doyne Farmer, Norman Packard, and others) created a shoe computer with toe-control and inductive radio communications with between a data taker and better. This is the only known roulette machine of the time to show a statistical profit on a gambling run, though they never made the "big score." See The Eudaemonic Pie, Thomas A. Bass, Houghton Mifflin Company, 1985.

1979 (F) Sony introduces the Walkman [Sony]

Sony introduces the Walkman, a commercial wearable cassette player. Later products would include Music CD-players.

1980 (F) Upton and Goodman file for patent on LED raster display [Textron, Inc]

Hubert Upton and James Goodman filed for a patent on a "vibratory scan optical display" where fibre-optical elements were driven by LEDs and scanned with an "electromechanical exciter." The patent was granted in 1982, patent number 311999.

1980 (C) Steve Mann designs backpack-mounted Apple-II computer to control photographic equipment

While still in high-school Steve Mann wired an Apple-II computer (placed in a steel-frame backpack) to control flash bulbs, cameras, and other photographic systems. The display was a camera viewfinder CRT attached to a helmet, giving 40-column text. Input was from seven microswitches built into the handle of a flash lamp, and lead-acid batteries powered the entire system (including flash lamps).

1983 (C) Taft commercialises toe-operated computers based on Z-80's for counting cards

At least by 1983, Keith Taft was selling Z-80 based shoe-computers with special software for card counting in blackjack. See The Eudaemonic Pie, Thomas A. Bass, Houghton Mifflin Company, 1985.

1984 (F) William Gibson writes Neuromancer

This book founded the genre of Cyberpunk, the dystopian future in which humans are augmented with computer implants.

1986 (C) Steve Roberts builds Winnebiko II, a recumbent bicycle with on-board computer and chording keyboard

Winnebiko II was the first of Steve Roberts' forays into nomadic computing that allowed him to type while riding. It included a packet data communication system for email via ham radio, an off-line HP laptop, chording keyboard for typing while riding, and 20 watts of solar panels. The bike was later replaced by BEHEMOTH (Big Electronic Human-Energised Machine... Only Too Heavy), a more sophisticated system that included a heads up display. See *http://www.microship.com/*

1987 (F) The movie Terminator is released

Of special note are the scenes from the point-of-view of the Terminator Cyborg, with text and graphical information overlayed on top of the real world.

1989 (F) Private Eye head-mounted display sold by Reflection Technology [Reflection Tech]

The display (designated the "P4") is a 720 x 280 pixel monochrome (red) monitor in a 3.5" X 1.5" X 1.25" package. Screen size is 1.25" on the diagonal, but the image appears to be a 15" display at 18" away. See *http://www.reflection.com/*

1990 (C) Gerald Maguire and John Ioannidis demonstrate the Student Electronic Notebook, with Private Eye and mobile IP [Columbia]

The IBM/Columbia Student Electronic Notebook Project used Toshiba diskless AIX notebook computers (prototypes) using direct sequence spread spectrum radio links to provide, the providing all the usual TCP/IP based services, NFS mounted file systems, X windows and a stylus based input systems + virtual keyboard, and running the Andrew environment. The work was first shown at the DARPA Workshop on Personal Computer Systems, Washington, D.C., 18 January 1990, and first published in J. Peter Bade, G.Q. Maguire Jr., and David F. Bantz, The IBM/Columbia Student Electronic Notebook Project, IBM, T. J. Watson Research Lab., Yorktown Heights, NY, 29 June 1990

1991 (C) Doug Platt debuts his 286-based "Hip-PC" [Select Tech]

Doug Platt's system was a shoebox-sized computer based on the Ampro "Little Board" XT module. The screen was a Reflection Technology Private Eye display and the keyboard was an Agenda palmtop used as a chording keyboard attached to the belt. It included a 1.44 megabyte floppy drive. Later versions incorporated additional equipment from Park Engineering. The system debuted at "The Lap and Palmtop Expo" on April 16th, 1991.

1991 (C) CMU team develops VuMan 1 for viewing and browsing blueprint data [CMU]

Students in a Summer-term course at Carnegie Mellon's Engineering Design Research Centre developed the VuMan 1, a wearable computer for viewing house blueprints. Input was through a three-button unit worn on the belt, and output was through Reflection Tech's Private Eye. The CPU was an 8 MHz 80188 processor with 0.5 MB ROM. See *http://www.cs.cmu.edu/afs/cs.cmu.edu/project/vuman/www/home.html*

1991 (F) Mark Weiser proposes idea of Ubiquitous Computing in Scientific American [Xerox PARC]

Ubiquitous Computing proposes a world in which most everyday objects have computational devices embedded in them. Weiser's Landmark article, The Computer for the 21st Century appeared the September 1991 issue of Scientific American, pp 66-75.

1991 (F) Olivetti develops an active badge system, using infrared signals to communicate a person's location [Olivetti]

Olivetti developed a name badge that transmitted a unique id to IR receivers placed in rooms around a building. This allowed these "smart rooms" to track a person's location and log it in a central database. The badges measured 55x55x7mm, weighed 40g, and could be made extremely cheaply. See *ftp://ftp.orl.co.uk:/pub/docs/ORL/tr.90.2.ps.Z*

1993 (C) Thad Starner starts constantly wearing his computer, based on Doug Platt's design [MIT]

Starner had attempted previous wearables based on both a TRS-80 model 100 and a SPARC Workstation, but never got them working reliably. When he heard Doug Platt give a talk at the MIT Media Lab he shifted over to Platt's system based on a 286 chip. In June '93, Platt and Starner custom made Starner's first working system with parts from a kit made by Park Enterprises, a Private Eye display, and the Twiddler chording keyboard made by Handykey. Many iterations later this system became the MIT "Tin Lizzy" wearable computer design. See *http://wearables.www.media.mit.edu/projects/wearables/lizzy/*

1993 (C) BBN finishes the Pathfinder system, a wearable computer with GPS and radiation detection system [BBN]

BBN's Pathfinder system was completed in Fall 1993, and included a wearable computer, Global Positioning System (GPS), and radiation detection system.

1993 (F) Thad Starner writes first version of the Remembrance Agent augmented memory software [MIT]

The Remembrance Agent (RA) was an automated associative memory that would recommend relevant files from a database, based on whatever notes were currently being written on a wearable computer. The system was integrated into Emacs, and later was rewritten as part of continuing research by Bradley Rhodes. See *http://www.media.mit.edu/~rhodes/Papers/remembrance.html*

1993 (F) Feiner, MacIntyre, and Seligmann develop the KARMA augmented reality system [Columbia]

Steve Feiner, Blair MacIntyre, and Dorée Seligmann at Columbia University developed KARMA: Knowledge-based Augmented Reality for Maintenance Assistance. Users would wear a Private Eye display over one eye, giving an overlay effect when the real world was viewed with both eyes open. KARMA would overlay wireframe schematics and maintenance instructions on top of whatever was being repaired. For example, graphical wireframes on top of a laser printer would explain how to change the paper tray. The system used sensors attached to objects in the physical world to determine their locations, and the entire system ran tethered from a desktop computer. See *http://www.cs.columbia.edu/graphics/projects/karma/karma.html*

1994 (C) Mik Lamming and Mike Flynn develop "Forget-Me-Not," a continuous personal recording system [Xerox EuroPARC]

The Forget-Me-Not was a wearable device that would record interactions with people and devices and store this information in a database for later query. It interacted via wireless transmitters in rooms and with equipment in the area to remember who was there, who was being talked to on the telephone, and what objects were in the room, allowing queries like "Who came by my office while I was on the phone to Mark?"

1994 (C) Edgar Matias debuts a "wrist computer" with half-QWERTY keyboard [UofT]

Built by Edgar Matias and Mike Ruicci of the University of Toronto, this "wrist computer" presented an alternative approach to the emerging HUD + chord keyboard wearable. The system was built from a modified HP 95LX palmtop computer and a Half-QWERTY one-handed keyboard. With the keyboard and display modules strapped to the operator's forearms, text could be entered by bringing the wrists together and typing. The system debuted at the CHI-94 conference in Boston, and is now slated for commercialisation by LG Electronics (Goldstar). See *http://www.dgp.toronto.edu/people/ematias/papers/chi96* The same technology was used by IBM researchers to create a "belt computer" -- see: *http://www.almaden.ibm.com/cs/user/inddes/halfkb.html*

1994 (F) DARPA starts Smart Modules Program

DARPA starts Smart Modules Program to develop a modular, humionic approach to wearable and carryable computers. Develops a variety of products including computers, radios, navigation systems, human-computer interfaces, etc. that have both military and commercial use. See *http://web-ext2.darpa.mil/ETO/SmartMod/index.html*

1994 (F) Steve Mann starts transmitting images from a head-mounted camera to the Web [MIT]

In December 1994, Steve Mann developed the "Wearable Wireless Webcam." Webcam transmitted images point-to-point from a head-mounted analog camera to an SGI base station via amateur TV frequencies. The images were processed by the base station and displayed on a webpage in near real-time. (The system was later extended to transmit processed video back from the base station to a heads-up display and was used in augmented reality experiments performed with Thad Starner.)

1996 (F) DARPA sponsors "Wearables in 2005" workshop

This July, 1996 workshop brought together industrial, university and military visionaries to work on the common theme of delivering computing to the individual.

1996 (F) Boeing hosts wearables conference in Seattle

Boeing hosted a small conference on wearable computing August 19-21, 1996. In attendance were researchers and administrators from industry, academia, and independent laboratories. Several vendors of displays, speech recognition systems, and full wearable computers were also present. There were 204 people registered for the event.

1997 (F) Creapôle Ecole de Création and Alex Pentland produce Smart Clothes Fashion Show

The fashion show was a design collaboration between the students and faculty of Creapôle Ecole de Création (Paris) and Prof. Alex Pentland (M.I.T., Boston), with the goal of envisioning the impending marriage of fashion and wearable computers. Beginning in April 1996, designs were iterated and clothes produced, with the final runway fashion show was held at the Pompidou Centre in Paris in February 1997.

1997 (F) CMU, MIT, and Georgia Tech co-host the first IEEE International Symposium on Wearables Computers

CMU, MIT, and Georgia Tech co-hosted the IEEE International Symposium on Wearables Computers in Cambridge, MA October 13-14, 1997. The symposium was a full academic conference with published proceedings and papers ranging from sensors and new hardware to new applications for wearable computers. There were 382 people registered for this event. See *http://iswc.gatech.edu/wearcon97/default.html*

2.0 Classification of Wearable Computers

Involvement of the body (Senses)	Kind of Device	Function	Remarks
1. Body	T-shirt (*Sensate Liner*)	Monitoring the health of soldiers, rescuers, the elderly and others who are medically vulnerable.	• Optical Communication Fibres • Pager-size processor
2. Hand	Pen Computer	Personal Digital Assistants	• Phoenix 2 Pen Computer
3. Fingers	Java ring	Personal information, electronic cash, driver's licence, storing URLs, opening locked doors for authorised personnel.	• 6kB RAM of information coded on the ring
4. Speech	Speech activated Wearable Computer	Applications for rugged environments, often where the worker needs to be mobile. Provide hands-free mobility for military, educational and industrial applications.	• Phoenix engine for speech recognition • Speaker independent and supports continuous speech and a large active vocabulary. • The Phonetic Engine performs well in noisy environments. • Its architecture is modular and can be ported to new platforms.
5. Wrist *(Seiko)*	Wristwatch computer	Can be used alone, but due to the small size of their keyboard buttons, the maker envisions them being used primarily together with a regular personal computer. Can be used to store addresses and schedules. Users can even transfer e-mails between the watch and a PC.	• A user first logs onto the manufacturer's homepage to download application software for the watch directly into the PC. • Uses a special adapter to connect and transfer data from the PC to the watch • Features 128 kilobytes of memory

			• Can be expanded with flash memory cards
6. Head (IBM Japan)	Headset display with palm size main module fitting in pocket	For businesspersons, who can use it to access e-mail and surf the Internet on the train to work or during business trips. Still looking for more specific uses for the product.	• Data entry is performed by voicing commands into a microphone that is built into the hand-held control device. • The screen, a thumb-sized, transparent, liquid-crystal display, is attached to a headset that holds it in front of the eye. Data is reflected in the display, just like a prompter used for speeches or news broadcasts. • The whole device--main module, headset, controller, and cables--weighs in at around 450 grams (1 pound), significantly lighter than even the smallest notebook computers, which weigh about one kilogram (2.2 pounds). The maker claims that the display unit should not be distracting to the user.
7. EPSS (Georgia Tech.)	Head mounted display with waist mounted electronic, battery pack	For monitoring the machines in a food processing industry	• Hands free operation by the workers

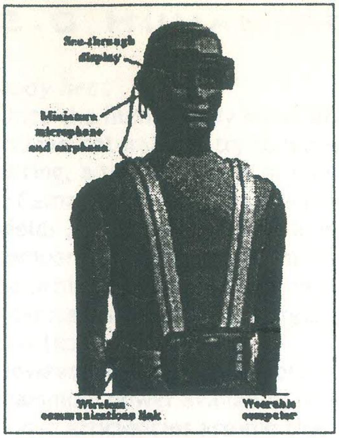


Figure 1: Model of a Wearable Device

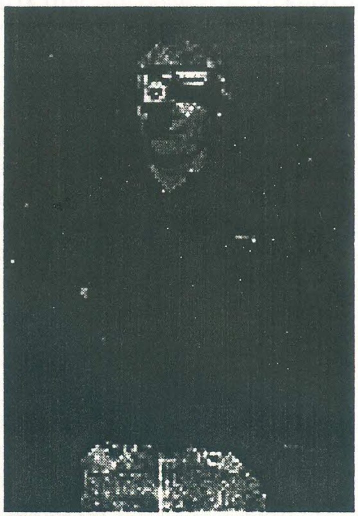
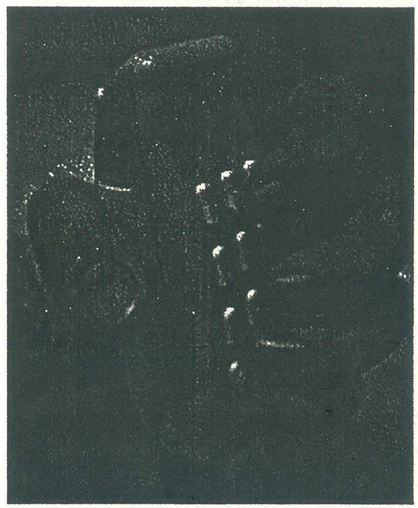


Figure 3: Actual Wearble Device

Figure 2: Java-ring

Figure 4: Twiddler



3.0 Human-Powered Wearable Computers

Body heat
Since the human body eliminates energy as heat, it follows naturally to try to harness this energy. For sitting, a total of 116 W of power is available. Using a Carnot engine to model the recoverable energy yields 3.7-6.4 W of power. In more extreme temperature differences, higher efficiencies may be achieved, but robbing the user of heat in adverse environmental temperatures is not practical.
However, due to various losses of the body, the maximum power available, drops to 2.8-4.8 W. The above efficiencies assume that all of the heat radiated by the body is captured and perfectly transformed into power.
The neck offers a good location for a tight seal, access to major centres of blood flow, and easy removal by the user. The neck is approximately 1/15 of the surface area of the "core" region (those parts that the body tries to keep warm at all times). As a rough estimate, assuming even heat dissipation over the body, a maximum of 0.20-0.32 W could be recovered conveniently by such a neck brace. The head may also be a convenient heat source for some applications where protective hoods are already in place. The surface area of the head is approximately three times that of the neck and could provide 0.60-0.96 W of power given optimal conversion. Even so, the practicality, comfort, and efficacy of such a system are relatively limited.

Breath
An average person of 68 kg has an approximate air intake rate of 30 litres per minute. However, available breath pressure is only 2 percent above atmospheric pressure. Increasing the effort required for intake of breath might have adverse physiological effects, so only exhalation is considered for generation of energy.
During sleep the breathing rate, and therefore the available power, may drop in half, whereas increased activity increases the breathing rate. Harnessing the energy from breathing involves breath masks that encumber the user.
Another way to generate power from breathing is to fasten a tight band around the chest of the user. There is a 2.5 centimetre (cm) change in chest circumference when breathing normally and up to a 5-cm change when breathing deeply. A large amount of force can be maintained over this interval. Assuming a respiration rate of 10 breaths per minute and an ambitious 100 N force applied over the maximal 0.05-m distance, power can be generated. The resulting 0.42 W is a relatively small amount of power for the inconvenience.

Blood pressure
Assuming an average blood pressure of 100 mm of Hg (mercury) (normal desired blood pressure is 120/80 above atmospheric pressure), a resting heart rate of 60 beats per minute, and a heart stroke volume of 70 millilitres (ml) passing through the aorta per beat, then sufficient power can be generated. Although the energy rate can easily double when running, harnessing this power is difficult. Even if 2 percent of this power is harnessed, low-power microprocessors and sensors could run.

Upper limb motion
Studies done by Braune and Fischer at the turn of the century show that for a particular 58.7 kg man, the lower arm plus hand masses 1.4 kg, the upper arm 1.8 kg, and the whole arm 3.2 kg. The distance through which the centre of mass of the lower arm moves for a full biceps curl is 0.335 m, and raising the arm fully over the head moves the centre of mass of the whole arm 0.725 m. Empirically, biceps curls can be performed at a maximum rate of 2

curls/sec, and lifting the arms above the head can be performed at 1.3 lifts/sec.
These calculations do show that there is plenty of energy to be recovered from an active user. The user might make one arm gesture every two seconds. This generates a total of 3 W of power. By doubling the normal load on the user's arms and mounting a pulley system on the belt, 1.5 W might be recovered.
The energy generation system, the CPU, and the interface devices could be incorporated into the jacket. Thus, the user would simply don the jacket to use his or her computer.

Walking
Using the legs is one of the most energy-consuming activities the human body performs. In fact, a 68-kg man walking at 3.5 mph, or 2 steps per second, uses 280 kcal/hr or 324 W of power. While walking, the traveller puts up to 30 percent more force on the balls of his feet than that provided by body weight. However, calculating the power that can be generated by simply using the fall of the heel through 5-cm (the approximate vertical distance that a heel travels in the human gait) reveals that enough power is available.

Piezoelectric materials. Piezoelectric materials create electrical charge when mechanically stressed. Common industrial piezoelectric materials: polyvinylidene fluoride (PVDF) and lead zirconate titanate (PZT).
The most efficient energy conversion comes from compressing PZT (d33). Even so, the amount of effective power that could be transferred in this way is minimal. Since energy is defined as force through distance, the effective energy generated through human-powered compression of PZT would be vanishingly small, even with perfect conversion. In contrast, bending a piece of piezoelectric material is much easier. Because it is brittle, PZT does not have much range of motion in this direction.

Thus, PZT is unsuitable for jacket design or applications where flexibility is necessary.

PVDF, in contrast, is very flexible. In addition, it is easy to handle and shape exhibits good stability over time, and does not depolarize when subjected to very high alternating fields. The cost, however, PVDF is significantly lower than that for PZT. A 116-cm^2 40-ply triangular plate with a centre metal shim deflected 5 cm by 68 kg three times every 5 seconds results in the generation of 1.5 W of power.

Piezoelectric shoe inserts. The natural flexing of the shoe when walking provides the necessary deflection for generating power from the piezoelectric pile. PVDF is easy to cut into an appropriate shape and is very durable. In fact, PVDF might be used as a direct replacement for normal shoe stiffeners. Thus, the inserts could be easily put into shoes without moving parts or seriously redesigning the shoe.

Air resistance A final potential method of generating power is to harness air drag while the user is walking. At a run of 6 miles per hour (mph), only 3 percent of the expended energy (10^3 W) are performed against air resistance. Although 30 W of power is a significant amount, little of this energy could be harnessed without severely encumbering the user. At more reasonable walking speeds, the available power declines sharply. Thus, it seems pointless to pursue a hard-to-recover energy source that can only yield 3 percent of the user's total energy when leg motion may consume over 50 percent of the total energy during the same activity.

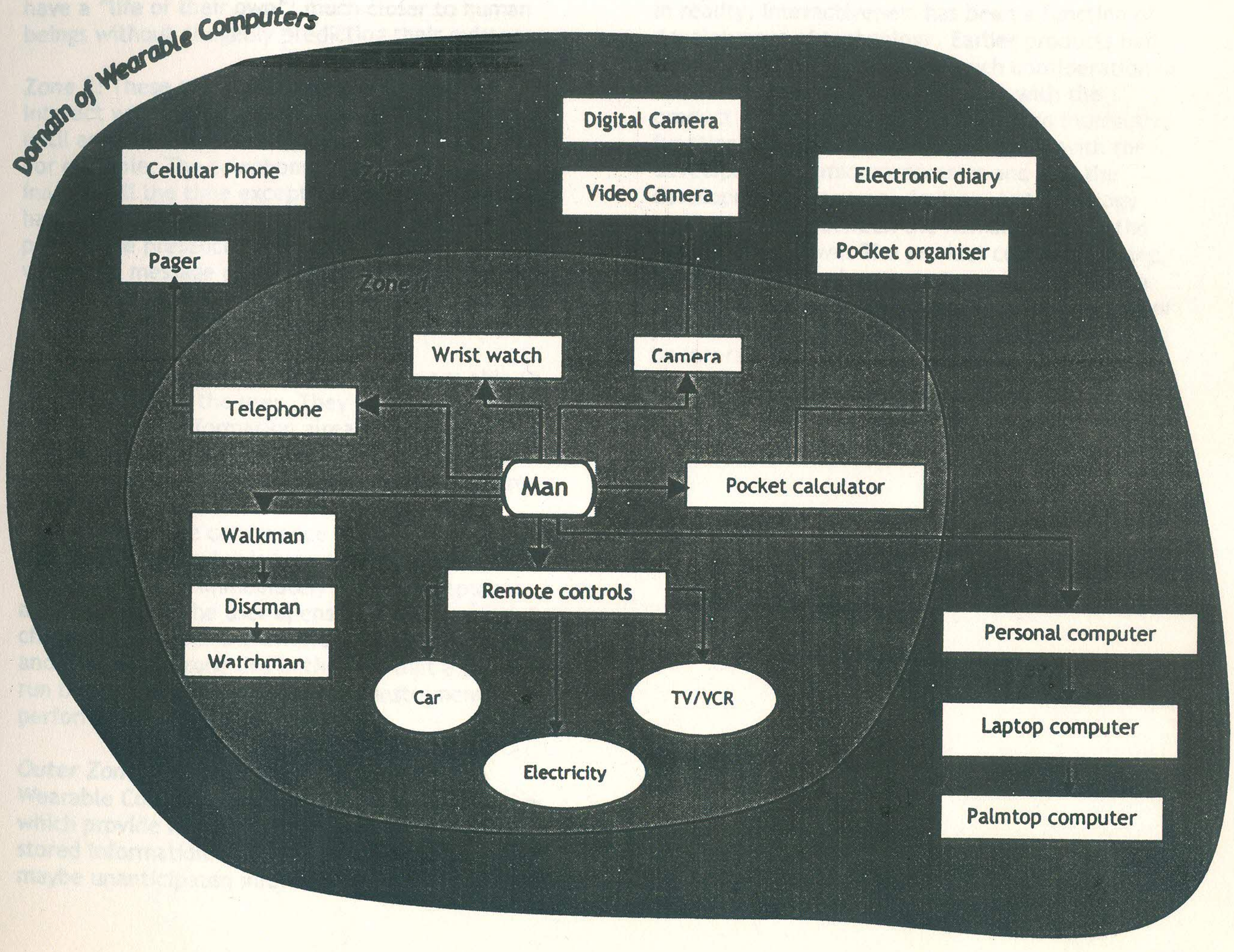
Finger motion
Keyboards will continue to be a major interface for computers into the next decade. As such, typing may provide a useful source of energy. On a one-

handed chording keyboard (HandyKey's Twiddler), it is necessary to apply 130 grams of pressure in order to depress a key the required 1 mm for it to register. A fast QWERTY typist (90-wpm) depresses 7.5 keys per second. A typical keyboard requires 40-50 grams of pressure to depress a key the 0.5-cm necessary to register a keystroke. Unfortunately, neither method provides enough continuous power to sustain a portable computer, especially since the user would not be continuously typing on the keyboard. However, there may be enough energy in each keystroke for each key to "announce" its character to a nearby receiver. For example, the keyboard may have a permanent magnet in its base. Each key would then have an embedded coil that would generate a current when the key was moved. Another possibility is to use PVDF, which bends at each keystroke, to generate energy (again, 11 percent efficiency). Thus, a wearable, wireless keyboard may be possible.

Notebook computer power
Current notebook computers offer a unique method for generating energy--simply opening the computer may supply power. However, this one action needs to provide power for the entire session; otherwise, users would be forced to flap their computers open and closed. For an hour's use, the available power is 12 mW. For most current applications, these power rates are inadequate.

3.0 Tree Diagram

The following tree diagram shows the various products, which a person uses, around his immediate vicinity.



4.1 Implications of the above Diagram

It may be predicted that as we move farther from the centre the products tend to become interactive and are able to send back feedback to the user. In some cases the products do not only send a feedback, but, new information which the user may not have anticipated. A higher level of understanding may suggest that those products have a "life of their own"; much closer to human beings without allegedly predicting their existence.

Zone 1: These are the products, which do not interact with the user. They are dead instruments until and unless handled by the user.
For example: The telephone. The telephone is inactive all the time except for the time when it has to deliver a message. This also brings into picture the presence of the user essential, without which the message cannot be conveyed. The instrument also lies dead, until and unless the user picks it up and sends the message to be conveyed.

Zone 2: These are the products, which are able to give feedback to the user. They either provide new information or information already fed by the user. This information is given out at the appropriate time as the user demands. These instruments are not dead.
For example: The conveyance of an E-mail. The computer is busy in doing a task. If an e-mail arrives, it immediately does not display anything unless the user opens up his account and checks it. However the difference between the first and the second zone lies in the fact that a task may run behind the main task that the instrument is performing.

Outer Zone: This zone is the place where the Wearable Computers belong. These are the devices, which provide new information as well as already stored information. The new information provided maybe unanticipated information.
For example: The receipt of an important message. The message may be forwarded according to the importance specified by the user. If the device is connected to a network then he can receive messages according to the importance of the sender also.

In reality, interactiveness has been a function of development of technology. Earlier products had only the technology without much consideration of how the human would act or react with the product. They did not have much of an interactive function built into them. They came in with the development of microprocessors and also the development of sensory devices. As technology grew, the wall between the human user and the device broke down. The product comes more and more close to the human in terms of interaction. There lies the main reason that in the evolution of products, the products developed later on tend to be interactive.

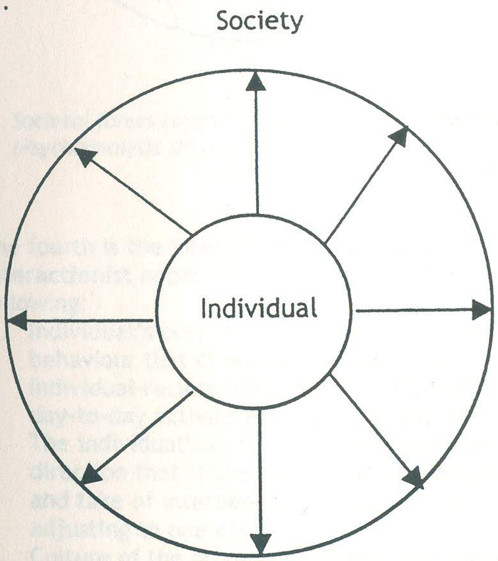
5.0 Study of Sociological/Psychological Aspects

Social interaction - "...communication by use of high-order abstraction and symbolical conception of ourselves as objects in a social environment."

-J.W.Kinch
Prof. of Sociology
California State University, San Francisco

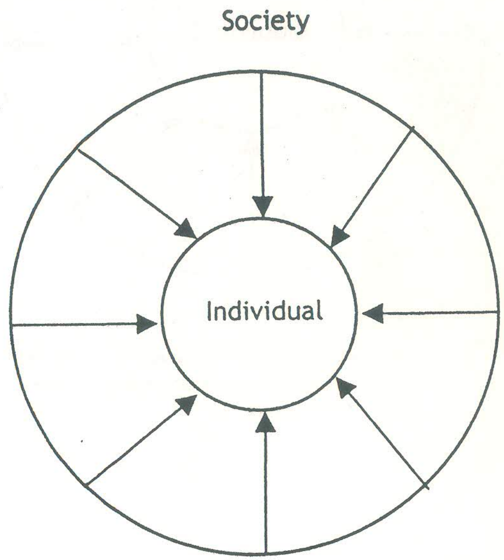
There are four theories by which the individual is affected in the society.

The first is the *Instinct theory* in which the individual affects the society. He has tremendous influence on the society and has the capability to affect the society. In fact the behaviour of the society as a whole is determined by the behaviour constituting the individuals. This is shown in Figure 7.



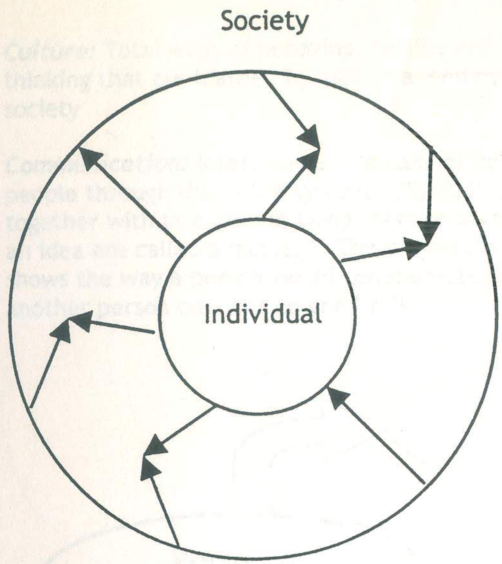
Society as conglomeration of predisposed individuals (Instinct theory)

The second is the *Cultural Deterministic theory*. The cultural deterministic theory predicts the influence of the society on the individual. The behaviour of the individual is shaped by the society. The contribution of the individual towards the society also depends on the demands of the society, the people around him.

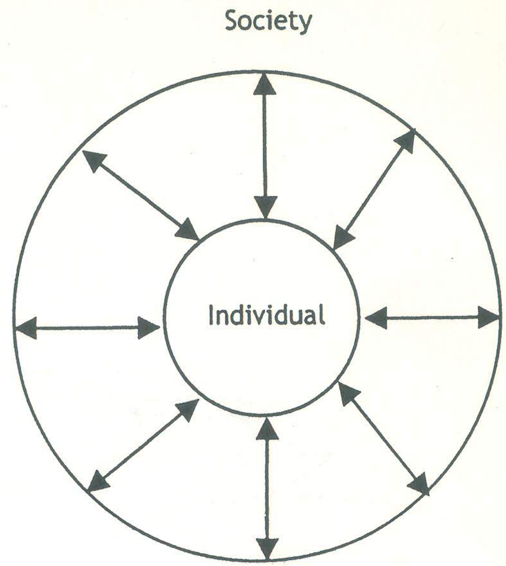


Individual molded completely by a preexisting society (Cultural deterministic theory)

The third is the psychoanalytic theory. Here the societal needs compete and conflict with the inborn needs of the individual.



Societal forces compete and conflict with inborn needs (Psychoanalytic theory)



Interaction of societal influences and individual potential (interactionist theory)

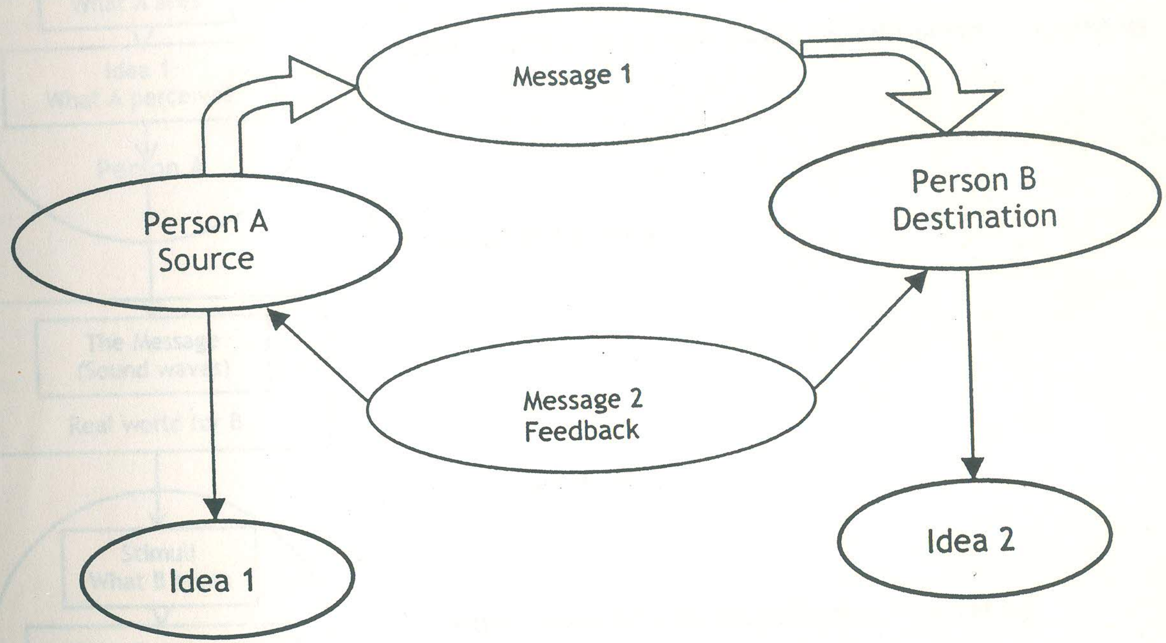
The fourth is the Interactionist theory. The **interactionist approach** in social psychology is as following:

1. Individual's personality: distinctive patterns of behaviour that characterises one as an individual-results from and is reinforced by his day-to-day activity association about him.
2. The individual's behaviour conduct follows a direction that is the result of reciprocal give and take of interdependent men who are adjusting to one another.
3. Culture of the group is a reflection of those agreements about proper conduct that emerge and are reinforced by man's continual communication as people collectively come to terms with life's condition.

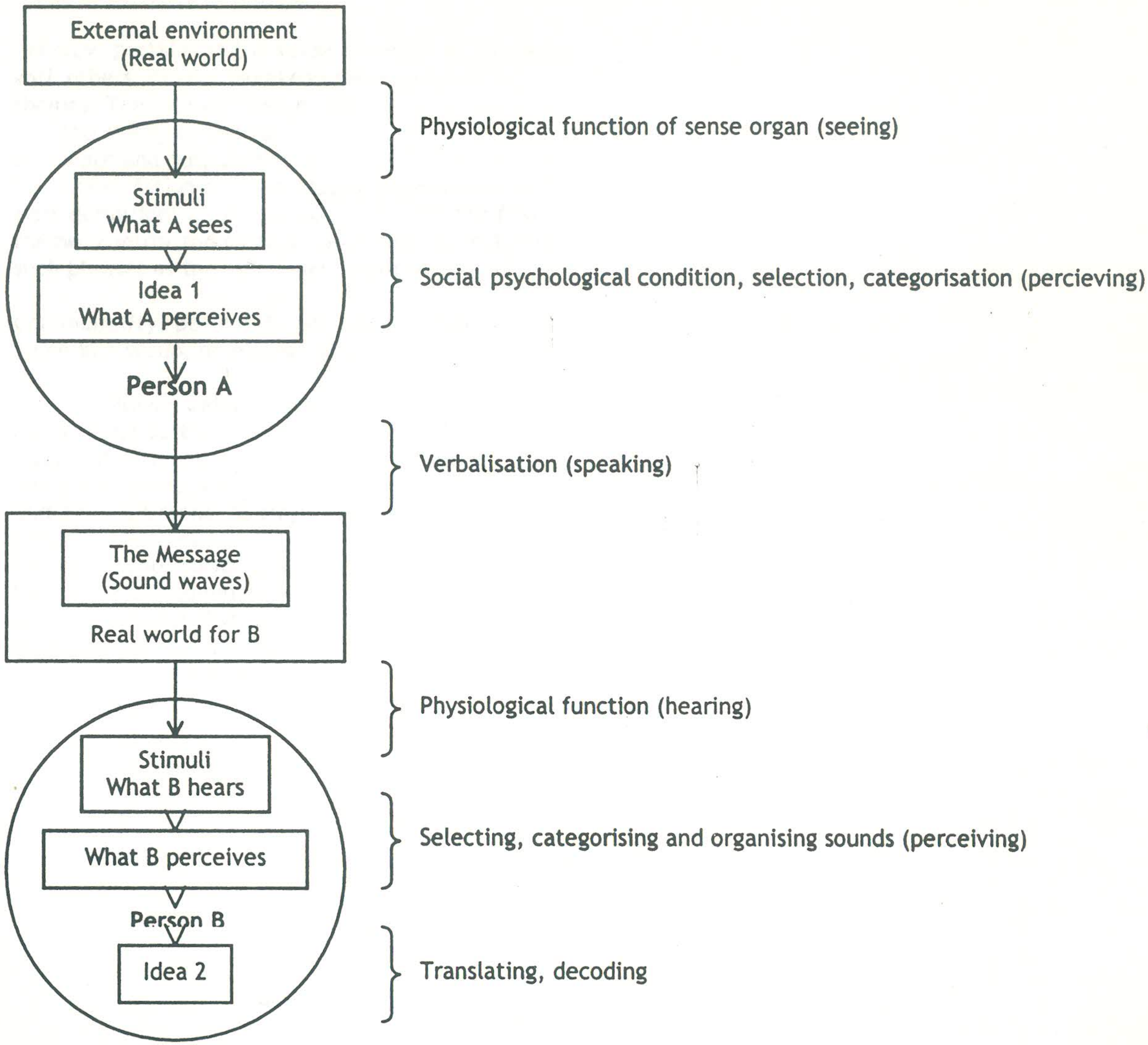
5.1 Relationship between Individual and Society

Culture: Total ways of behaving, feeling and thinking that are learned by man as a member of society

Communication: Interchange of meanings between people through the use of symbols. (Symbols put together with intention of using them to transmit an idea are called a message) The diagram below shows the way a person would communicate with another person on a one to one basis.



Perception: Ways in which organisms respond to stimuli picked up by their sense organs.



5.2 COMMUNALITY AND PRIVACY

Communality and Privacy are not separate concepts, but corollary ones - different aspects of a single experience or feeling.

Privacy: pertains to the sense of self or of intimacy with others. Altman isolated several common themes. The primary themes are

1. the ability to control
2. input and output through
3. the variation of interpersonal boundaries.

Most definitions of privacy centre around the first theme, control and freedom of choice, by including such phrases as the individual's right to control.

Communality: pertains to the sense of being at home in a group, or among many others

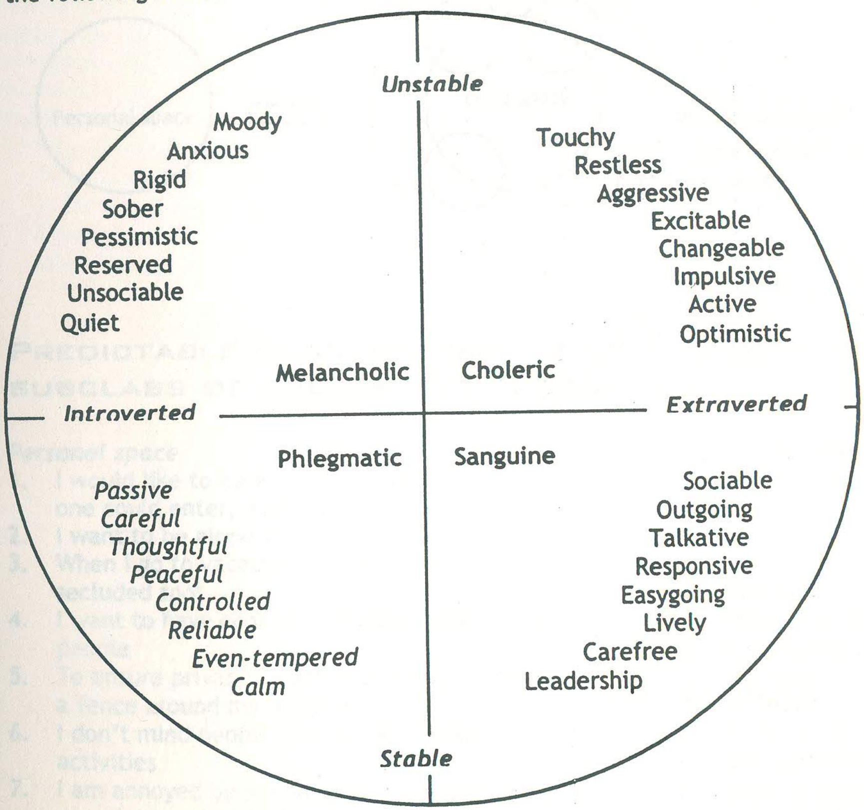
Human beings move continuously in and out of these settings. All behaviour takes place in some sort of space; social identity and social behaviour cannot be separated.
Individual (Personal Space): territory may be related to privacy
Primary group (Social Space): it relates to the feelings of the community
Secondary group (Public Space): "It is characteristic of technology and commerce."
-Impersonal group relationship
-Larger level of communality

5.0 SCENARIO BUILDING

Based on the study done above and the compilation of the information about the Wearable Computers two concepts are being hypothesised.

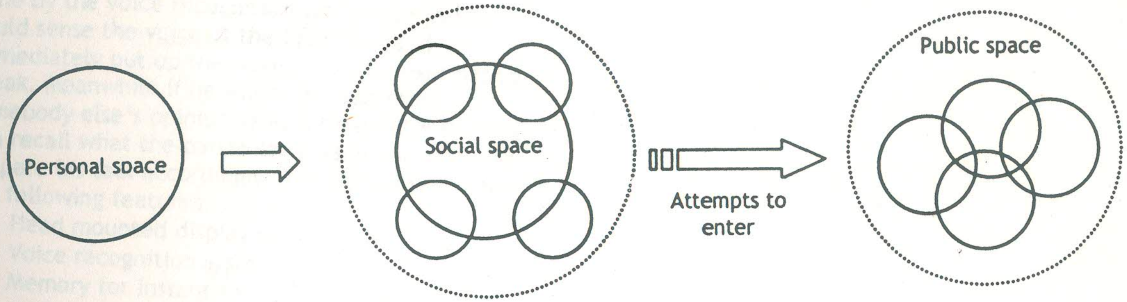
5.1 FIRST CONCEPT

Eysenck and Eysenck has listed the following types of personality which is appropriately described in the following circle:



This concept is based on the application of augmented reality: the remembrance agent. After the study of the social psychological conditions I decided to concentrate on the person who is a subclass of the phlegmatic personality (stable and introverted). This person feels comfortable as an individual (personal space). This comfort also extends to the primary group (social space).

The person has got the talent in his field and always desires to jump to the next group i.e., the secondary interpersonal relationship group (public space). This would envisage the interaction of different social groups with a common goal characteristic of commerce and technology.



PREDICTABLE CHARACTERISTICS OF A PERSON BELONGING TO A SUBCLASS OF PHLEGMATIC PERSONALITY

Personal space

1. I would like to have a private retreat, which no one could enter, without asking me.
2. I want to be alone when I wish
3. When I go to vacation I prefer to go to a secluded spot
4. I want to have control over when I see other people
5. To ensure privacy I want to live with a hedge or a fence around my backyard
6. I don't mind people knowing a lot about my activities
7. I am annoyed by people who try to get to know mew better than I wish
8. I like having people drop by my home without calling me beforehand
9. I would disclose me annual income to anyone who wanted to know

Social Space

1. I wolf like to have a close group of friends with whom I do things regularly
2. I would like to have a few close friends who all know each other well
3. I would like being a member that does things together

Public Space

1. I would like to be a member of a diverse membered work group
2. I like to engage in co-operative endeavours with others
3. I need to be around people who accept me as I am

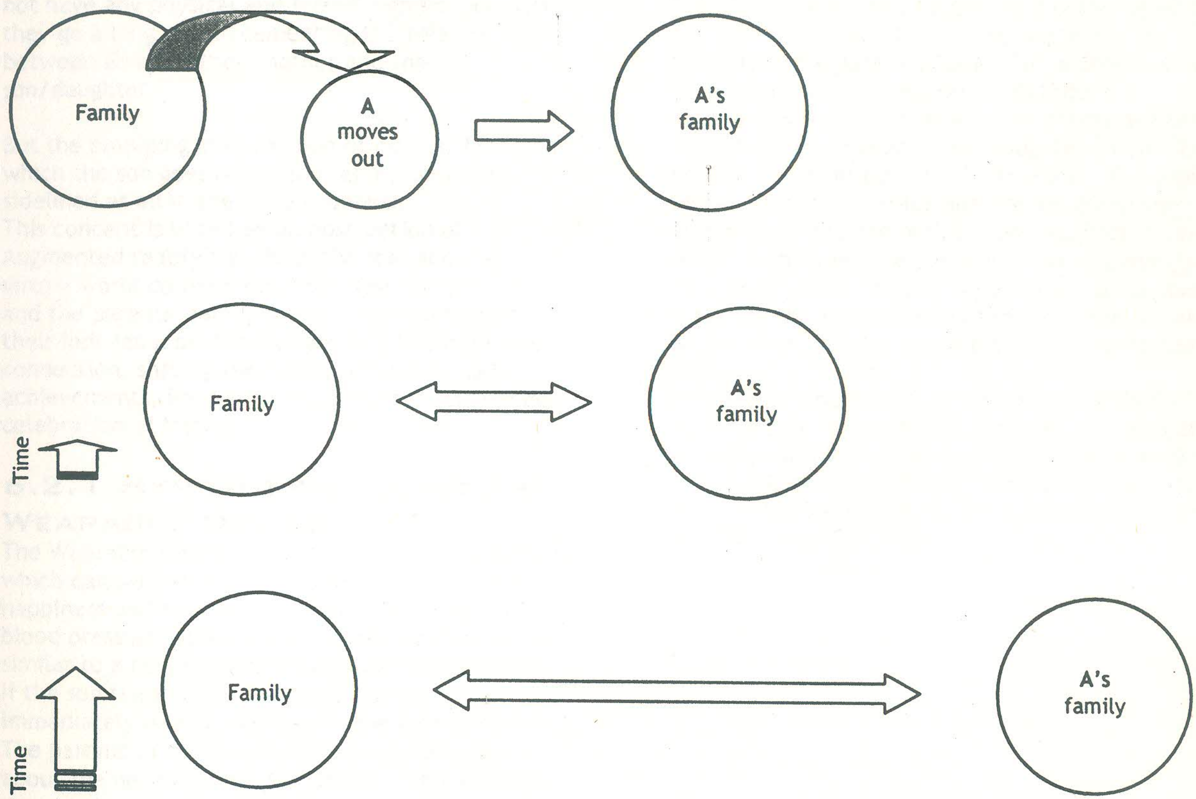
6.1.2 Hypothesis about the Wearable Device

The device would be having a Head mounted display along with a voice recognition system. To build a scenario the person is participating in a group meeting. Suppose the Chairman of the meeting is speaking on a topic on which our person is able to give a good feedback. But due to his inhibition he is unable to speak. A device, which aids in immediately displaying the points he has to speak, on his personal display will help him and encourage him to give the feedback. This can be done by the voice recognition system-the device could sense the voice of the Chairman and immediately put up the points that the user has to speak. Meanwhile if he wants to counteract somebody else's opinion after a time lapse then he can recall what the particular person had said and prepare his talk accordingly. The device would have the following features:

- Head mounted display system
- Voice recognition system
- Memory for instant recall of what a person has said

5.2 Second Concept

The case of Indian Sociological Condition - The dilemma of Nuclear family and the Joint family
Western social conditions offer great importance to the privacy of the individual. Immediately after adolescence, young people tend to 'migrate' out of the family.
Indian social conditions have woken up to this phenomenon in the recent decades after the emphasis of living changed from agriculture to industry. But the tradition of the joint family is still preserved in the villages as well as some urban areas.



As explained in the above diagrams the son's family tends to distance itself from the parents.
Let's imagine a scenario of a joint family where the son and the parents are both staying together. The daily interaction may involve sharing of happy moments, small achievements, and small celebrations, agreements and disagreements. These daily activities though are not remembered and do not have any physical and formal significance, but they go a long way in cementing the relationship between an old father/mother and the son/daughter.

But the emerging phenomenon of nuclear family in which the son goes out of the family cannot be sidelined at all in the Indian context.
This concept is based on an *abstraction* of Augmented reality i.e.; both the real and the virtual world co-exist together. The son's family and the parents' family though are maintaining their individual privacy but are still in continuous connection, sharing their daily activities, daily achievements, important discussions, 'synchronous' celebration of festivals.

6.2.1 Hypothesis about the Wearable Device

The Wearable Device would be a wrist worn device, which can sense the emotion of the user, namely - happiness and depression by the monitoring the blood pressure/pulse beats. Communication devices similar to a cellular phone would be incorporated.
If the son feels happy the device would immediately relay a message to the father/mother. The parents in turn could ask the son/daughter about the news through the device. (This attempts the simulation of a son coming to his home and the parents see the cheerful expression on his face and ask him the reason).
When the device senses depression in the son it asks the son whether to send the particular news to his father/mother. This is to prevent unintentional worry in the parents. If the son feels that the parents should know about the news then he sends the message.
On hearing the good news the father/mother can relay a simulated hug to the son. The device would give a slight compression to the wrist to resemble a hug or a congratulatory message.
The mother and the daughter-in-law can celebrate a festival by recreating the atmosphere that prevails in the parent's home. The mother cooks a particular food. A smell sensor detects the ingredients that she puts into the recipe and the weight is also relayed to the daughter-in-law. E.g.: the mother picks up a pinch of pepper. The smell sensor detects the spice and the weight of the amount put into the recipe. The daughter-in-law receives this message and she cooks accordingly. This would make the son happy in the sense that he is tasting the food as his mother makes it, as well as, his wife can take the credit of preparing the food.
The device would work in two networks. Refer figure In the first network the user communicates with his parents or wife. In the second network the user is interacting with his colleauges, mainly for communicating business. The device could have the following features:

- Wrist mounted
- Voice Input/ Output
- Pulse beat sensors
- LCD Display
- Pressure pads
- Touch screen for number dialing

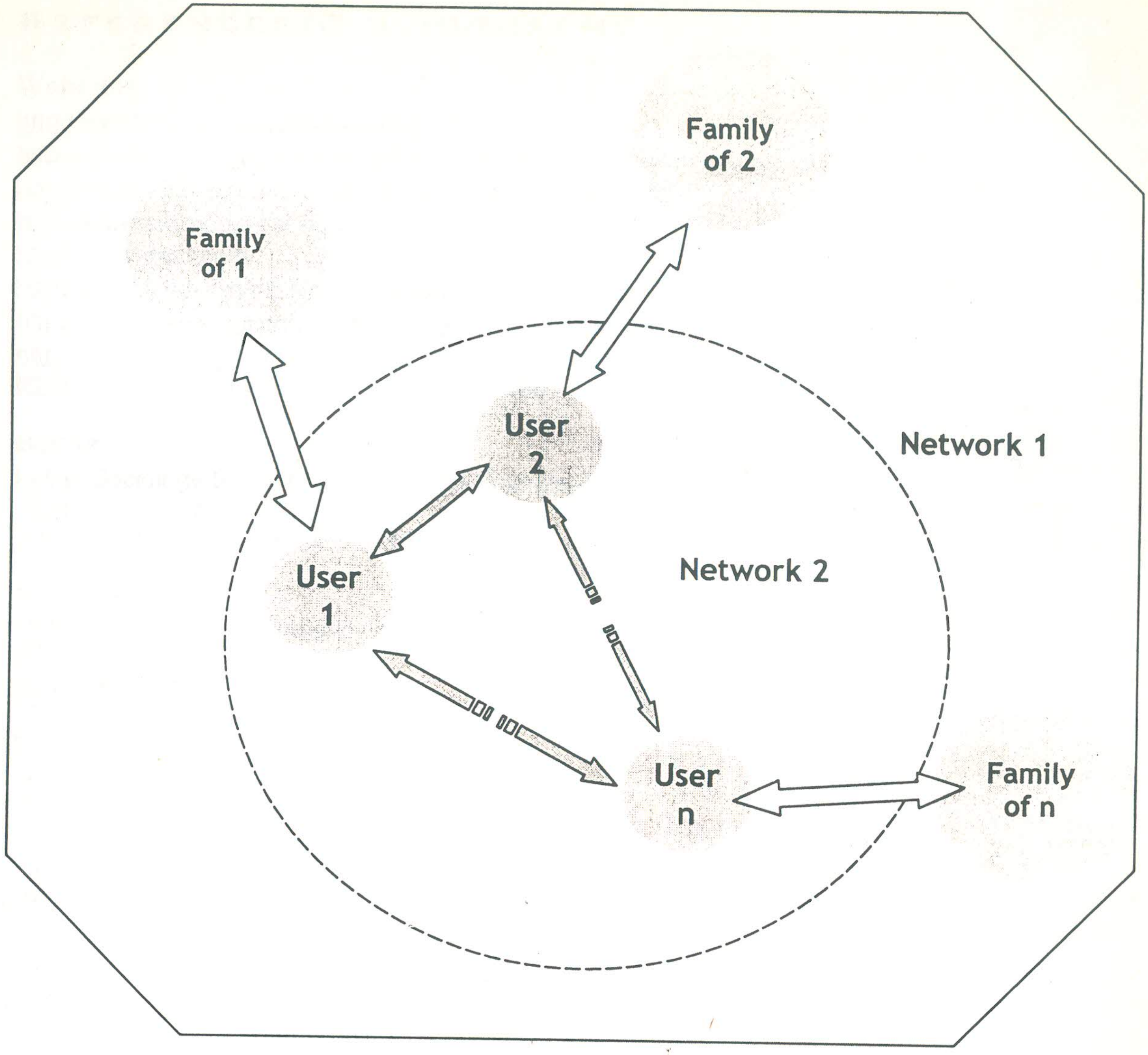


Figure 11: Use of the device in two networks

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