RESPONSIVE ENVIRONMENTS: DIGITAL OBJECTS IN THE LANDSCAPE

BY

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A Practicum submitted to
the Faculty of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree of

MASTER OF LANDSCAPE ARCHITECTURE

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THE UNIVERSITY OF MANITOBA

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Part Three

List of Abbreviations

AR	Augmented Reality
CT	Calm Technology
GIS	Geographic Information Systems
GPS	Geographic Positioning Systems
GUI	Graphical User Interface
HCI	Human Computer Interaction
HMD	Head Mounted Display
HWD	Head Worn Display
HUD	Heads Up Display
MARS	Mobile Augmented Reality Systems
PC	Personal Computer
PDA	Personal Digital Assistant
RF	Radio Frequency
RFID	Radio Frequency Identification
UC	Ubiquitous Computing
UPC	Universal Product Code
VR	Virtual Reality
WIMP	Windows-Icons-Menus-Pointers

Abstract

This study explores how emergent technologies could be used in the enhancement of human made landscapes. It begins with the argument that digital information is becoming an important influence on society and that it is quickly moving to outdoor environments. The study is divided into four parts: Part One introduces the topic and describes the research premise; Part Two follows with reviews of emergent computing concepts and technologies, such as Ubiquitous Computing, Pervasive Computing, Calm Technologies, RFID Tags, Wearable Computers and Augmented Reality; Part Three discusses the assumptions, limitations and relevance of using technology in the environment, it also presents the design program which outlines the parameters of a design scenario; in Part Four, the design scenario demonstrates how the researched technologies might be integrated into a site on campus to aid in the instruction of landscape architecture. This is followed by a review of the possible applications developed in the Design Scenario. The study concludes that it is an opportune time for the profession of landscape architecture to get involved in the exploration and development of emergent technologies. In order to be ready when widespread use of these systems arrives, they will have the ability to control the effects emergent technologies may have on landscapes, and take part in creating new applications and tools for the exploration and education of landscapes.

Part One

Chapter 1

You see things; and you say "Why?" But I dream things that never were; and I say "Why not?"

– George Bernard Shaw

Introduction

1.1 What is this practicum about?

Digital technologies are becoming a major influence on how we live. Everywhere we go computers and digital technologies are being used to simplify how we do things and provide us with information. With the advent of faster, more reliable portable computing devices, wireless electronic communication and vast information systems, these technologies are appearing and being used increasingly, including wide uses in outdoor environments. As landscape designers we deal with information daily. Every design we produce is about communication with users; we introduce hints of our concepts, establish desired views and experiences, as well we create restrictions by directing user movement with the addition of planting or deliberately planned objects. Since greater numbers of digital devices will eventually influence how outdoor spaces are perceived and used, this practicum explores how emergent technologies could be used to enhance human made landscapes. It also demonstrates how these technologies might be incorporated in a specific outdoor setting.

What is driving our desire to access and use information from the environments that we inhabit? The personal computer is a digital tool which has assisted us with our daily tasks for the last two decades. With the creation of the laptop, we gave computers the portability we required to be able to become mobile in how we work in different environments. Our desire for mobile computing led to the creation of Personal Digital Assistants (PDA's). However, even with the advance of current technologies, we are still missing certain opportunities not yet provided by existing technologies. How to make these technologies work for us, with increased ease and efficiency? Technologies have to be designed to allow us to use them whenever, wherever, and however we want without interference or stoppage. Currently to use digital computing devices we either have to go to them or stop to look at them. As we turn them on, then we need to find and select the application we want – all of which takes time and distracts us from our pursuits of knowledge. These devices demand our full focus in order to perform the activities we want. In our fast–paced world, we want our tools to be portable, wireless and ready to work the second they are needed. This practicum looks at the future of computing devices that are being designed to be embedded in our surroundings and provide us with the computing power that we desire, when we desire it. A major issue will be how information is displayed and the kind of information that society will want to be made available.

With the growth of the Internet and our increasing dependence on it for information, the desire has arisen to access the Internet everywhere we go. Those who have not embraced and harnessed the Internet to its full potential cannot understand this need. The Internet is becoming a source for local information and services, such as transit schedules, transit route planning ("Navigo"[1]), library catalogue searches, telephone directories, movie listings etc. It is also becoming a major source of how we inform ourselves on current events, listen to streaming audio and video, and communicate with each other. Society wants to be able to access this information wherever and whenever they desire. The question which this raises is how we can achieve these goals using our current and emerging technologies. With respect to the profession of landscape architecture, the question becomes, how will this new world of portable information affect landscapes?

Futurists such as William Gibson have alluded to the image of people plugging themselves into

1 Winnipeg Transit, "Navigo - Winnipeg Transit's New Online Trip Planner," <http://139.142.210.148/TripPlanner/TripPlannerMain.html> (26 February 2004).

computers to live in "Cyberspace". Many people already live a form of this life with online games and chat rooms. However, this vision is unappealing to many people because to them, being human means interacting with other people and our surrounding environments. I believe that this is what mobile wireless technologies are all about, providing society with the connectivity they want wherever they may want to go. In reality, the infrastructure needed for total coverage is a limiting factor. The way we currently interact with our computer systems is a major hurdle. We need to simplify and integrate computers into our environments like we have done with past technologies such as the book. Many may not see a book as technology, however, a definition for technology reads: "The body of knowledge available to a society that is of use in fashioning implements, practicing [sic] manual arts and skills, and extracting or collecting materials".[2] Books have gone from complicated manuscripts used by an elite few, to the mass published paperbacks available to everyone about any topic. The main limitation of a book these days is a person's literacy. Computers and digital technologies have to become like a simple book, and allow instant interaction without added steps and knowledge. They have to become as intuitive as a pencil. This quest for the simplification and merging of digital technologies with our environments is known as Responsive Environments.

This practicum will review some of the technologies being developed in universities and research departments around the world that form part of the field of Responsive Environments. The parameters which I have set for this research were to examine in detail up to five major technologies which will change how we use digital information in our environments over the next five to ten years. This practicum will also examine how these technologies could be used to access information in our landscapes, as well as what types of information we may want to access and design into our landscapes. The main objectives are to create a platform for further exploration and discussion as to how technologies may affect and enhance our landscapes and to demonstrate how they might be incorporated into a specific outdoor setting.

2 "Technology." The American Heritage® Dictionary of the English Language, 4th ed. Boston: Houghton Mifflin, 2000. <http://www.bartleby.com/61/91/T0079100.html> (26 February 2004).

Chapter 2

Research Premise

2.1 How this practicum topic came to be

When initially considering a study topic, the idea of looking at Virtual Reality systems as a means of designing landscapes was of interest to me due to current trends of 3-D modeling in landscape architecture. The principal idea was to look at the development of a system that a landscape architect could use to work in a virtual world in the conception and design of landscapes. Unlike 3-D modeling where a designer works on a computer screen creating photo realistic objects and landscapes three dimensionally, the idea was to fully immerse the designer in a virtual world. However, after exploring this approach, the idea of leaving the real world to design in a virtual world began to upset my natural instinct. Something about working in a Virtual world to create a real landscape just did not seem right. The question arose, that if we were to work and live in a virtual world with virtual landscapes, at what point would real landscapes become obsolete? I therefore, made the decision to explore connections between digital technology and the real world. Rather than plugging into a computer system and disconnecting from the real environment, digital computing could instead be incorporated into all natural and human made environments. This might serve two purposes. First it would create more accessibility to computers and digital equipment for those who are not computer aware, giving them access to large amounts of public digital information becoming available daily. Second, it might attract those who are immersed in computers out of their virtual worlds and bring them back to real environments. The initial exploration looked at placing sensors and switches in the environment that would trigger multimedia light shows and digital audio recordings providing pedestrians with important information. This seemed the perfect solution until I realized that by filling environments with information in the form of multimedia light shows and digital audio for all to see and hear, we are also causing undesired information pollution. Eventually these new technologies would taint our environments creating a world that some people may dislike and avoid. My focus then changed to the exploration of personal digital information technologies being developed for implementation over the next five to ten years, which might impact landscapes. This exploration also warranted further investigation as to how these technologies could be implemented allowing existing landscapes to remain visually unaltered, yet links layers of digital information to outdoor environments without affecting the enjoyment of others who do not desire the information. This study therefore became about emergent technologies that allow the use of computing technologies without tying a user to a cubicle or changing the outward appearance of landscapes for their implementation. The field of study that explores placement of non-desktop computers and digital technologies into building and office environments is called Ubiquitous Computing (UC).[3] The practicum begins by exploring how UC might be applied outdoors in order to develop digitally Responsive Environments capable of informing us of any changes past, present or future.

2.2 Defining Responsive Environments

The definition for Responsive Environments[4] for the purpose of this study is the one found in countless technology research departments, many of which even incorporate the phrase into their name. One such group for example is the Responsive Environments Group (REG) at the Massachusetts Institute of Technology (MIT).[5]

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3 Mark Weiser. Some Computer Science Issues in Ubiquitous Computing, 23 March 1993, <http://www.ubiq.com/hypertext/weiser/UbiCACM.html> (8 April 2002).

4 Myron Krueger. Responsive Environments, (NCC Proceedings, 1977), 375–385.

5 Joseph A.Paradiso. Responsive Environments Group, MIT <http://www.media.mit.edu/resenv/> (12 February 2002).

“Responsive Environments use sensory technology, coupled with computer equipment, to create a collaborative relationship between objects in an environment and movements of the human body. Responsive Environments are alternative design advancements in the discipline of human-computer interaction.”[6] The presence of a person in a certain location would elicit a certain response from the sensors and computer technologies embedded in the space.

2.3 Defining Digital Objects

Digital Objects represents any device that **stores**, **transmits** or **computes** information in any given form. These objects can either be used actively by a person or sit inactive until another device requests the information stored.

2.4 Technologies being researched

This study attends to the methods being developed to allow the access and use of information desired quickly “at our finger tips”. At the moment the bulk of that information only exists via personal desktop computers through access to the Internet and other information databases. Technologies such as laptop computers, Personal Digital Assistants (PDAs), cell phones and similar devices are increasing significantly the availability of portable information and our desire for more ubiquitous access to information. However as this desire for information increases, new forms of handling and accessing information are necessary. We have to rethink how we want to use information and the technologies that will provide it. How can these technologies be used in outdoor environments? What kind of information could be made available? How could information and emerging technologies affect how we learn, entertain ourselves and do our jobs? These are some of the questions that this study will be exploring, first by examining some of the emerging technologies being developed in Universities and research labs around the world, and then through an exploration of how these technologies might be applied in landscape architecture.

6 James Pyfer, “Jim > technically speaking > responsive environments,” <http://www.jimpyfer.com/re.php> (24 February 2004).

The technologies examined in this study were chosen from research done on Responsive Environments and Ubiquitous Computing (UC). This led to the examination of how Digital Objects could be used outdoors to communicate instant information about changing conditions and about other site-specific facts. An initial consideration was the creation of an environment in which a user's movement through a space would trigger switches and sensors to provide a physical response. Focus then developed from controlling and changing the appearance of an environment to keeping the visual appearance the same while allowing the environment to transmit information in a completely unique way. Users might access information instantly, in forms that could be viewed, manipulated and controlled without affecting how others view the landscape. This led to Ubiquitous Computing, a major component of Responsive Environments, regarded as "the next era" in computing after personal computers.[7] The philosophy behind UC is the placing of computing functionality into everything in our environments. Looking further into UC shows various new technologies and theories that are being developed in this area. The question becomes how are these computing devices going to be used and integrated into outdoor environments, in order to provide information for users without altering their appearance? Two of the technologies examined are Wearable Computing and Augmented Reality (AR). The objective of researching these technologies was to explore the possibility of providing digital information as an overlay to what is seen in outdoor places through the use of special glasses. A way of providing and placing digital information into outdoor environments may be through the placement and use of Digital Tags. Finally, Calm Technologies[8] (CT) can be used as a principle for creating new tools to manage and use information efficiently. In order to have a truly effective system, the proliferation of information and computing devices known as Pervasive Computing[9] would have to occur. These technologies and concepts have either evolved out of UC or are being developed to be part of it (see Figure 1).

7. Björn Hermans, Desperately Seeking: Helping Hands and Human Touch Chapter 4: "An Introduction to Ubiquitous Computing, Calm Technology and Augmented Realities". 8 July 2000, <http://www.hermans.org/agents2/ch4_1.htm> (11 June 2002).

8 Mark Weiser and John Seely Brown. The Coming Age of Calm Technology Xerox PARC. Palo Alto, CA., 5 October 1996, <http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm> (12 February 2002).

9 IBM Pervasive Computing "What is pervasive computing?" <http://www-3.ibm.com/pvc/pervasive.shtml> (10 June 2002).

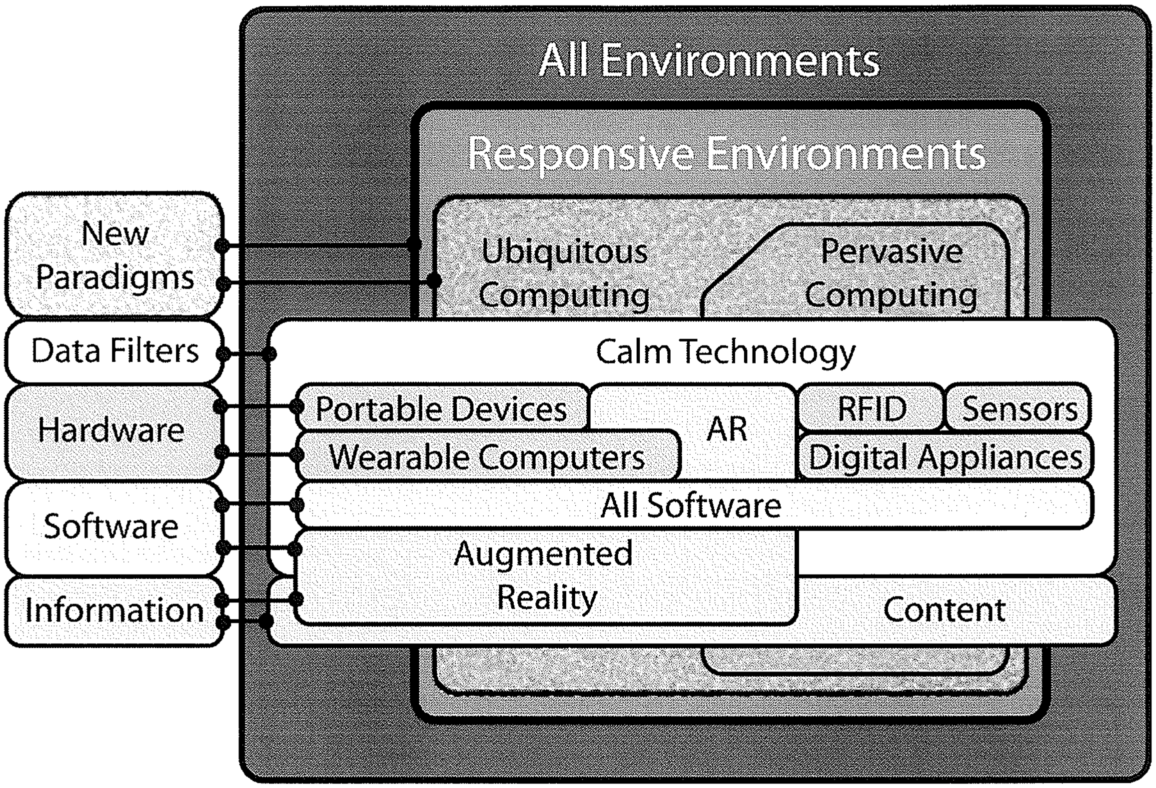

Figure 1. Relationship of technologies (Illustration by author)

2.5 Research limitations

This research has been limited to a brief review of concepts, theories and technologies that are emerging in computer science for the development of Responsive Environments. The research for this study was conducted two years ago and was put together with information available at that time, mostly from research papers collected from the Internet. Technology and information are both moving at a fast pace and this has been made clear from the changes seen in technology and its information since the start of this practicum. The concepts and technologies behind this study also seem to have more people involved in research at even more universities and research departments.

This study also limits itself by excluding detailed concerns around civil liberties, ecology, economics or management issues, but brief commentary is made in Part Three of this practicum concerning the scenario developed. Further investigation into the full effects, content and infrastructure of these technologies should follow. This study is an introduction and preliminary exploration of applications for emerging digital technologies in the landscape.

2.6 Application of research

The research reviewed will be used in the creation of a scenario, which explores the use and development of these theories and technologies within a specific site dedicated to research and education. This practicum concerns itself only with the conception of applications a specific user might have to aid them in the study and exploration of landscape architecture in an outdoor laboratory. Therefore this study is not concerned with overall issues that may effect the implementation of these technologies into society as a whole. Initial development and use of some of these technologies may be site specific, like the outdoor laboratory scenario, however as demand increases for the technology, with further availability of content and resources, a move into other non-specific locations in society might occur. Any research following this initial exploration, should explore in detail, issues such as civil liberties, economics and overall management strategies needed for application in other areas.

2.7 Development for further research

This practicum raises many questions. One of the intents of this research was to open up a new wave of research by the landscape architectural profession. This practicum will try to show the different possible situations in an outdoor laboratory in which these technologies may be applied or affect the landscape. Through the inference of the design scenario, this practicum hopes to allude to possibilities in other outdoor environments. The development of these technologies is actively proceeding and their application to human environments is imminent. This practicum tries to provide insight into how the landscape profession may be able to become developers and early adopters rather than late comers with a technology not fully suited to their needs (such as what occurred with early versions of AutoCAD® being designed and created only for the engineering profession, not taking into account other possible users such as the landscape profession).

Part Two

Chapter 3

An Introduction to Ubiquitous Computing

3.1 What is Ubiquitous Computing?

> *[...] The first wave of computing, from 1940 to about 1980, was dominated by many people serving one computer. The second wave, still peaking, has one person and one computer in uneasy symbiosis, staring at each other across the desktop without really inhabiting each other's worlds. The third wave, just beginning, has computers serving each person everywhere in the world. I call this last wave 'ubiquitous computing'."*[10]

The new digital technologies covered in this practicum can all fit under the heading of Ubiquitous Computing. This "third wave of computing" is best defined as the development of computers as integral parts of our environments through the embedding of computational devices into walls, chairs, clothing, cars, landscapes and every object in our world. Mark Weiser started the study of Ubiquitous Computing; (or ubi–comp) in 1988 at the Xerox Palo Alto Research Center (PARC), where he and his team saw UC as the radical answer to what was "wrong" with computing based on desktop personal computers. They are too complex and hard to use; demanding of attention; isolating us as they colonize our desktops and

[10] Mark Weiser. "Open House." Xerox PARC, March 1996, 2. <http://www.ubiq.com/hypertext/weiser/wholehouse.doc> (10 March 2004).

our lives. The Xerox PARC team wanted to rethink computers and how they fit into our environments by focusing on *human-to-human* interfaces and less on *human-to-computer* ones.[11] By 1992, when the first experimental "ubi-comp" system was being implemented, the realization came that what was really occurring was in fact a redefinition of how humans relate to work and technology in the post-PC era.[12] Ubi-comp created a new field of computer science; one that considers a physical world of richly and invisibly interwoven sensors, actuators, displays, and computational elements, which are embedded seamlessly into everyday objects and connected to a continuous network. It is remarkable how quickly these new computational forms are being developed and used. A few research centres in the world are already working to develop these types of computational environment where every person is continually interacting with hundreds of nearby, interconnected wireless computers. These developments are made in order to achieve new computing technologies that are both extremely functional and essentially invisible to users. In order to achieve this goal it is necessary to develop radically new types of computing devices taking many different forms.

"The idea of ubiquitous computing first arose from contemplating the place of today's computer in actual activities of everyday life. In particular, anthropological studies of work life [Suchman 1985, Lave 1991] teach us that people primarily work in a world of shared situations and unexamined technological skills. However, the computer today is isolated and isolating from the overall situation, and fails to get out of the way of the work. In other words, rather than being a tool through which we work, and which disappears from our awareness, the computer often remains the focus of attention."[13]

> *"The concept of computers as things that you walk up to, sit in front of and turn on will go away. In fact, our goal is to make the computer disappear. We are moving towards a model we think of as a 'personal information cloud'. That cloud has already begun to coalesce in the form of the Internet. The Internet is the big event of the decade [...]. We'll spend the next 10 years making the Net work as it should, making it ubiquitous." (Frank Casanova, director of Apple Computer Inc.'s Advanced Prototyping Lab)*[14]

Therefore a desire exists for new ways of interfacing and interacting with computers. The advent of the Internet has brought a combination of the Guttenburg printing press, telegraph, radio and television all in

11 Mark Weiser, R. Gold, and J. S. Brown, The origins of ubiquitous computing research at PARC in the late 1980s, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 693–694

12 Ibid., 693

13 Mark Weiser, Some Computer Science Issues in Ubiquitous Computing, (CACM, July 1993), <http://www.ubiq.com/hypertext/weiser/UbiCACM.html> (21 June 2002).

14 Björn Hermans, Desperately Seeking: Helping Hands and Human Touch Chapter 4: "An Introduction to Ubiquitous Computing, Calm Technology and Augmented Realities". 8 July 2000, <http://www.hermans.org/agents2/ch4_1.htm> (11 June 2002).

one, there exists a necessity to find ways of coping with all this overwhelming information. All these past technologies have found ways to become mobile technologies, through pocket novels, mobile phones, portable radios and televisions. The challenge is how to make the Internet and all of its current and future contents mobile. Experts believe it will be through UC technologies. For this to occur these technologies have to become pervasive in every environment including natural landscapes. A precedent for emerging technologies becoming pervasive in natural landscapes is that of cellular phones which have invaded every possible environment, in a relatively short time, affecting landscapes acoustically through the cornucopia of rings and conversations and visually through the addition of towers. The first cell phone was used in 1973, ten years later it arrived in the market place, and by 1990 there were only a million subscribers in the United States.[15] "Today, there are more cellular subscribers than wireline phone subscribers in the world."[16] So, as landscape designers, we need to look at how emerging technologies have and may affect landscapes and how they could be used to enhance them.

3.2 What are the goals of Ubiquitous Computing?

Those studying UC are looking to create a new form of computing, that allow humans to interact intuitively with computers, by embedding them in human environments and with the ability to be aware of their context and environmental conditions.

Ubiquitous computing is not about developing computers. It is about developing digital technologies that work in unison to provide invisible computational and information networks. Computers inhabit almost every corner of the world, living in devices that we would never guess are digital and in those that clearly are. Many of these devices repeat similar specific goals duplicating information incorrectly. If a power failure occurs we have to reset manually every digital clock, as well as T.V.s, VCRs and other electronic devices. What is sought through UC is the creation of an environment where computers communicate and work together to eliminate redundant human interaction; for example, "digital clocks", a UC enabled appliance would be able to access a network time server to obtain the correct time and then use this information to synchronize all other appliances without human interaction, giving the

15 Mary Bellis, Martin Cooper - History of Cell Phone and Martin Cooper, About: What you need to know about – Inventors, 12 October 2003, <http://inventors.about.com/cs/inventorsalphabet/a/martin_cooper.htm> (9 March 2004).

16 Ibid

correct time throughout homes and environments. An objective is for UC to create digital computing systems that perform these tasks and allow undisturbed use of electronic devices and allowing people to accomplish tasks without having to worry about the system itself, only the task at hand. Proponents of UC are trying to make computers vanish, by allowing computing to occur on many devices using wireless communication, hence removing computing from the confines of just one main device. Over the last thirty years, the main ideology behind computer design has been to create a system that "does everything" from one box. This ideology does not take into account that humans are mobile creatures; many preferring to work and think "outside the box". UC is about re-addressing how we work and interact with our environment, coming to the understanding that if we can make computers invisible by embedding them into our environment, we may be able to create a system that is more natural to us; that could be used without it being visible. This idea is comparable to the way that eyeglasses or contact lenses allow people to see without realizing that they are wearing them, or how a blind person tapping a cane feels the street and not the cane. UC is trying to get the user to focus on the task being performed and not the use of the tool.

Ubiquitous Computing is not so much about creating a new Graphic User Interface (GUI) as being about, changing the whole context of how computers are seen and used by humans. The first phase in the study and development of Ubiquitous Computing by the Xerox PARC team, therefore, was to create a new computing environment consisting of many devices (tabs, pads and boards) which became a testing ground and a study about user interaction. This new direction in computer science removed attention from the machine and focused it on the user and how they live, work and play in modern society. Understanding the way people interact with devices is vital to their success. "Bearing in mind current and upcoming technologies, such as increased processing power (even on mobile devices), availability of sensors (ranging from simple temperature sensors to cameras), and the resulting perceptional capabilities as well as the fact that the main user group of current computing devices (e.g. mobile phones, PDAs, etc.) are non experts, we may observe yet another shift in HCI (Human Computer Interaction)."[17] People interact with each other through a medium of gestures, body language and voice intonations not found in HCI. We can therefore see how current computer interaction affects how humans interact with each other when computers are present, weaken both relationships, affecting a person's focus on a task. UC is trying to change how computers and humans interact, so that people do not have to change how they interact with other people.

Researchers working on UC are also trying to create components that are augmented in a way that

[17] Albrecht Schmidt, . Implicit Human Computer Interaction Through Context, TecO, University of Karlsruhe, Karlsruhe, Germany. 1. <http://www.teco.uni-karlsruhe.de/~albrecht/publication/draft_docs/implicit-interaction.pdf> (21 June 2002).

allows them to be aware of their location and surroundings. The importance of location awareness is not necessarily about the location itself but about the information that a location may be able to provide. UC researchers are looking into how to exploit location-awareness in mobile and stationary computing systems through the embedding of autonomous awareness in objects. This is done through the use of sensors and perception algorithms, allowing a device to learn about a user and the environment it is in so as to provide better assistance in the future.

> ***A vision of future devices:*** *We will be able to create (mobile) devices that can see, hear and feel. Based on their perception, these devices will be able to act and react according to the situational context in which they are used.*[18]

As a user moves through an environment, the context for that user may go through many changes. A location-aware system would be able to adapt to these contextual changes allowing devices to function appropriately in all parts of the environment. This could be how a phone handles the change in ambient noise as a user makes their way from their office to the parking lot. New computing devices will be able to assess if they can interrupt a conversation to remind a user to pick-up their dry cleaning, or whether they are available to receive a valuable call, or is the current activity more important than anything else. The context that UC systems will consider is: the people around the user, the situation (e.g. in a meeting, making a phone call, having a coffee, walking, etc.), the environment (e.g. location, temperature, time, light, etc.), how the user feels (e.g. pulse, body temperature, skin resistance, etc.). This additional information about context can make a computing device act and react with greater sophistication and less obtrusiveness.[19]

It is assumed that computation in the future will be freely available. The goal of Ubiquitous Computing is to move computers away from our central focus to where we can use them subconsciously, enhancing our existing tools and communication devices.

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18 Albrecht Schmidt, . Implicit Human Computer Interaction Through Context, TecO, University of Karlsruhe, Karlsruhe, Germany. 1. <http://www.teco.uni-karlsruhe.de/~albrecht/publication/draft_docs/implicit-interaction.pdf> (21 June 2002).

19 Albrecht Schmidt and Michael Beigl. New Challenges of Ubiquitous Computing and Augmented Reality, TecO, University of Karlsruhe, Karlsruhe, Germany. 2. <http://www.teco.uni-karlsruhe.de/~albrecht/publication/cabernet/ubicomp1.html> (21 June 2002).

In short, the three main aims of UC products are:

- to exist everywhere invisibly,
- have greater intuitive interaction with humans,
- the ability to be aware of surrounding environmental context.

These three goals give a user complete freedom of movement and freedom of interaction. One of the ideas behind these goals is that to many non-technical people, computing should become more inviting and intuitive. Those in the field of UC believe that the crossover point with personal computers will occur between the years 2005 and 2020.[20]

3.3 What are the problems with Ubiquitous Computing?

The initial concept of UC was to only have computing that would recognize our presence in the environment, then provide us with personal information wherever we are. One problem with this type of UC is the "Big Brother" effect, of not knowing who would have access to our information and how the system would work. A second problem is a dependence on our ability to place computers into every part of our environment that need to access a central database, to move a person's data from location to location, creating a security challenge. Another way of approaching UC is to allow people to control their own information through the creation of wearable computers, which a person takes with them into every environment. That way, if an environment does not have a fully networked space, a user can still access their information and accomplish digital tasks.

When UC was first introduced existing technologies did not allow users to carry all their digital data around with them. However, through the development and nurturing of emerging wearable technologies it is now possible to achieve this goal. Future development of (continually increasing) storage capacity, will allow a person to continue adding to their digital profile. So the face of UC might change in that a user would be able to control their information and use digital environments only for additional information and additional computing power to accomplish their tasks.

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20 Mark Weiser and John Seely Brown, The Coming Age of Calm Technology, Xerox PARC. Palo Alto, CA., 5 October 1996. <http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm> (12 February 2002).

A problem that affects both UC and wearable computing is location-awareness. The direction taken by those in these fields is to incorporate Geographical Positioning Systems (GPS) and Geographic Information Systems (GIS) into their components. However, the accuracy and hardware needed to constantly locate a wearable computer through satellite triangulation and/or reference to GIS database causes location errors and requires large, demanding systems. A technology that might help solve location problems is the addition of digital tags into human environments. These would hold coordinates and other location and contextual information, and would be keys to information about a user's location. They could become a digital version of current construction bench marks and other physical location markers. Wearable computers become not only a storage device, but also the main interface device allowing a user to communicate with computational devices located in the environment and displaying their information.

A way of displaying this extra information is through augmenting a person's environment with information. So those studying wearable computers developed the field of augmented reality, which takes a person's view of the environment and adds information over the top of it. With all this extra information available to people, they might be subjected to information overload. This is where the area of Calm Technology (CT) comes in. CT involves the development of systems that provide greater amounts of information without overwhelming people. Future systems will be able to decide what information a person might need or might want, while weeding out all other data that is irrelevant to the user. This should allow people to work more efficiently and without added stress.

The main requirement for the implementation of UC is the creation of systems that are wirelessly connected to "everything" allowing us to receive information quickly from "everywhere". Technologies are sometimes taken into directions which may pose risks to society, by following the adage "bigger is better". Bigger is not always better. For example in the telecommunications industry the development of wireless communication has created cell phones and towers that send powerful signals in order to communicate with each other at greater distances. This has caused social and health concerns in many countries and a viable alternative might be the creation of smaller, less powerful interconnected systems. Instead of depending on a powerful cell phone tower in a city, it might be feasible to place wireless communication devices in street lamps or other objects in the landscape. This would allow for greater connectivity and higher data transfer since most of these objects could be tied directly into a physical network. UC in human made environments can be envisioned as environments which become broad based networked hubs of computing power available for all to access and use. A park could become its own networked environment, having its own network addresses, which could be accessed locally in the park, throughout a city, or even globally over the internet. This way computing becomes like ecology where it is both a gigantic system that affects the entire globe, but is comprised of many smaller systems that evolve to respond to local conditions, and together create the larger system.

3.4 What Ubiquitous Computing technology is being examined?

When Ubiquitous Computing was first developed, it was believed that there would be only one way of achieving it – through placing computers into an environment that would handle all information so that people would not need to operate manually any computing device. However, as UC developed, some of the initial thinking changed and different directions were examined by different groups. UC, instead of being a future method of computing, should become the goal as a future method of computing – an environment in which all types of digital systems are able to communicate and work together to simplify people's (digital) lives. UC is about creating a new infrastructure that works together. When it comes to new technologies everyone always talks about the next "killer" application, but the future of computing is not a matter of a single application that does everything for people, but a matter of new infrastructure which works together to allow people to accomplish their daily tasks without having to stop and think about how they are accomplishing them and fix their tools along the way. This practicum examines technologies which might help to create Responsive Environments, by placing digital objects into landscapes. The technologies which are examined include:

- ***Pervasive Computing*** – the embedding of computers into our environments
- ***Calm Technology*** – systems that reduce information overload
- ***Digital Tags*** – that will assist in identifying objects
- ***Wearable Computers*** – that may become our interface with our digital environment
- ***Augmented Reality*** – that will offer supplemented information about environments.

These technologies are examined in greater detail in the following Chapters of Part Two in order to help understand how they work, and how they may become vital components of a ubiquitous computing world.

3.5 How can Ubiquitous Computing benefit landscapes?

As acceptance and use of new technologies develops, shortcomings in those technologies become apparent. With development of the Internet and the age of instant information, people are starting to demand the ability to access this information where ever they are. UC is about trying to develop appropriate technologies and infrastructures that allow people to do this when, where and in the way that they want.

The benefit that a UC landscape can give is the ability to access any type of information instantly from, say, a park bench. It will allow people to enquire and learn instantly about everything that is encoded into a landscape. If people enquire what a certain tree is and how long it has been there, the environment will be able to tell them. If they want to know the history of a particular location, they could just query their surroundings. Landscapes could become museums, libraries and research centres, but to the normal eye they would only be seen as park, garden or green space. Only through the use of digital technologies would people be able to easily access and unlock these information data banks. Through the use of special eyewear they could even see virtual landscapes that could coexist in the same time and space with real landscapes. People might be empowered to see virtual sculptures and art exhibits placed in certain outdoor spaces – but it would be each individuals choice whether or not to see these "virtualscapes". If digital eyewear becomes pervasive enough people might even be able to make all non-essential signage into virtual signage which could appear in the font of the viewers choice or spoken to the visually impaired.

New digital technologies are likely to be developed and placed into human environments whether people want them or not. The purpose of examining UC as a student of landscape architecture is to see how these technologies can be used in such a way that landscape architects can help design or develop these technologies to achieve desired intentions rather having others determine what information is made available. By the same tenet, if cell phone technology had included landscape design perspective better cell tower designs with less powerful signals might now be more widespread.

Chapter 4

Pervasive Computing

4.1 What is Pervasive Computing?

Pervasive Computing has grown out of the Ubiquitous Computing movement. However, where as Ubiquitous Computing is about creating specific devices and network connectivity, Pervasive Computing is about the proliferation of computers into all areas of the human environment through embedding them in existing objects and by creating new manufactured goods that emulate and enhance currently used objects. This proliferation of computers in everyday objects will also include the addition of wireless networking into those same objects. Proponents of Pervasive Computing support the creation of an infrastructure, that would allow people to access relevant information and services from powerful ubiquitous secure intelligent networks. This new infrastructure would allow a user to improve efficiency and modify their experiences by minimizing the involvement required to accomplish a task.

Current digital devices require users to focus their full attention to use them. Sometimes these digital devices demand extensive user input and time to set-up and configure. These pervasive devices will be able to create spontaneous seamless networks, allowing them to adapt to their changing environments, instantly collecting relevant information from other devices. All these digital computing devices in the environment will be able to talk to each other allowing park users, for instance, to receive information about the park. A user could be looking for a park bench or picnic table to have their lunch at and may ask where the nearest open bench or picnic table is and the park network would be able to provide that information instantly. Or the question "I would like a bench that is in the sun during the next half hour" the park will be able to say whether this will be possible or not, weather permitting.

With a dramatic increase over the last decade in the use of embedded computers in consumer products such as telephones, cars, microwave ovens, video and audio equipment and a multitude of other systems and devices, why should electronic devices not have greater connectivity? The field of Pervasive Computing by its very nature is being driven by human interaction requirements. Why should a new TV and DVD player not automatically recognize each other and configure themselves? Why should a garden not digitally collect and distribute information on soil nutrients, precipitation, temperature, solar hours etc. for anyone who is interested? This is the same with other devices. Information appliances should be easy for everyone to use and human interaction with these devices should be intuitive.

With the development of smaller microchips which are finding their way into almost every possible artifact, and our desire to simplify our lives, the question is how to make such devices talk to each other in order to share common data and reduce the need to input possibly redundant information.

4.2 How does Pervasive Computing work?

At present Pervasive Computing needs a few key technologies to become truly functional. First, the development of new, smaller and more powerful computer chips, which would be embedded into digital devices. This reduction of computer chip size allows devices such as environmental sensors to take on new functionality to simplify and enhance the usefulness of a product. Second, devices that can communicate with each other are now able to transfer important information, which would otherwise have to be inputted, such as environmental data collected and transferred by many sensors to create a large environmental data base. This is possible through the development of inexpensive wireless data communication in homes, businesses, vehicles and public places. Third, once this infrastructure is created, what will still need to be done is the development of software that will allow these devices to run and share applications, and be capable of exchanging information regardless of platform, manufacture or implementation. This suggests information appliances that will work together to achieve a greater ability to access the information that people want, when they want it.

Initial pervasive systems should be based on an open standard of wireless networking, with software that is able to talk to other devices in order to transfer information. Subsequent systems may include intelligent software agents that will look for information a user may need soon, but has not yet requested. These systems will be able to read necessary information from surrounding devices in order to assess where and under what context it is being used (be it in a restaurant, meeting, store etc.) as well as who is with the user. It will basically be able to know the "who, what and where" of a situation. The networking infrastructure which has been used for the Internet may be the base of the system. Small intranets will, however, appear in various locations, enabling access to bigger networks when needed. Pervasive computers may record events and process information so that people will be free to attend to, synthesize, and understand what is happening around them more fully with the knowledge that specific details will be available for later perusal.[21] This could be the collection of meeting notes, a colleague's phone number, email address or an automatic entry for laundry dropped off at the dry cleaners. Microprocessors will be attached to sensors which could provide many forms of previously unthinkable information such as localized weather conditions, current air quality due to traffic pollution, up-to-the minute bus schedules with time of arrival, precipitation that the roots of a certain tree receive, distribution of nutrients in a plant bed, precipitation on a plant bed, solar hours received, a person's vital statistics etc. The applications are limitless.

Speech-based user interfaces have been proposed as an alternative to standard keyboards because speech is a natural form of communication that uses little physical space and offers extended mobility. Pervasive computers may often fulfill certain social roles for people, such as acting as personal assistants, delegates, or guides throughout an environment. They will therefore have to take verbal cues from their

[21] Gregory D. Abowd, Classroom 2000: An experiment with the instrumentation of a living educational environment, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999), 508 <http://www.research.ibm.com/journal/sj/384/abowd.pdf> (10 June 2002).

users. Pervasive computers might appear to have a considerable level of intelligence and know something about the relationships between persons, places and events. In addition, the devices themselves will take on a personal nature by virtue of their extreme physical proximity.[22]

4.3 What are Pervasive Computing's social issues?

A problem with many digital devices is that they require the user's full attention as do desktop, laptop, Personal Digital Assistants (PDA's), remote controls (until we memorize all the buttons) cellular phones, etc. Those studying Pervasive Computing are looking at how computing technologies are seen and used, in an effort to create new devices that accomplish tasks without interfering in people's lives and without the steep learning curves currently encountered. Their question is whether these systems will enhance or inhibit social interactions.[23] "If pervasive computing has the effects imagined today, humans will not only have a far different kind of relationship with information and computers, but that relationship will pervade much more of our lives and in many more ways than today."[24]

"Many individuals fear that as life becomes more technological it also becomes less 'human.'"[25] Pervasive Computing developers are trying to make computers and technology more compatible with humans so they will complete tasks without having people focus and interact with them – in effect, making them disappear into the background. The intention is to create technologies which allow humans to apply greater emphasis on human social interaction, rather then interacting with the technology itself.

Current market research shows that mobile computing is growing quickly, suggesting that people want to be able to carry and access information instantly wherever they are. With today's technologies, however, time is mainly spent interacting with devices rather than with each other.

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22 D. C. Dryer, C. Eisbach, and W. S. Ark, At what cost pervasive? A social computing view of mobile computing systems, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 652 <http: //www.research.ibm.com/journal/sj/384/dryer.pdf> (10 June 2002).

23 Hoffnagle, Gene F. Ed., Pervasive Computing – Preface, (IBM Systems Journal – Pervasive Computing Vol.38, No.4, 1999) 503 <http://www.research.ibm.com/journal/sj/384/preface.pdf> (10 June 2002)

24 Ibid., 503.

25 D. C. Dryer, C. Eisbach, and W. S. Ark, At what cost pervasive? A social computing view of mobile computing systems, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 652 <http: //www.research.ibm.com/journal/sj/384/dryer.pdf> (10 June 2002).

> "The market research firm Frost and Sullivan projects the mobile computing market to reach $99.9 billion by 2003. This market includes a growing variety of laptop computers, hand-held computers, personal digital assistants (PDA's), wearable devices, and appliances. The IDC reports that portable-PC-unit sales alone are already 22 percent of desktop-PC-unit sales (15.5 million vs. 71.5 million worldwide in 1998) and that over the next four years the unit-sales growth rate for portable units will be higher than that for desktop units. The rise of these portable computers means that computers are becoming more pervasive and will be affecting human lives in unforeseen ways."[26]

Studies also show there is a certain awkwardness to using a computer in the company of other users. "As an example, persons often avoid using laptop computers in meetings or other social situations. Using computers is typically a sufficiently complex task that it distracts a person's attention away from others. Moreover, the sound of typing and the raised screens of laptops themselves can be disruptive in meetings."[27] Dryer's studies have led him to suspect that new devices could avoid some negative impact if they took on forms that were more familiar. These could be computers that resembled leather portfolios, watches and other familiar forms. "Some companies have explored designing pervasive products for women and other groups… their target group was women between the ages of 18 and 30 and their target product was a pager. The design of these pagers was informed by interviews of their target group. Unlike the pagers that were common at the time, the new designs could be worn as jewelry and had a very sleek, aesthetically pleasing case."[28] Since, "we are social animals, and for any technology to be useful, it must eventually support socialization; otherwise it will not survive."[29] Societies support for digital technologies seems to occur, either through the elimination of technological interference or through the creation of devices which have greater aesthetic appeal which removes any negative connotation associated to them.

4.4 What are the problems with Pervasive Computing?

Standards are a major problem for Pervasive Computing. As long as there is more than one standard, digital objects may not be able to communicate correctly. One set of rules has to be developed and all key contributors have to adopt and adhere to those rules for Pervasive Computing to be truly successful.

26 D. C. Dryer, C. Eisbach, and W. S. Ark, At what cost pervasive? A social computing view of mobile computing systems, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 652 <http: //www.research.ibm.com/journal/sj/384/dryer.pdf> (10 June 2002).

27 Ibid., 652.

28 Ibid., 652.

29 W. S. Ark. and T. Selker, A look at human interaction with pervasive computers, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 506 <http://www.research.ibm.com/journal/sj/384/ ark.pdf> (10 June 2002).

4.5 Case Studies: How can Pervasive Computing be used?

In order to understand the potential impact of Pervasive Computing three examples are given here of this technology.

Imagine walking up to an exercise machine while wearing some form of identifier. As you sit down at the machine, the voice of an electronic trainer welcomes you personally and reviews what you have previously achieved at this machine. "Hi Wendy, it's been two days since you worked out. I think you're ready to raise the weight by ten pounds. What do you say we do ten reps (repetitions) at 100 pounds?"[30] At this point you are able to accept the program or modify it further. During the course of the workout the machine could encourage and coach you in order to help you achieve a better workout. Once the workout is completed this information is automatically added to your personal workout record, which monitors your progress and physical condition.

In another example Pervasive Computing is being developed for use in a classroom environment in a project called "Classroom 2000".[31] This project is an attempt to support both teaching and learning in a university setting. Imagine a pervasive classroom which records the activities of the class, all presented notes, slides, the instructor's explanations, students' questions and answers. These records would all be time-coded so as to enable future access of any part of the lecture in any order. Notes and slides would be presented on a "smart" whiteboard that would instantly supply this information wirelessly to students via their portable computers. This would remove the need to rewrite notes presented in class and allow students to add their own thoughts on the subject. This type of teaching environment would allow for greater interaction between instructor and student and create an environment that would encourage free thinking rather than pure note taking.

The third example is how pervasive computers could monitor global biodiversity, and sense for low-level sources of pollution. "Equipped with a new generation of sensors, automobiles and trucks could

30 W. S. Ark. and T. Selker, A look at human interaction with pervasive computers, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 505 <http://www.research.ibm.com/journal/sj/384/ark.pdf> (10 June 2002).

31 Gregory D. Abowd, Classroom 2000: An experiment with the instrumentation of a living educational environment, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999), 511 <http:// www.research.ibm.com/journal/sj/384/abowd.pdf> (10 June 2002).

monitor their own emissions and download the data at a service station, to a home computer or transmit it in batches over cellular networks... as networked sensors become dramatically less expensive and have wireless capability built into them, we may find them in a Midwest cornfield, helping farmers optimize water and fertilizer use and minimize the use of harmful pesticides. Sensor systems could go where we cannot, monitoring environmental damage in an oil spill or forest fire, tracking ocean currents or helping biologists unravel the wonders of a rain-forest canopy. We could begin to instrument whole ecosystems, using ground-based sensors."[32]

4.6 Summary

Pervasive Computing is quickly becoming the next stage in the information technology industry. It brings with it simplicity of use, ubiquitous access, reliability and a more intuitive interaction, with a minimal technical expertise. "Part of the beauty of pervasive computing is that we will not even realize it is here, once it has become a necessary part of our lives. In the future it will often be invisible, and the user interface will be intuitive. The other important part is that it will all be networked. Data, once entered, will never have to be entered again, but will be readily available whenever and wherever needed."[33] The question is not whether society will embrace this developing technology but how it will happen. Landscape architects must start looking at how this will affect our profession and how they may benefit from its adoption.

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32 John Seely Brown, and David Rejeski., Ecological Computing, The Industry Standard, (25 December 2000) <http://www.findarticles.com/cf_0/m0HWW/52_3/68658711/p1/article.jhtml> (8 April 2002).

33 W. S. Ark. and T. Selker, A look at human interaction with pervasive computers, (IBM Systems Journal – Pervasive Computing Vol. 38, No. 4, 1999) 504 <http://www.research.ibm.com/journal/sj/384/ark.pdf> (10 June 2002).

Chapter 5

Calm Technologies

5.1 What are Calm Technologies?

> *"When computers are used behind closed doors by experts, calmness is relevant to only a few. Computers for personal use have focused on the excitement of interaction. But when computers are all around, so that we can compute while doing something else and have more time to be more fully human, we must radically rethink the goals, context and technology of the computer and all the other technology crowding into our lives."*[34]

If computers are to inhabit every corner of the world, they should be as unobtrusive as possible. Therefore they have to be designed so that those using them can remain serene and in control at all times. This implies that the Ubiquitous Computing era brings with it a new challenge of designing calmness into computers. This has led to the idea of Calm Technology (CT), a term coined by Mark Weiser, chief technologist, and John Seely Brown, director of the Xerox PARC lab. The idea behind CT is to reduce the

[34] Mark Weiser and John Seely Brown. The Coming Age of Calm Technology Xerox PARC. Palo Alto, CA., 5 October 1996, <http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm> (12 February 2002).

"excitement" of information overload by allowing a user to select what information is peripheral. Calm Technologies are about creating a system where information is allowed to exist in our *periphery*, which can be switched to our *centre* (main focus) the moment we need it and back once done. It is believed that doing this will not only relax a user but allow greater amounts of information to exist in their periphery until it is ready to be used. The idea of periphery is similar to an expert's acquired knowledge. It is stored in the unconscious mind and then is brought to the conscious mind when needed. This is also known as intuition. The idea is that the smartest people are those who have built up the densest periphery, and can apply it quickly to new problems. CT is about creating a digital periphery that can be quickly accessed allowing people to attain needed information for instant decisions. Mark Weiser has compared today's PC's to looking at the world through narrow tubes taped to our eyes, blocking our peripheral vision: causing us to stumble, constantly be surprised, and tire quickly.[35] PC's narrow our peripheral vision to only the information on the screen in front of us, demanding our full attention.

> *"So the ultimate goal of ubiquitous computing is to implement calm technology, a world where computers do not cause stress, but enhance our lives and make many tasks easier. Eyeglasses are an example of calm technology. They help us to see the world more clearly, but they do not distract us from what we are doing, and we are barely aware of their existence. [Weiser]*[36]

The purpose of a computer is to help people to accomplish tasks. Logically, therefore computers should disappear, becoming an extension of our unconscious mind and helping make people smarter, allowing them to work intuitively and directly on any problem. The greatest strength of Calm Technologies lies in the fact that computers are designed and developed to conform to the user, and not the other way around. CT is about allowing users to become more attuned by allowing them to attend to less. This suggests the design and building of technology that complement human modes of thinking. The information technology revolution is only fifty years old and is still in its infancy. Compared with the millennia of human history, it should be unthinkable that this technology dictate our existence.

35 Weiser, Mark. The Invisible Interface: Increasing the Power of the Environment through Calm Technology, Opening Keynote Speech, 25 February 1998, <http://www.darmstadt.gmd.de/CoBuild98/abstract/0weiser.html> (8 April 2002).

36 Björn Hermans, Desperately Seeking: Helping Hands and Human Touch, "Section 4.3 - Calm Technology (CT): Increasing Supply Without Increasing Demand", 8 July 2000 <http://www.hermans.org/agents2/ch4_3.htm> (11 June 2002).

5.2 How do Calm Technologies work?

CT has a goal in achieving harmony and calmness with its users. It is therefore not a method and giving a detailed description may not be possible. Expressing the ideology behind it can, however, be accomplished. The main goal behind CT is to help solve the problem of "information overload" by remembering things for people and storing this information in their "digital periphery" until it is needed and required. Humans already have many things in their periphery (street signs, traffic signs, commercial signage, etc.) that are quickly seen and acknowledged, allowing them to use these forms of information to help in decision making and on how to proceed with activities. Calm technology tries to do the same thing with digital information as has been done with traffic signage and other environmental information. If people can use current signage in their periphery the question becomes whether computing systems can be developed to do the same thing? There are many clues in the human environment which provide information about what people need to do. A push bar on a door tells us that the door opens outwards. This information exists in the mental periphery and does not interrupt human actions since it quickly informs people to push and not to pull from the design of the door hardware. Digital information should work in a similar way by placing relevant information in the user's periphery in easy-to-access forms so that it can quickly become acknowledged by the user and then allowed to disappear back into the periphery. Research centres are trying to achieve these calm technologies by developing systems with verbal and visual interfaces that will create a less obtrusive way of communicating with computers than current input and output interfaces.

5.3 What are the difficulties surrounding Calm Technologies?

The difficulty with developing new technology and introducing theories like CT is that their development uses existing technologies ones as guidelines. This can lead to the redevelopment and redesign of existing technologies. The development of Calm Technologies requires understanding of how humans think and work – not with existing electronic goods but rather as a whole. How do humans adapt to new tools, experiences and environments? What matters is not technology itself, but its relationship to humans.[37] Computers have changed how humans work by obliging them to learn new techniques and technologies. The computer was designed to support people with daily work, yet it can be argued that humans have been relegated to supporting computers in their daily work.

5.4 Case Studies: How can Calm Technologies be used?

With a greater integration of computers into human routines, they will become so unobtrusive that we do not even notice how they increase the ability to execute better informed actions. Mark Weiser likens Calm Technology to an office window, where an occupant can get a sense of the office's atmosphere through their peripheral vision while accomplishing their own tasks. These peripheral movements can inform someone that it is lunchtime, that a meeting is about to start or that someone urgently needs to speak to someone else when they finish a phone call, because they have peeked into the office three times in the last couple of minutes. The office window becomes a connection to what is happening in the rest of the office. This is the type of connection that proponents of calm technology want to achieve with computers.

Artist Natalie Jeremijenko created an installation called "Dangling String" which translates how busy a computer network is.[38] This is accomplished by mounting an electric motor to the ceiling with an eight foot piece of plastic string, which is connected to a computer network. As each bit of information travels through the network it causes the motor to move the string. A busy network would cause the string to whirl quickly and a quieter network would hardly move the string at all. This installation is a simple example of how digital information can be communicated to us through our environment, without us having to look for it or focus on it. It is like a gust of wind or drop of rain informing us about environmental conditions.

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[37] Mark Weiser and John Seely Brown. The Coming Age of Calm Technology Xerox PARC. Palo Alto, CA., 5 October 1996, <http://www.ubiq.com/hypertext/weiser/acmfuture2endnote.htm> (12 February 2002).

[38] Mark Weiser and John Seely Brown. Designing Calm Technology, Xerox PARC. Palo Alto, CA., 21 December 1995. <http://www.ubiq.com/weiser/calmtech/calmtech.htm> (10 April 2002).

5.5 Summary

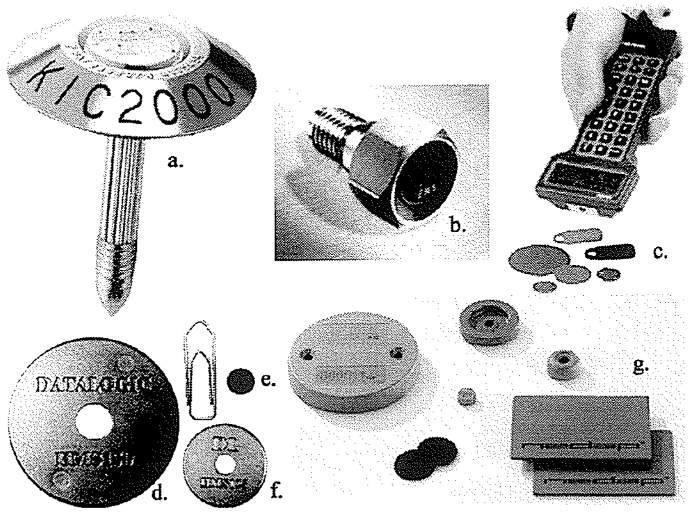
> *Over the next twenty years computers will inhabit the most trivial things: clothes labels (to track washing), coffee cups (to alert cleaning staff of moldy cups), light switches (to save energy if no one is in the room), and pencils (to digitize everything we draw). In such a world, we must dwell with computers, not just interact with them."*[39]

Calm technology is about creating new ways to allow computers to communicate information to people without having to pay full attention to them. Mark Weiser believes this may be the most important design problem of the twenty-first century. Designers must direct their work of the human periphery so that humans can fully command technology without being dominated by it.[40] This type of technology is about creating an information system that alerts human senses but not the conscious mind, allowing access to the information that people want. The result of calm technology is to make people feel that they are in a familiar place. When the human periphery is functioning well, people are tuned into what is happening around them, what is going to happen, and what has just happened. People are connected effortlessly to a myriad of familiar details. This connection can be called "locatedness".[41] The fundamental challenge in the development of new digital technologies should be to create technologies that respect humans for who and what we are, as well as the environments we inhabit.

39 Mark Weiser. "Open House." Xerox PARC, March 1996, 3. <http://www.ubiq.com/hypertext/weiser/wholehouse.doc> (10 March 2004).

40 Mark Weiser and John Seely Brown. Designing Calm Technology, Xerox PARC. Palo Alto, CA., 21 December 1995. <http://www.ubiq.com/weiser/calmtech/calmtech.htm> (10 April 2002).

41 Ibid.



Chapter 6

Figure 2. Examples of RFID digital tags and reader: a. Data Nail, b. Bolt Tag, c. Low frequency tag reader and writer, d. HMS150(HT), e. HMS108, f. HMS125(HT), g. Low Frequency Tags

Digital Tags

6.1 What are Digital Tags?

Radio Frequency Identification (RFID) is a technology that is changing the way that humans interact with everyday objects. It is being developed mainly as a supplement and eventually a replacement for current bar code systems. This technology also has many potential applications beyond its intended use for supply chain management.

In order to understand RFID it is necessary first to understand how a Universal Product Code (UPC) bar code works. Most goods sold by retailers have a UPC bar code printed on their packaging. These bar codes help manufactures and retailers keep track of inventory. They also give valuable information about the quantity of products being bought and, to some extent, by whom the products are bought. These codes serve as "product fingerprints" made of machine-readable parallel bars that store binary code.[42] UPC was created and adopted in the 1970s in order to speed up the check out process in grocery stores. With the many advantages of UPC bar codes also come some disadvantages. In order to maintain current inventories, companies have to scan the bar code of every product. Also, bar codes are a read-only technology.

The concept of RFID systems originated in the 1940s as a means of distinguishing friendly aircraft from enemy aircraft during WWII. "In the 1970s the technology was applied to the identification and temperature sensing of cattle. In the early 1980s railroad companies began using the technology for tracking and identification of railcars."[43]

RFID technology appears to maintain the benefits of UPCs as well as correcting its disadvantages. The creation of "Smart Tags" will enable the embedding of intelligence and identity, and will allow network connectivity into everyday objects.

"Radio-frequency identification systems allow non-line of sight reception of an identification code assigned to an object. The identification code is stored in a tag consisting of a microchip attached to an antenna. A transceiver, often called an interrogator or reader, communicates with the tag. RFID systems alone are worthless. Though they may be able to collect identification codes, those codes must be assigned to an object and they must be made available to an accessible database. A network infrastructure that will support efficient and robust collection and delivery of information captured by RFID systems, or any other system capable of detecting identification codes, is currently being developed [2]. This system should support the capture, storage, and delivery of vast amounts of data robustly and efficiently".[44]

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42 Keven Bonsor, How Smart Labels Will Work, Marshall Brian's How Stuff Works, 2. <http://www.howstuffworks.com/smart-label.htm/printable> (10 June 2002).

43 Tom Ahlkvist Scharfeld, "An Analysis of the Fundamental Constraints on Low Cost Passive Radio-Frequency Identification System Design:" (Masters of Science Thesis, Massachusetts Institute of Technology August 2001), 8.

44 Ibid., 9.

6.2 How do Digital Tags work?

In simple terms, RFID systems are made up of two types of hardware – the tag and the receiver or reader. These are supported by software that includes digital ID codes and databases.

There are two types of RFID tag - passive and active tags. "Passive RFID tags are small electronic components with an integrated circuit and a small antenna usually sealed in one small package... The tags do not need a battery; they are energized during access by the reader via electromagnetic induction".[45] Some passive RFID tags can be read from distances of up to 10 metres away.[46] "They transmit data by reflecting or back scattering the RF energy back to the reader. The reader (scanner) becomes both a communications device and an energy supply for tags... Active RFID Tags are designed to actively transmit data to the reader using the power of a battery attached to the tag. The RF received from the transceiver is used for communication only".[47] Active tags are capable of transmitting data further distances, about 100 metres with some currently marketed products.[48] These distances may someday be surpassed with the development of new tags and readers.

"Unlike bar codes where the data is fixed once it has been printed, the data stored in an RFID label can be modified, extended or reduced by authorized users (read/write labels only)... Also unlike bar codes, RFID labels are not subject to the same restrictions of visibility. All that is required to detect an RFID label is that it must be within the field of the reader and not be blocked by metals or liquids".[49]

The reader or transceiver can be either static or portable. Static readers could be built into grocery shelves, check-out lines, conveyor lines in warehouses, in airport security scanning devices and many

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45 Albrecht Schmidt, Hans-W. Gellersen, and Christian Merz, Enabling Implicit Human Computer Interaction A Wearable RFID-Tag Reader, (TecO, University of Karlsruhe, and SAP AG, Corporate Research, CEC Karlsruhe),<http://www.teco.edu/~albrecht/publication/iswc00/wearable-rfid-tag-reader.pdf> (21 June 2002).

46. RFID Journal, Passive, Active RFID Tags Linked, 24 July 2003, <http://216.121.131.129/article/articleprint/512/-1/1/> (10 March 2004).

47 SCS Corporation, RFID Overview, <http://www.scs-corp.com/RFID_Overview.htm> (10 June 2002)

48 RFID Journal, Passive, Active RFID Tags Linked, 24 July 2003, <http://216.121.131.129/article/articleprint/512/-1/1/> (10 March 2004).

49 EAN International & Uniform Code Council Inc. "EAN.UCC White Paper on Radio Frequency Identification", November 1999, 11. <http://www.autoid.org/SC31/clr/200305_3821_EANUCC RFID WP.doc> (21 June 2002).

other locations. Portable readers are currently used by delivery persons, warehouse workers, department and grocery store stock persons and many others in order to track products from creation to delivery to the customer.

"The reader is comprised of an antenna and a controller. The controller can be further broken down into three main functions:

- A processing function that codes and decodes the data, checks the data, stores the data and communicates with the host
- A RFID tag communications manager is responsible for activating the RFID tag, initializing a session, reading and writing data, authorization, integrity checking, etc.
- Physical communications, the frequency, data rate, modulation and power."[50]

With the hardware components in place, RFID's also needs a software solution to enable them to communicate information. The joint venture organization EPCglobal was formed for the development of standards for identification and classification systems that will allow readers to use and interpret RFID's.[51] These digital tags theoretically have no limit to their data capacity. But the more data capacity a tag has, the greater the cost, with a reduced range of operation. Unique ID's are being developed consisting of 96 bits of information, including the product manufacture, product name and a 40-bit serial number.[52] These smart labels will be read and compared to a networked database. Like any digital medium, an RFID label can be password protected for both reading and writing. This will allow a single RFID label to contain both protected and unprotected data.[53] A reader will be allowed to read only a few bits of information from anywhere on the label to the entire label depending on the access granted to the reader. These digital labels are set up to identify more than 268 million manufacturers with more than a million individual products

50 EAN International & Uniform Code Council Inc. "EAN.UCC White Paper on Radio Frequency Identification", November 1999, 7. <http://www.autoid.org/SC31/clr/200305_3821_EANUCC RFID WP.doc> (21 June 2002).

51 Bob Brewin, "Defense Dept. working to resolve RFID standards issue - Computerworld," 4 December 2003, <http://www.computerworld.com/softwaretopics/erp/story/0,10801,87808,00.html> (10 March 2004).

52 Keven Bonsor, How Smart Labels Will Work, Marshall Brian's How Stuff Works, 6. <http://www.howstuffworks.com/smart-label.htm/printable> (10 June 2002).

53 EAN International & Uniform Code Council Inc. "EAN.UCC White Paper on Radio Frequency Identification", November 1999, 12. <http://www.autoid.org/SC31/clr/200305_3821_EANUCC RFID WP.doc> (21 June 2002).

each.[54] This unique ID is used in relation to a large data base system which is connected via wireless local area networks (WLAN) and also via internet connection to company or universal product databases.

Most of the data retrieval can occur with the local network of the store or warehouse without connecting to the Internet. The user can customize the reader's operations to suit the requirements of the application through the software associated with the reader.

6.3 What are the problems with Digital Tags?

The main problem with digital tags is that their cost is still higher than the cost of bar code labels. Although the use of RFID's may not be very economical at the moment, with further development and advancements in this area, digital tags will eventually surpass the data capacity of bar codes for the same price point. Other problems with digital tags are ineffective readability due to interference of metals, liquids and EMI (electro-magnetic interference) from computer equipment and some other electric components. These problems are likely to be eliminated in due course. There are also concerns of health risks due to RF emissions. RFID labels do not present any risk since they are inactive until a reader is present.[55] Further study on levels of emissions, proper shielding and use of the technology, means health risks will likely be eliminated. One problem with digital tags that can not be solved through research, testing and development is public perception of this technology being used to spy on people purchasing habits. This can only be controlled through legislation designed to ensure that this technology is only used for its intended purpose. Like all technologies, inappropriate uses could develop and, as a society, we have to create laws to protect ourselves from them.

6.4 Case Studies: How can Digital Tags be used?

Digital tags have many potential uses. They were designed for use in logistics, asset management and Electronic Article Surveillance (EAS). RFID tags will allow companies to track a product through the supply chain right until it is bought by a customer. Products with digital tags will warn when they

[54] Stephen Shankland, "Digital dog tags: Would you wear one?" Staff Writer, CNET News.com, 8 February 2002, <http://news.com.com/2100-1001-833379.html> (10 June 2002).

[55] EAN International & Uniform Code Council Inc. "EAN.UCC White Paper on Radio Frequency Identification", November 1999, 14. <http://www.autoid.org/SC31/clr/200305_3821_EANUCC RFID WP.doc> (21 June 2002).

are leaving a warehouse or arriving at a department store so that the wholesaler or store personnel will instantly know when a product is in stock. A supplier will rarely run low on stock since products will instantly be inventoried. Digital tag readers can be built into shelves to aid in the placement of stock or to alert when stock has been misplaced in the wrong location by new staff or customers who have changed their minds about purchasing a product and do not return it to the correct product location. Readers which can automatically tally or store the product ID codes for rapid checkout upon leaving the store could also be built into shopping carts. The digital tags could be used by stores for theft protection and for tracking stolen goods. Tags could also warn customers that they are leaving the store with unpaid goods and that if they proceed the products will be marked with a "stolen product" code. These digital codes may even act as digital keys disallowing products from functioning if they have been encrypted by the security system. These digital codes could also allow customers to access product information via a cellular phone or other personal communication devices.

Once a customer has purchased and returned home with a product, these digital tags could have instructions for the products use such as cooking times for microwaves and ovens, as well as instructions for smart washing machines on temperatures and settings. They could also allow smart appliances to know when a product has expired or needs restocking, reminding the customer to purchase more or take it off their list if they no longer use the product.

Airport security and baggage management is another large current and potential user of this technology. Digital tagging allows an airport to handle baggage more quickly and more efficiently. It can confirm that both the passenger and baggage are on board and if not to locate and remove the baggage, or determine its location in the airport. Baggage could also be tagged upon check-in with a corresponding confirmation tag on the boarding pass.

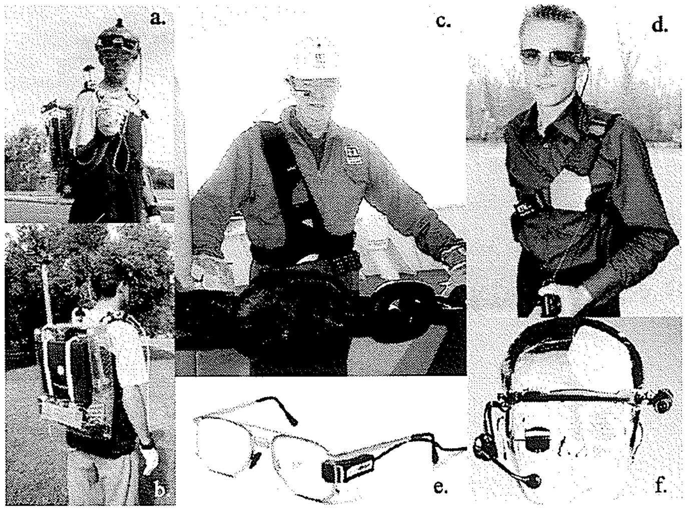
"Digital tags have many potential uses in product authentication, image/brand protection, and document management such as medical records, passports, visas, drivers licenses and identification cards... They could be used to verify the authenticity of sporting event tickets, concert tickets, gaming chips in casinos, and ski lift passes."[56] In the landscape, digital tags could be used to track and record information

[56] SCS Corporation, Authentication Applications, <http://www.scs-corp.com/auth-apps.htm> (10 June 2002).

about the vegetation, such as in a botanical garden, to inform visitors of the types of plants they are viewing. In amusement parks they could be used as digital passes onto rides, and to set off certain devices in the landscape when the user is close to them, depending on the type of experience purchased. In a historic site they could be located in objects throughout the site to inform visitors about objects of particular interest to them, providing them with an enhanced informative tour or journey through time. Digital tags could also be placed into playground equipment and surrounding areas, to allow for digital treasure hunts and other games that could help enhance a users learning.

6.5 Summary

Digital tagging has great potential and merits extensive research and development. There are many ways in which this technology should and should not be used. Certain specific types of information might be valuable for specific needs – such as the tagging of trees and other plants in order to track their progression from germination to final placement on a site. The collection of this information could give a clearer picture on stresses to which certain vegetation may have been subjected to and help identify how such problems may be reduced. This technology has the potential for many different applications – some of which will be examined in Part 3 of this practicum.



Chapter 7

Figure 3. Examples of Wearable Computers: a. Tinmith Endeavour Backpack front view, b. Backpack back view, c. Mobile Worker, d. WC Zurich, e. Project vision, f. Warp computer

Wearable Computers

7.1 What are Wearable Computers?

With a greater acceptance and use of Personal Digital Assistants (PDAs), laptop computers and cellular phones, people are demonstrating that they want to have instant and constant access to digital data and communication networks. Current portable computers and PDAs fail to become fully part of our daily lives by making us stop our natural activity flow and expend unnecessary conscious effort in their use. Wearable computers which can be left constantly running to interact with the user and the environment are a possible alternative. Not needing a user's full attention to function, they would allow a person to perform tasks which would otherwise be interrupted if any other type of system where used. One form of wearable computer might be a small lightweight device that can be worn on one's body without causing discomfort and using some sort of video display built into a pair of glasses and connected to a wireless computer network. The term "wearable computer" still often invokes images of a person weighted down with a large backpack of electronics, including a large helmet "heads-up" display, similar to the system that Professor

Steve Mann developed and pioneered while a student at MIT. Needless to say wearable computers have changed greatly since their first incarnation and with further development they will become even smaller and less obtrusive to users and those around them.

7.2 How does a Wearable Computer work?

In order to understand how a wearable computer works we must first have an understanding of the hardware used in the creation of the first and current models. "A typical wearable computer consists of a battery powered PC carried on a belt or backpack, a head mounted display, input devices such as a touch-pad or a chord keyboard and a wireless communications device."[57] Some incarnations also include video cameras and microphones that are used as data input devices for recording the world around the user. Some people have also developed systems which include sensors for monitoring a user's biological signals such as heart rate and body temperature.[58] Since wearable computing is still a relatively new form of computing many of the systems developed are experimental. However, there are a few companies that are now developing and producing commercial versions of wearable computers. These commercial systems are a cross between a laptop, a PDA and a Walkman – but without a built-in monitor.

A major component of a wearable computing system is the display and how the user views information. This is accomplished by the use of a head mounted display (HMD) which projects an image directly in front of a user's eye, creating the illusion of a larger screen several feet away from the user's head. Initial systems were big and cumbersome, but recent advances in this area have led to tiny displays that can be mounted unobtrusively onto eyeglasses.[59] A HMD has the possibility of displaying areas larger than today's current monitor sizes and also allows for data to be laid over the top of the users field of vision, making it usable for Augmented Reality applications. One company, Microvision even developed a display system which does not project data on a screen surface but which draws patterns onto the retina using a laser beam, creating a red transparent computer display that only the wearer can see, the light levels it produces are much lower than U.S. nationally accepted standards.[60]

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57 Patrick Sinclair, PhD Nine Month Report Intelligence, Agents and Multimedia Group: Department of Electronics and Computer Science, University of Southampton, UK, 8 August 2000, <http://www.ecs.soton.ac.uk/~pass99r/research/9monthsfirst/> (12 February 2002).

58 Ibid.

59 Ibid.

60 Candace Heckman, "Eyesight of the future is here", 18 June 2001, <http://seattlepi.nwsource.com/business/27731_retina18.shtml> (3 May 2002).

The development of broad bandwidth wireless data channels, digital communication devices and the need for hands-free operation, sets the stage for wearable computers to manage cell phone communication, spoken email, verbal web browsing and other network data exchanges a user may have. However a wearable computer's functionality should not depend entirely on network solutions, since there may be locations where connectivity may fail.

A mobile computing system such as a wearable computer, in common with other computing systems, needs to provide a user some way of entering data into the system for processing. This could be accomplished with a wearable track pad, keyboard, or data glove. Other options may be the use of voice command or a system that tracks eye movements as an object-selection tool.

In addition to a wearable computer, such systems will need new graphic user interface (GUI), which will give users all the information they need without overwhelming them with data. Many previous and current wearable computing systems have been developed using available GUIs, however, developing the appropriate GUI for these types of system is necessitated by their particular use. Any new GUI must be able to present information quickly and concisely so as not to obstruct a user's view, or distract them from the "real" world. This will only come about by studying and understanding the needs and desires of the mobile computer wearer, through the development of new applications and methods for dealing with digital data that afford individual users the flexibility to adjust the systems to their desired comfort level.

7.3 What are the problems with Wearable Computers?

Current computer interfaces are often based on the windows-icons-menus-pointers (WIMP); this is the same for the interfaces of most appliances. Since these interfaces assume interaction with the device to be the primary task, and one which demands a user's full concentration, it is therefore not suitable for wearable computing. Users of wearable computers may be walking across the street, riding a bicycle or have distractions such as wind, rain or background noise and cannot afford to be interrupted by the interface. So, "wearable computers should be designed to support interaction with the real world rather than distract the user from what is occurring around them."[61] This leads to the paradigm shift of wearable

[61] Mark Billinghurst, . Wearable Appliances: the future of wearable computing, (Appliance Design Issue 2: Wearable Appliances, 2002), 6. <http://www.appliancedesign.org/issue2/issue2.html> (June 2002).

computing focusing on creating an appropriate interface rather than just being about hardware.

Another issue affecting wearable computers due to their inherently mobile nature is the demand for and efficient use of available power. Since these systems will always be on and ready to use, it is not logical to have to recharge or change battery packs on a regular basis. Therefore these systems need to be designed around power conserving technologies and to incorporate new power supply technologies. New smart computer chips are being designed to use only the amount of energy required, as opposed to mainstream chips that always function at full power capacity. Research is also being done at MIT on the creation and harvesting of personal energy for the generation of electrical power which can be used directly or stored for later use.[62] Research should address the new technology and also look at how the old technologies might be redesigned. But new technological demands generally need new solutions, not just a restructuring of old ones.

A major problem facing the development of wearable computers is their acceptance by society and future users. Like most new technologies, initial users are seen as techno "geeks". This negative view of technologies plays a big part in their future acceptance. A key question is whether the benefits of wearable computing are powerful enough to transcend any negative image and attract users. One problem is that anyone talking to a wearable computer user will never know if they are paying attention, surfing the web or doing something else between verbal exchanges. However, this is no different from today's verbal interaction. One is never sure whether the other person is listening, thinks of something else or daydreaming. As with all technologies it is a matter of raising people's comfort level with them. When cell phones were initially available, users were seen as elitist and cell phones were not seen as useful by the general public. As the user base increased and more people obtained cell phones, acceptance levels increased and its usefulness became evident to all. A certain social etiquette needs to be created for technologies in order for society not to lose grip on human values. The use of some technologies should be restricted in combination with certain activities, such as cell phones and driving. If wearable computing is truly deemed useful, its negative stereotype will disappear with its increased use.

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62 Nathan S. Shenck and Joseph A. Paradiso, Project: Parasitic Power in Shoes, Responsive Environments Group, <http://www.media.mit.edu/resenv/power.html> (10 March 2004).

7.4 Case Studies: How are Wearable Computers being used?

Some of the applications being developed for wearable computers span a range of different activities. At the University of Birmingham, England two design projects are currently underway examining the development of applications of wearable computers in the paramedic and fire-fighting fields. The paramedic application uses a wearable computer with a see-through head-mounted display. The system would allow a paramedic to record information about a current medical situation and patient details, and then allow the recording and display of diagnostic equipment. Paramedics would also be able to display a patient's medical alert information and receive guidance on protocol and procedure. Most of the information could be recorded through speech recognition and handwritten onto a digital tablet. The data could then be time stamped and linked to the recorded information from the diagnostic equipment. This would give hospital medical personnel a clearer picture of what procedures have already been performed and their effects on the patient. The fire-fighter system would use micro controllers connected to peripherals mounted in the fire fighter's helmet. The system would inform fire fighters of the ambient temperature in a burning building by sampling the surrounding environment as well as air supply levels in their breathing apparatus. These systems could also provide timing information (e.g., countdown to evacuation) and biometric data (e.g., heart rate, oxygen consumption, body temperature) giving a fire chief a clearer picture of the fire and of her/his crews' condition. In summary, wearable systems will allow quicker informed decisions that can save lives and fight fires more efficiently, reducing risk and personal injury.

Another use being studied and developed for wearable computing is the development of compelling consumer experiences or situated digital experiences, in which digital experiences are created to reflect and enhance a physical location. Some examples include digital art interventions and context-sensitive tourist and local history guides.[63] One such project is an art installation in the atrium at the Hewlett-Packard building in Bristol, England. It was developed with the collaboration of a local artist and musician. The installation, *A Year and A Day*, builds on the work of artist Liz Milner (Figure 4). An existing exhibition of woodland photographs is augmented by a digital soundscape created by the musician Armin Elsaesser. Visitors to the exhibition are invited to wear headphones with an integral ultrasonic

63 Richard Hull and Jo Reid, Experience design for pervasive computing, (Appliance Design Issue 2: Wearable Appliances, 2002), 19. <http://www.appliancedesign.org/issue2/issue2.html> (June 2002).

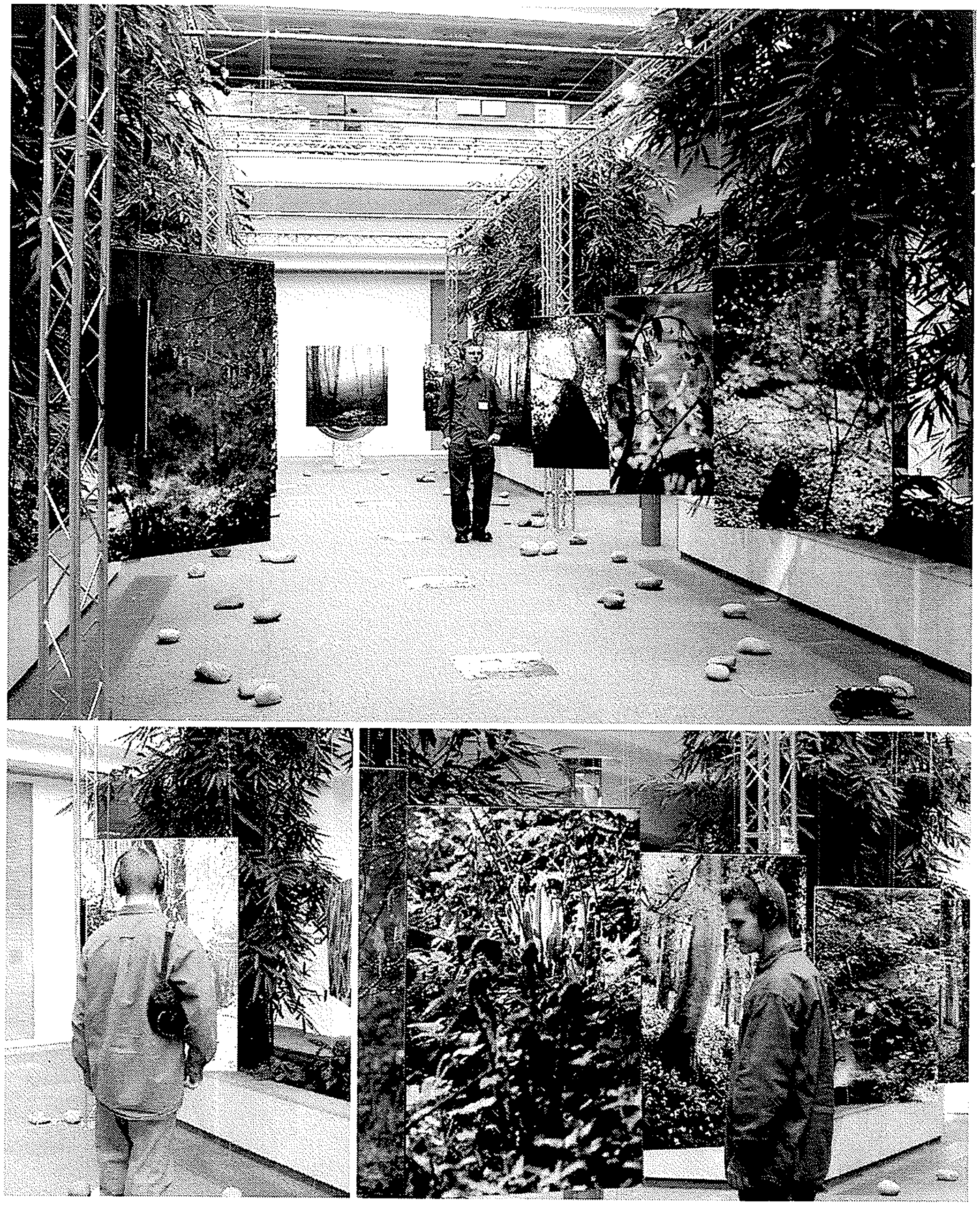

Figure 4. Images of A Walk in the Wired Woods at Hewlett–Packard in Bristol, England.

sensor that is connected to a handheld computer (with a wireless network connection) located in a small shoulder bag. "Equipped with this 'wearable client', the visitor typically spends around twenty minutes wandering around the exhibition, viewing the photographs and hearing music, woodland sounds and speech chosen to enhance their content. The particular sounds heard by the visitor at any point are determined automatically by the system according to their location within the exhibition space. For example, as the visitor approaches certain photographs, they might begin to hear atmospheric music appropriate to the scenes depicted. As they move on to other images, the music might be replaced by natural woodland sounds, or by a spoken fragment of woodland mythology".[64] The location of over thirty audio 'auras' used in the exhibition were determined by the artists relative to the association of particular sounds with photographs. These audio auras cover a one to two metre circular area each and are detected when a visitor enters the area. Where they overlap, the aura whose centre is nearest the portable system is the one that begins to play. The augmented exhibition received a positive visitor response and was likened to a walk in the woods rather than to a museum tour.

Another use of wearable computers is Augmented Reality (AR) systems that combine real world scenes and virtual scenes, augmenting the real world with additional information. This use will be discussed further in the next chapter.

7.5 Summary

It appears that, through Smart technology research, wearable computers have become a feasible method of mobile computing. Hardware has been designed, developed and built, and is being improved daily. But it is still not fully known how wearable computers will affect, change and enhance people's everyday lives. New uses for the technology have to be explored and studied. Attention can then be focused on studying the many different user requirements. As with all technologies, once the many eventual uses and benefits of the technology have been developed, it can become a mass-marketed commodity.

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[64] Richard Hull and Jo Reid. Experience design for pervasive computing, (Appliance Design Issue 2: Wearable Appliances, 2002), 21. <http://www.appliancedesign.org/issue2/issue2.html> (June 2002).

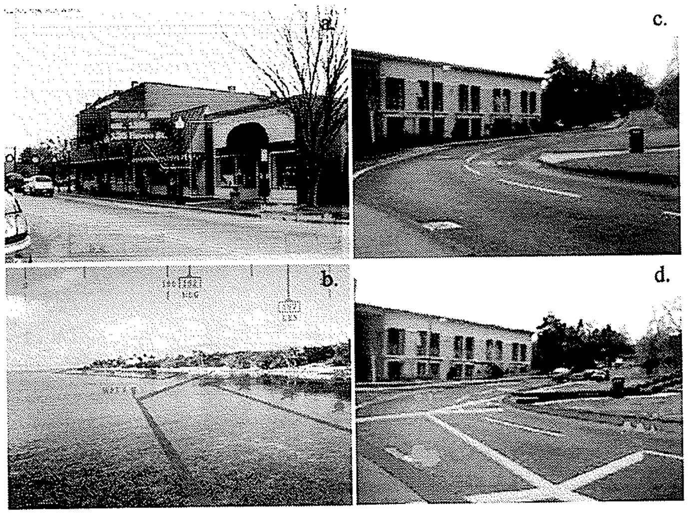


Figure 5. Examples of Augmented Reality: a. Overlay of computer–generated graphics b. Minefield Navigation, c. Real World, d. Augmented Subsurface Visualisation.

Chapter 8

Augmented Reality

8.1 What is Augmented Reality?

Augmented Reality (AR) is the enhancement of the real world by the superimposition of a complementary virtual world through the addition of real time computer generated graphics and data. This definition describes AR as a system that creates and applies enhancements with results that can be viewed on any form of output device or display. Current AR systems are able to present information in visual and audio formats. Future systems may also handle haptic and olfactory data. This study is primarily focused on AR systems developed for outdoor users that overlay graphic information on head-worn displays called Mobile Augmented Reality Systems (MARS). These may eventually be worn to create environments that are enriched with additional information about a landscape. This information might be tied to physical objects within the landscape, such as a statue or a bus stop.

Even though AR is still in the early stages of research and development at many Universities and high tech companies, other AR technologies have been the subject of studies and experiments for many years. This has made great contributions to AR. These include wearable computers, Virtual Reality (VR) systems, Head Mounted Displays (HMD), computer graphics, tracking systems, user interfaces and similar technologies. AR has quickly become a growing research field because it takes wearable computers beyond computational devices by creating systems that allow users to interact with their surrounding environments. Now is a good time to start developing strategies for AR, in landscape architecture because by its nature this highly inter-disciplinary field has many challenges and unexplored avenues, which can effect how environments are seen. It is believed that by the end of our current decade the first mass-marketed AR systems will be available. One researcher has called these "the Walkman's of the 21st century".[65]

Most of the work in AR is based on work done with its sister technology VR. Work in the field of VR has explored the development of virtual worlds and how to visualize them using Head Worn Displays (HWD). These HWDs have a tracking system that monitors users' head movements in order to coordinate what they see to the direction they are looking. Unlike VR, which places a user in a totally constructed computer world, AR takes the real world and adds digital information to it. AR has some similar conditions to VR – however, it does not need to create whole worlds and does not need as much of the rendering power that a VR system uses. AR is only concerned with the rendering of those objects needed in the creation of the enhancement, and not the whole viewing area. Since these virtual objects get placed in the real world, the main problem becomes how to locate them accurately so that they will always appear in the same location when viewed. Many of the problems that researchers are having with AR systems are about image registration - which is discussed later on in this Chapter.

The human environment is full of information that is not understood or accessed by many people. With its many types of plants, building styles, landmarks, businesses, etc., people may wish to have additional information available to them. This might include the name of a plant, location of an office or greater detail about a landmark. Augmented Reality presents information directly to the user who requires or inquires about it. AR can be applied to many different fields; therefore, what is required is to focus research and development toward the field in which one wants to apply the system. As landscape architects

65 Kevin Bonsor, How Augmented Reality Will Work, Marshall Brian's How Stuff Works, <http://computer.howstuffworks.com/augmented-reality.htm/printable> (15 May 2002).

and scholars part of our job is to present information about landscapes and the design of those landscapes to students and clients. AR is about presenting this information in a quick and easy to understand format. What better way to learn about something than to have the object and information directly in front of you as you are studying it? If plants in an environment were labeled using this technology, a student could learn their names and what they look like much more efficiently. The ability to access immediate information about a plant would assist a student in growing their overall knowledge base.

8.2 How does AR work?

The main components needed to make a mobile augmented reality system function are; a head-worn display, tracking system and a mobile computing system with wireless communications. There are two types of display systems that can be used. One is a transparent display that adds the AR data onto a projection surface. This system is similar to Heads Up Displays (HUD) used by fighter pilots. The other system uses video cameras to record what is being viewed, and then merges those images with the AR data, where it is finally projected on the Head Worn Display (HWD). This system is similar to VR glasses, because when the system is turned off, the user has to remove the glasses to see their real environment. The ultimate goal in the development of hardware for AR systems is to have head-worn displays that look and function like normal sunglasses. With the ability to incorporate the technologies from both types of display systems by adding computer - generated data and other graphics to the inside of the glasses.

An important part of AR systems is their ability to change graphics in relationship to a user's head-and-eye movements, so that the graphics always suit the perspective. Two main research activities in AR deal with the development of a proper registration system to handle overlaid images, as well as how the system displays merged images. Some of the computed data may need to be partially hidden by actual objects in the environment, such as a proposed building behind existing vegetation. AR systems not only need to add objects to the environment but may also require the ability to remove existing objects from the same environment. As well, it is important to create a system that is constantly registering images and properly handling their projection, because errors will cause user discomfort and reduce usability of the system.

AR will be able to give users a form of "x-ray vision" by displaying a digital representation of what is 'behind an object'. In relation to architecture, this "x-ray vision" will allow a user literally to see through walls by laying out the skeleton of the building and any mechanical and electrical systems in front of them, so that the user knows precisely where things are and/or where they were placed. The precision of what is being viewed might be aided by digital tags, which may be used in the tracking and inventory of building materials. In an outdoor environment it may allow the user to locate objects or buildings within the landscape that are hidden by other objects or buildings. It may also allow users to see where sub-surface structures and utilities are located and how they work, such as how water drains on the surface compared to its movement below-grade.

The linking of electronic data to physical locations is called "location-aware" computing. AR systems can be used for this type of data access, whether it is information about a historic site, transit schedules or current event information. The ability for people to access public information when they need it can be beneficial for residents or guests of a city. Essentially it allows them to be better informed.

One of the capabilities being developed for AR systems is the ability to let users add 'footnotes' to the physical world with their own views and data. This data could remain private or be posted to a public domain as a commentary of their experience. AR is a way of joining people's everyday lives, to what has now become their digital life. The same way people post comments to message boards on the Internet, people could do in their environments. This would help researchers analyze and access the types of changes the public may demand from their environment, as a result making some processes more democratic. AR systems will initially provide text and graphic-based information about a location, which could be enhanced by embedding multimedia into hypertext links allowing for other data such as animated fly-throughs, structural and thermal analyses, videos, essays and facsimiles of construction documents. These types of system could eventually provide an interdisciplinary database of information.

8.3 What are the problems with AR?

The accurate registration of computer-generated images with the real world is one of the main concerns with this new technology, because errors in registration will not allow the user to see the real world and the augmented world as one image. This registration must be maintained as a user moves within the real environment. If registration is not properly accomplished a user may get distracted or even physically ill from the movement of images, making the system unusable. Until an accurate registration is accomplished, AR systems can be developed without complex virtual augmentation or photo realism. Accurate registration is accomplished by having a system that accurately tracks the position and motions of the user. Researchers are creating systems that incorporate more than one tracking system; these require further study before becoming widely usable. "These technologies include a ceiling-mounted ultrasonic tracker covering a portion of an indoor lab, and a real-time kinematic GPS system covering outdoor areas with adequate visibility of the sky. For areas outside the range of both of these tracking systems, we have developed a dead-reckoning approach that combines a pedometer and orientation tracker with environmental knowledge expressed in spatial maps and accessibility graphs."[66]

AR systems could potentially create visual clutter. Research is being done with Information Filtering systems which will identify and prioritize what "information is relevant to a user at any given point in time. These priorities may be based on tasks, goals, interest, location, or other user context or environmental factors".[67] Research is also being done with View Management systems. "View management attempts to ensure that the displayed information is arranged appropriately with regard to its projection on the view plane; for example, virtual or physical objects should not occlude others that are more important, and relationships among objects should be as unambiguous as possible."[68]

As with many of today's emerging technologies, new solutions come quickly, especially when a technology is deemed worthy of development. AR has the potential for many applications in both the military and public realm and will hopefully develop at an relatively quickly rate.

8.4 Case Studies: How can AR be used?

The following case studies have been completed or are still in progress at various Universities. AR systems are being developed to instruct and guide users through tasks or through environments.

66 Tobias Höllerer and others, eds., Steps Toward Accommodating Variable Position Tracking Accuracy in a Mobile Augmented Reality System, (2nd Int. Worksh. on Artificial Intelligence in Mobile Systems (AIMS '01), Seattle, WA, August 4th, 2001), 31–37. <http://www1.cs.columbia.edu/graphics/publications/hollerer-2001-aims.pdf> (9 April 2002).

67 Höllerer, Tobias and others, eds., "User Interface Management Techniques for Collaborative Mobile Augmented Reality," Computers and Graphics, (25 (5), Elsevier Publishers, Oct. 2001), 2. <http://www1.cs.columbia.edu/graphics/publications/hollerer-2001-candg.pdf> (9 April 2002).

68 Ibid., 2.

Researchers at Columbia University are trying to develop AR systems to improve methods in construction, inspection and renovation of architectural structures in order to maximize efficiency by minimizing training time, and damage due to errors and costs. This system is called "Architectural Anatomy". It creates an AR which shows what happens behind architectural and structural finishes giving additional information about hidden structural elements.

Such systems will guide construction workers through the assembly of buildings and landscapes in order to help improve the quality of the work done through elimination of errors in understanding of 2-D drawings and the ability to have instant updates of current versions of construction drawings. A worker would be able to download current versions of the construction drawings from the main office each day and changes would be highlighted and audio commentary / directions could be included with the download.

AR displays could be used to show proposed buildings, landscapes or other environmental changes to a site so clients and politicians could have a quicker overall understanding of the project. This understanding could be further enhanced by allowing them to walk the actual site and experience the changes that will effect the site and surrounding area.

Inspectors could go through a site, checking off the highlighted objects that need to be inspected. These objects could have a verbal or text file attached to them to supply more information on what needs to be checked. This system would reduce any misunderstanding from what would otherwise have been written on their checklist or drawings. Any notes taken during the inspection would be annotated to the object or section being reviewed, allowing workers to have information automatically available to them.

Outdoor AR systems can also be used as navigation aids, providing users with information about their surroundings, and correct directions so they can find a better alternate route to their destination. This could be done by using the user's location and a map of the area to plot out the directions, thereby showing the user the correct route to take whether it is a street or a trail up a mountain in a national park. Some of the information they may receive could include street names, mountain peak names, elevations and distances to desired locations.

AR systems may also be used to give a tourist a sense of historical locations, such as ruins and legendary battlegrounds, appeared at the time the event occurred. Ruins could be reconstructed giving the user a better understanding of what these buildings looked like and how they were once used. A battleground could have a re-creation of the events and a description of the effects the battle had to the area. The tourist could see the events of many hundreds of years unfold in a matter of minutes; one could see the building being built, used, its first destruction, reconstruction, its final destruction and its decay to its current status as a ruin. This could all be happening right in front of their eyes. This could also be done with the decaying process of a tree or other vegetation in a forest trail. These AR techniques would give people a better understanding of how things work and how events have unfolded. Simply put, it has the potential of becoming an important learning tool.

8.5 Summary

Many of the hardware and technical challenges will likely be addressed with new research and technologies, which seem to be developing quite quickly. Regardless of current restrictions existing in the hardware, there will be significant benefits in developing the software and information that this new technology will use. So when hardware limitations are finally overcome, we may be positioned to be able to use these technologies immediately, than having to wait for the software. AR may become an important tool in education and for many other activities including landscape architecture.

Part Three

Chapter 9

Assumptions, Limitations and Relevance of using Technology in the Environment

9.1 Introduction

There are always many assumptions made by the designers and developers of new technologies. One of the main assumptions is that people are going to adopt and adapt these new technologies into their everyday lives. Many technologies have fallen by the wayside while others have bloomed into indispensable tools. It is hard to know what will succeed or fail but some common elements do exist in technologies which have succeeded. It seems that the technologies that help people to be more productive and do more with less have moved ahead together with those technologies that simplify people's daily tasks. However, sometimes competing technologies exist and it seems that unless one has more to offer then another, the one that can be mass produced and marketed seems to win out. With this in mind I will now review some of the assumptions and limitations made in this study concerning the use of digital technology in the human environment.

9.2 Assumptions

The assumption is that people will want to populate its outdoor environments with digital technologies. Humans constantly crave information but do not know how or when to access and deliver this information. A current movement in architecture and advertising is "Light Architecture", the development of buildings as multimedia displays. Society seems to want to layer human environments with more and more information. As this occurs, more of what many people really love is removed from human environments (such as the stillness and darkness of the night sky). The types of technologies reviewed in this study have been selected with the idea that people can personalize the information they receive and when they want to receive it. The adoption of many past technologies hinged on their usefulness and impacts on people's daily lives. People can not truly know how useful or detrimental a technology is and its total effect until it is developed and used. Society can only then decide whether it wants to adopt and adapt the new technologies to everyday life. It can be suggested that the technologies examined in this practicum will allow society to satisfy its quest for information without negative visual impacts on the environment. Only society can decide if this is a direction in which it wants to go, technologists can only offer the opportunity for it to happen.

It has been assumed that these technologies will function perfectly from the outset. Like all technologies there will have to be early adopters who will set the pace and direction for these new technologies. The vision that this study presents, requires the development and adoption of a basic system marking the shift toward ubiquitous computing. This study seeks to create a vision of how these technologies can be developed to assist in the quest for information and the development and conservation of landscapes. In order for this vision to be truly successful, hardware cannot be the only focus. Strategies need to be developed for the creation of information network's and services which will become the main focus of these systems. Furthermore, it is important that the user not become totally dependent on being connected to networked information systems. This is simply because, some environments may not be connected to these networks. The final product – whatever it may be – will have to be able to work independently as well as with information networks that are available.

9.3 Limitations

The main limitation of using technology in the outdoor environment is the slow growth and development of the technology industry in this direction. This industry as a whole has the power to direct users in the direction it wants them to go. It can be argued that the industry ought to consult users more about their needs and develop products that will better suit and serve them. The second limitation in the development of a digital technology is providing enough and appropriate services to convince potential users that this is a valuable tool that will grow and expand with their needs. A major limitation to implementation of any system is the development of the technology to work in expansive spaces such as the outdoor environment. An essential first step is to imagine the ultimate use of this technology. Once this has been established the challenge is to develop a cost efficient system that will handle the information that users might want to access. Once this has been solved users will be restricted by the content that is accessible by the system. Key questions include how this content will be produced; who will be responsible for the content, whether new tools have to be developed to create the content for these systems; whether the technology that will be used in outdoor environments will be reliable; what might happen if the information system were to go down; and whether there is a backup so that users are not at risk if this happens. Also, we would have to consider how these technologies might be developed in ways that respond to concerns about the protection civil of liberties, and the protection against undesired surveillance of individuals.

9.4 Relevance

People do not normally see technology in any scenario involving architecture and landscape architecture. Throughout human history many technological changes have been applied to outdoor environments. This can be seen in the materials being used, such as pressure treated wood, sprinkler systems, concrete products, plastics, as well as the development of new cultivars. Many people might contend that computers do not have a place in outdoor environments. Nevertheless, people are prepared to install timed plant watering systems and other digital controls in the landscape. It is often suggested that computers are a simple tool to accomplish one or two tasks. We have, however, seen computers become an integral part of every industry which has adopted them. They have become more than simply a tool, they have become a way of life and central to the carrying on of business. If computers became completely unavailable it would be comparable to living without electricity. People would find it hard to live in the manner to which they have become accustomed. Humans are thinking, sentient creatures who are constantly inventing, adapting and creating better ways of living. New technologies cause people to change their ways of living but it is human nature to constantly seek change. Part of this pattern of change is the desire for humans to develop computers with greater portability and functionality.

There are at least two principal directions in which computers might be developed. They could also be kept just as they are today with humans continuing to be drawn into a Virtual World where the computer is an integral part of human routines. It would be feasible for information and computers to be incorporated into every human environment filling the world with more artificial elements, or their visibility might be reduced by integrating technologies into human environments and letting individual users decide their own preferences. Those who might want to be more "plugged-in" would have the opportunity to be so. Those who might want minimal amount of interaction would be able to achieve it. The idea is to make computers almost invisible and to create a system which is ubiquitously available and which maintains the privacy of personal data. The future envisaged in this practicum is one where a person puts on a pair of glasses which provides the wearer with the type of information they would like – just as a person can put on a pair of rose coloured glasses they could put on, for instance, vegetation enhancing glasses or biology enhancing glasses. It is suggested, however, that the development of such technologies should ironically aim for them to operate in a harmony with nature.

9.5 Summary

This study assumes that society wants to make computing available in all environments – even those that are outdoors. This assumption is supported by current trends in technology and the blossoming of demand for information from the Internet. The extent to which society wants computers and new technologies in outdoor environments depends on their inherent usefulness. The principal question is whether such technologies might receive sufficient wide spread acceptance in order to make their development viable.

Chapter 10

Design Program

10.1 Introduction

This study is based upon the premise that it is necessary to understand and explore the implications of trends in the development of computer technologies in order to conceive of how they might affect the human environment. With an understanding of the possibilities and limitations of emerging technologies, it is possible to envisage technologies that could support development and maintenance of human-made landscapes.

What follows is a consideration of how emerging technologies could be developed for users with specific goals and intentions concerning outdoor environments. This is also an exercise in formulating potential areas for future research rather than an in-depth study of all viable uses. Rather than cataloguing a long list of user desires, the design program began by generating sample desires from different user types, as a springboard for developing applications of digital technologies, for use in the design scenario.

10.2 Site

The design scenario developed is for a potential outdoor laboratory located in the area around and between the Russell Building, Architecture II Building and the School of Music, on the Fort Garry campus at the University of Manitoba.

This outdoor laboratory might be used for research and instruction by the many Faculties that surround it in order to study the application of information to the site and how it would aid in informing on the subjects they teach. All information and technologies applied to the site would be updated and maintained by the students and staff of the faculties involved. The parties involved could be the Faculties of Agriculture, Engineering, Music, Fine Arts, Architecture, Sociology, Psychology, Education and any others who could contribute information or benefit from research the site might provide.

10.3 Program

The intention is to consider what it means to create landscapes and landscape interfaces that:

- allow users to become active participants in experiencing and learning about their immediate outdoor environments

- allow these participants to achieve daily routines that currently can only be accomplished in an indoor environment.

- allow developing an environment that collects, shares and is enhanced by information, without actually changing the physical look or feel of the intended landscape when not using the technologies.

In certain respects, the practicum envisages leaving landscapes untouched and using technology to add invisible layers of information, which would only be accessible through the use of technology. This has been accomplished by developing a list of possible information needs of four different user types (found in section 10.4), then selecting one of these user types, Landscape Architecture Students, for the development of a scenario in Part Four exploring hypothetical possibilities for the technologies examined in Part Two. As the scenario progresses, certain technologies are highlighted and discussed in greater detail, in order to further explore the possibilities of the technology in outdoor environments.

i) System being designed

The design scenario developed is an environment to aid in educating students about landscape architecture and assist in the research and development of emergent technologies. Information could be accessed with many different mobile devices, however for the purpose of this study and scenario the device under consideration involves a Wearable Computer with Augmented Reality capabilities. The site would be speckled with digital objects such a RFID tags and sensors, which would communicate with a users information system. These digital objects would also communicate with their corresponding databases to send or receive updated information (see Figure 6.). Each digital object would have a purpose in the landscape whether it is to collect spatial data or to just inform and denote the location of a tree or other landscape features. A user wanting information from the landscape would have their information system communicate with the digital object which could either reply with its limited data (tree type, current temperature, etc.) or send the information system its registration number linking the digital object to a database that might provide the desired information pertaining to it or send off the request for more information to other databases. With information being sought by many people, and with the increasing difficulty in managing personal information let alone that contained on numerous databases, some type of data management strategy will need to be implemented into the development of any emergent technologies. This is an area which has not been looked at in this research but would benefit the development of these technologies and how computing technologies are used to access information.

A person's information system would hold any important information that a user may need to access at any moment and may not want to have to access remotely. This information would be secured within the system and may only be made available to the user. One of the many objectives in the development of these types of systems is to build into them security measures that would protect and maintain a person's civil liberties. In order for this to happen, a better understanding of how information about the environment, communications and that of a personal nature might be used is needed. New digital technologies may be able to enhance individual possibilities by allowing individuals to control their own digital records, rather than have databases across the world littered with their personal information that currently exists. In order to make sure civil liberties are protected, respected, and properly legislated, constant reviews of how technologies, companies, and governments handle personal information must occur. Technologies should not be feared when it comes to civil liberty protection, but rather used to help

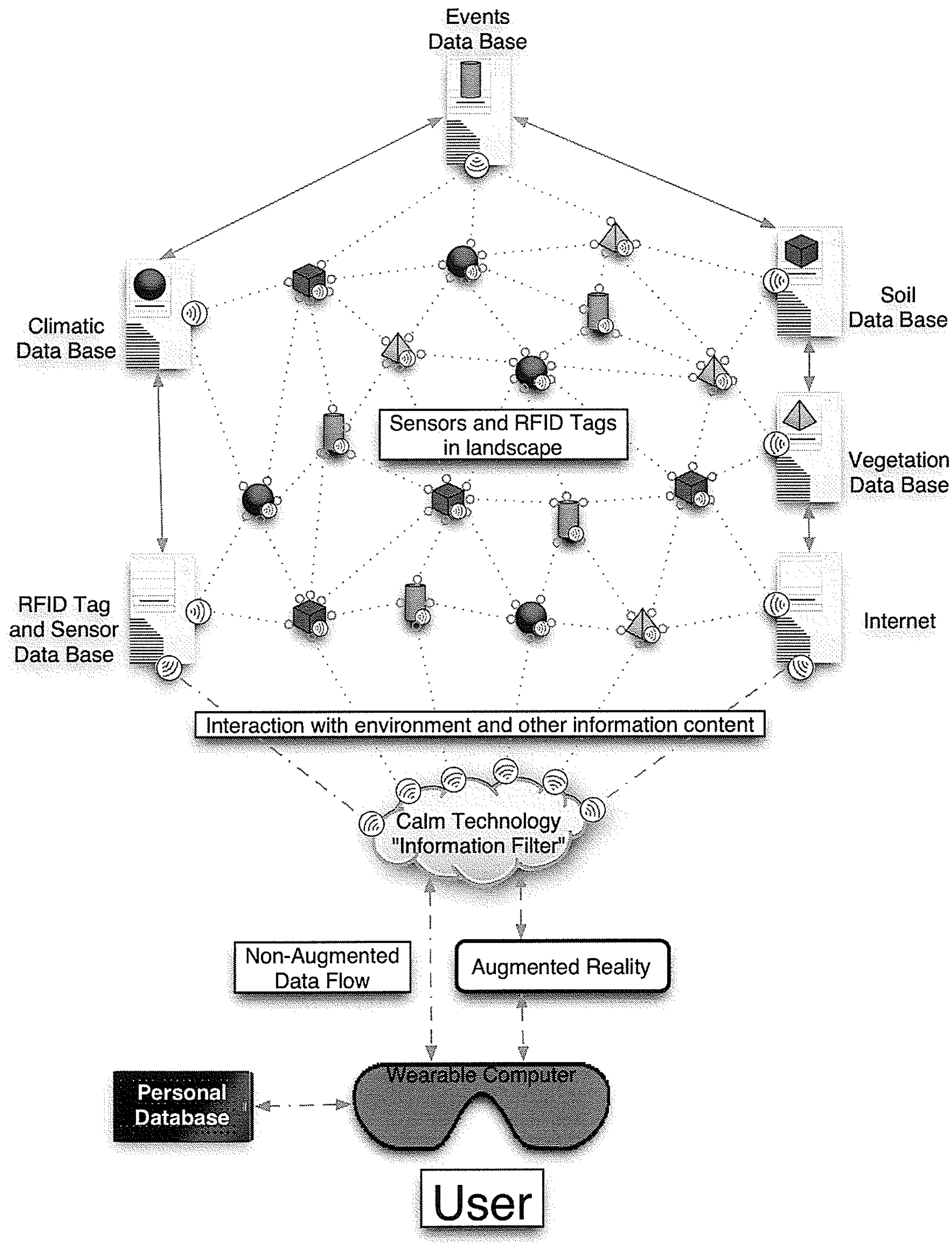


Figure 6. Schematic of Responsive Environment system for outdoor laboratory (Illustration by Author)

protect them. Once a user accesses the information they need from the landscape it would get displayed in the form previously selected by the user. The idea behind the development of these systems is to be able to allow as much flexibility so that users can get what they want, when they want, without getting overloaded with unnecessary data. An example might be of a person standing at a transit stop who may only require the waiting time for the next bus not the entire schedule. Augmented Reality systems might be used to develop new creative ways of presenting information using Calm Technology methods. These might allow data to become part of an augmented visual landscape which would not create confusion or attract a user's attention just inform them. For example the wait time for the next bus might be displayed as changing colours on a transit stop as the arrival time approaches. Augmented Reality may sometimes be graphically intensive due to the information being displayed, other times it could present information in a method that complies with the concept of Calm Technologies. How information is provided to users of these systems is one of the things the profession of landscape architecture could inform, since it deals with creating, developing and framing views of the landscape in the creation and design of landscape spaces. The profession is very visually oriented not only in the landscapes it produces, but also in the drawings, concept plans and images it produces in the process of developing those spaces. This insight is one that could aid and guide in the development of these new technologies so that it provides a greater enhancement to the landscape as opposed to detracting from it with the layering of information.

ii) Content available to user

In these scenarios the content that is provided to the user is information present for the study of landscape architecture and other data that an outdoor experimental laboratory may provide of the surrounding environment. The system would also be able to access and search currently available information sources such as the Internet on behalf of the user as required. What differs from current Internet searching is that the interface the student is using would be designed and developed to gather only the required information from the source. This could be through the use of a special search engine customized by the user to search for specific information. As an example the system may be able to perform multiple searches for data; it might create a list of web sites matching an initial set of criteria, then using a second set of criteria automatically search through the content of those selected sites for the required information; finally presenting the user with only those sites or links that serve his/her exact criteria requirements. This is another area that needs to be looked into when developing a system that will be capable of collecting information from the surrounding environment as well as from remote sources. Content and its creation is an important part to the development of any information system. Something that many do not do when it comes to its creation is providing appropriate labeling or content descriptors. Many programs have provided for the input of this information but few actually use it. In Adobe's Photoshop program there is a "File Info" menu, which allows the input of information about title, author, caption, copyright, location etc. (that would aid searching, archiving and give details about the image). These menus are available in many different types of programs for varied types of content, but rarely do they get used. The content used with these information systems may have to conform to certain standards that require content descriptors be added to any documents or data available to users. The scenario shows a few ways that content may be made available to a user. Many other types of content have not been covered in the development of this scenario or researched in this practicum. Further development on how to handle content would need to be investigated in order to create truly calming systems.

Information could initially be inputted using personal computers and keyboard into proper corresponding databases. Each database could have its own data input screen made up of the necessary data fields that might allow a user to input data in a certain prescribed manner. Students and others using the system might also input information through speech, the system could give the user verbal clues on the data required to be entered into which appropriate field. Data inputted by students could be flagged for review by either their professors or whoever will be in charge of that particular database. Once reviewed the flag could be removed, then the data might get locked in order to protect it from undesired changes, as well any empty field may remain unlocked for further input. This could allow more people to input data and still maintain a certain level of accuracy. To really understand how information and these technologies could be maintained, an experimental model such as the scenario suggests will need to be developed and tested. By making this a collaborative effort by many faculties, aspects of how a system like this may be applied to other non-research public spaces could be established. This type of project could initially be funded through research grants for the study and development of the technologies for application to public spaces or more practically as research into new design pedagogy. An economic model for how information may be handled, used and paid for in society could be a combination of how cellular phone, cable companies and some Internet news sources are currently charging for their services and content. Initial systems could be sold or leased very similarly to the model used for cellular phones. As usage increases then content brokers similar to cable companies may come into the picture to offer different levels of access to content. Basic or low-end usage plans may include a higher percentage of advertising; those wishing to limit or do away completely with advertising would have to pay a premium for that privilege. Since information is becoming the commodity of the new millennium, further research into how it will be created and how those creating it may profit must be researched further. Because landscape architecture has been described as the most public of the arts, issues surrounding access to information in responsive environments raises some fundamental questions, should principles of "universal design" be extended to the information infrastructure of public spaces?

10.4 User Groups

The development of the scenario took form as a result of looking at four different user groups that might use the selected site and developing a sample list of information desires for each group related to the site. These sample desire lists were required as a springboard to aid in the development of possible applications for the creation of the scenario. From these four user groups, one has been selected for the development of the design scenario.

The four user groups are:

- Landscape Architecture Students
- Landscape Architects
- Landscape Maintenance Crews
- Visiting Guests to the University

The four groups are used purely to illustrate the types of information these systems might be designed to provide. The scenario for Landscape Architecture Students will be developed since it is the user group with which the author is most familiar. This group also encompasses many of the qualities of the other users. The scenario will focus on the movement of a landscape student through the site on a typical day.

i) Landscape architecture student

What might be the requirements of a Landscape Architecture student from the site?

- Plant recognition
- Site Grading data
- Climatic Data
- Plant Information
- Site history information
- Ability to view new site designs for the site (Student Projects)
- Ability to access library data
- Ability to access departmental data
- Communication capability with students and professors
- Information about current departments activities
- Information on current campus activities
- Information on up coming activities and department due date
- X-ray vision being able to see cross-sections of trees, berms, locate underground utilities.

ii) Landscape architects

What might be the requirements of Landscape Architects from the site?

- Plant recognition
- Condition of Plants
- Ability to choose plants from campus planning guidelines and nurseries for new designs based on conditions
- Soil conditions
- Grading
- Drainage
- Underground utilities
- Site History

- Site usage patterns
- Information about which persons to contact for more information
- Instant geographic location information for building corners, trees and other static elements
- Ability to present a 3-D modeled design to clients on site so they can actually walk the site and experience what has been proposed instead of having to imagine it.
- X-ray vision having the ability to see underground utilities.
- Planning regulations and long-term visions/studies

iii) Landscape maintenance crew

What might be the requirements of University of Manitoba maintenance crews from the site?

- Maintenance schedule
- What trees need to be trimmed
- What trees are going to be moved
- When to fertilize plants or trees
- If certain trees or plants need watering
- Information on how to perform new maintenance requirements
- X-ray vision having the ability to see underground utilities.
- Snow storage locations/opportunities

iv) Visiting guest to site

What might be the requirements of visiting guests to the University of Manitoba from the site?

- What buildings are they looking at
- Route to the building they are looking for
- What departments are based in which buildings
- History of the buildings, information about important people that studied in the buildings and on the campus

- Event calendar for different areas highlighting "must see" events currently throughout the year
- Information about the landscape, and buildings - eg. who designed them?
- Plant Information
- "Must see" areas in the landscape
- Information about statues and sculptures
- Information about what the departments do and examples of work done by professors and students

10.5 Limitations

Limited to the technologies already researched and the sample list of user desires for landscape architecture students developed, the design scenario will indicate directions in which further study for the creation of an outdoor laboratory could be conducted. The technologies and ideas researched thus far may be applied to any context.

10.6 Summary

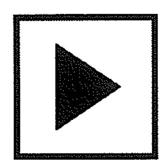
The design scenario follows a landscape architecture student through part of a typical day, as he uses and experiences these technologies in a outdoor laboratory, icons are used to represent the applications encountered. These icons become links to in-depth descriptions of the applications following the scenario. The applications are developed by taking the user information requirements and creating a tool to facilitate the access or display of information using the emerging and existing technologies examined in Part Two as a basis for their development. This study provides an overview of some of the possibilities, which these technologies can give to an outdoor laboratory in the development of applications for the education of landscape architecture. It also examines the application of emerging technologies to see how they might grow and how humans might grow with them while continuing to control them.

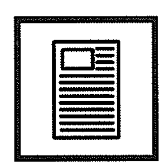
Part Four

Chapter 11

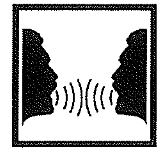
Design Scenario for a Landscape Architecture Student

It is the first week of October and a first year Masters student in Landscape Architecture is arriving at the University of Manitoba by bus. He has just finished watching a video on Middle Eastern gardens and landscape designs as reference material for a guest speaker's lecture, through the glasses of his wearable Personal Information System. As the bus nears his stop the glasses go from video mode to full transparency. Once he steps off the bus he sets his Personal Information System to accept local area activity information, this he requests by looking up and to the right. At once he gets a message that has been filtered through his interests list about a lecture on "The Great Landscapes of Europe". This activates a virtual bulletin board system which shows him the information about the lecture and any other local information that may interest him. He verbally tells his Personal Information





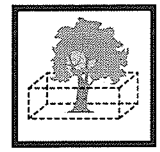
System to record this into his calendar. His Information System replies that he is meeting friends for a drink that evening during the time of the lecture; would he like to reschedule. He replies yes. The system instantly tells him that his friends are both online, would he like to chat with them? Replying yes again, he is instantly linked, via "chat" mode, with his friends. Verbally, he asks his friends if it would be possible to meet later, since there is a lecture he would like to attend. His friends ask what the lecture is on and one of them expresses interest in going to the lecture. Meeting after the lecture for drinks would work for all of them. His friend asks him for more information on the lecture. He tells his Information System to forward the lecture information to his friend and to reschedule the meeting. He tells his friends that he will talk to them later, he is on his way to class. He then tells his Information System to sign off from "chat" mode. All this time he has been moving.



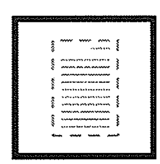
As he was chatting with his friends he was walking past the Faculty of Arts outdoor sculptural garden, which showcases both real and virtual sculptures. Artists have now combined real sculpting with virtual sculpting to create new and unique experiences. After ending his chat with his friends he tells his Information System that he would like to be reminded to explore the garden later.

Asking for his class schedule, the system tells him his first class is meeting in the courtyard of the Russell Building and that his second and third classes have swapped times due to a change in the guest speaker's schedule. Since all students and staff access the faculty's calendar and scheduling system, any changes made to the system by an authorized user would instantly be available for all users of the system. Realizing he now has some extra time to review and research more questions to ask the guest speaker, he tells his Information System to schedule some research time after his second class reminding him 15 minutes after his morning class. The system confirms his request.

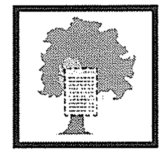
He is approaching the location of his current studio project. His class is supposed to design a new space for the north front of the Russell Building and he currently has his system set up to display his design so that whenever he walks by he can assess what is missing or clashes between his design and the surroundings. The design is laid out onto the landscape using the coordinates from at least four geographic locators to which his design is referenced. There are geographic locators situated throughout the entire campus which are programmed to the exact geographic location where they are positioned. Their job is to communicate with all devices that require knowledge of their exact location. The coordinates are calibrated automatically via satellite to ensure the correct location is always maintained. This allows any design with the appropriate coordinates and scale to be placed automatically onto the landscape in the correct location when selected for viewing. The design can be applied to the landscape in many different ways. It can be made to appear as if it completely replaces the existing landscape features by blocking out and replacing current visible features. This is done through video projection. The user's visual interface enhances the natural landscape by overlaying a combination of live feed and the virtual design, so that elements may be added to, or removed from the site visually. This gives the user a true visual representation on the landscape of how the new space might appear like. The design can also be applied as an overlay of the existing landscape, allowing the viewer to see all existing landscape features as well as those being proposed. Another option is to view a 2-D representation that is laid-out on the ground, making the site into a live drawing board that can be walked on.



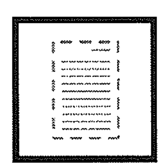
As he approaches the steps to the Russell Building a message appears in front the student him informing him that a book he is interested in, from previous inquiries, is currently on sale at the Bookstore. Interested in buying the book, since some books still hold certain intrinsic qualities unobtainable in digital media, he flags the message to reappear after his first class in an hour. Arriving at the courtyard for his class, he begins to review the virtual



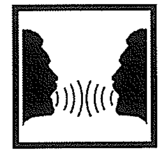
class notes, and notices they will be receiving an assignment requiring students to identify, locate, document and write-up a short report on the characteristics of 10 different plant species found on campus. Each student will be given a different list of plants to work on. There will be at least 3 plants from every student's list that will already exist in the Campus Vegetation Identification System, the others can be found and identified using the Virtual Vegetation Library. The Campus Vegetation Identification System (CVIS) is a large database that holds the information from all plants on Campus. Digital tags are embedded in all trees and planting beds throughout the Campus. This system actually allows users of wearable computing systems to see digital information about each plant or tree automatically by visually laying out the information on or beside the corresponding planting. The system also allows a user to access a complete history of that particular tree or planting bed and any information about the species' main characteristics and actual location with geographic coordinates. Much of the vegetation in this system has been inputted into the system, because it was planted after the system's inception or it has been inputted by previous students or by campus planting crews. There are similar Vegetation Identification Systems on the Municipal, Provincial and Federal levels which all work in tandem to avoid duplication. The Virtual Vegetation Library is a combination of databases which hold information on every species of vegetation on earth, can be accessed from anywhere in the world. Information from this database can be narrowed down to the particular region that the user is in by selecting the appropriate criteria when accessing the system. This system is built so that people using different types of computing systems can access this information; but where it excels is in providing to users of wearable computers the information as visual overlays on the landscape, so that the user can quickly search and compare many different types of plant.



As he arrives at the class the student's Information System automatically sets itself to standby mode and will only interrupt the user with incoming messages if they require his immediate attention. All messages that can wait may be transferred into either voice mail

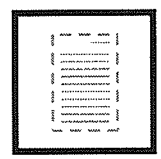


or text messages if a text record is warranted.

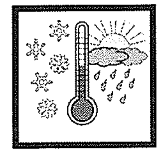


Students no longer need to copy notes from white boards or projectors since these are instantly accessible from the class database. The only notes students need to take are of their own thoughts on what they are learning and how the information relates to other subjects. Students can choose whether or not they want their information to be shared with other students.

This class requires them to report on ten different plants located on campus. After a short lecture they are given time to go out and work on their assignment. Since every student has their own Information System, they all can be in contact with their instructor during class time through the class database which has a communication module activated during class time only. It plugs into the users communication system allowing real time communication during class time anywhere on campus. This allows an instructor to relay important information to the class on questions posed by other students in the class while actively working on their assignment.



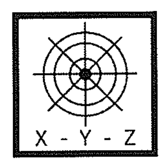
The students prepare themselves to go out and work on the assignment. They are told they will be meeting again in the courtyard ten minutes before the end of the class for a quick review of what they have accomplished, followed by a brief question period. Each student accesses their list on their AR glasses as they start off on their quest. Our student decides to collect all pertinent information he can find on the Virtual Vegetation Library, so he can start compiling and reviewing the information needed for his assignment. This information will also help him in the appropriate identification of his plants. He matches up the appropriate records with the appropriate plants. He now sets out to find and locate the plants from his list throughout the campus. From the data he has collected from the Virtual Vegetation library, he sets up a search with the appropriate climatic criteria for each plant type. This will give him an overall view of where these plants may be found on Campus according to their climatic needs. He will now have to visit each location and see if he can spot the plants he is looking for. The search is made possible because of the collection of climatic data on campus. It is not a complete data base since it only holds information for those locations on campus that already have climate sensors installed. Additional ones get installed as resources become available.

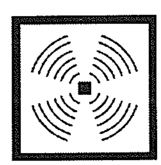


The locations that the system identified will give the student a better understanding of the correct climatic requirements by showing him an exact example of what he is looking for.

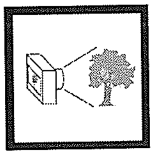
He separates the plants into their respective climatic zones so he can search all species that may occur in a certain zone at one time avoiding having to re-visit the same location. As soon as they have been sorted, he places their image on his display so he can have a visual representation of the species as he is looking for them.

The student finds his first plant and begins to collect the required data for his report. He begins by locating the plant in the landscape using the campus-wide location module. He then scans for digital tags in the landscape, which have previously been geographically located and recorded into a geographic database. The program takes three digital signals and calculates their location creating the proper coordinate for the plant location. Once the student has completed this task he searches for any sensors in the soil that could give him a quick reading of what the current soil conditions are, as well as any past soil readings. If there are no sensors present in the soil the student will have to make a note of this and take a soil sample for analysis. Each student will have to collect at least two soil samples, which will then require laboratory analysis, that will then be added to the database. Luckily this planting bed has a few sensors and he is able to retrieve the soil conditions record for the past three years.





This will give the degree of moisture and nutrients currently in the soil as well as any previously recorded data about the soil's condition. He also records the sensors' IDs for inclusion in his report. All that remains is to photograph the plants. He takes a photograph of the location, a close up of the full species, leaf system and flower/fruits. Once he has completed this he can continue locating the remaining plants on his list. Once all data for his assignment is collected the student will have to compile the data for that one plant and give his assessment on the plant's well being.



As he is working on his fourth plant his Information System tells him he has to head back to class since he is a four minutes walk away and in six minutes the instructor wants them all back to review the completed work and answer any questions. The student heads back to class for a final review.

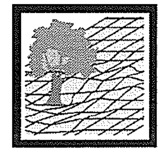
After the class, his Information System reminds him about the book he wants to buy at the Bookstore and he heads off to pick it up. As he is leaving the Bookstore his Information System notifies him that he asked to be reminded about doing some research for his lecture. As he heads toward the Library he starts to make inquires from his Information System to the Library's catalog system. He finds four books he wants to review. Two of them are physical books, the other two are in digital format and will be available for electronic checkout. These electronic books will be in a file format which would enable him to upload them easily to his system. This electronic book file is copy protected giving only the publisher the ability to reproduce it. The user can read the document, use quotes, and make instant references to the book only. The user will have to return this digital book to the library or late fees will be incurred just like a physical book. The only difference is that he can take this book out and return it from anywhere in the world as long as he has the appropriate library membership to access it.

As the student is making his way to the Library he has already signed-out the two digital books and located the others through the book's digital tags and the tag readers in the shelves at the library.

He now has one of the digital books open and has started a query using keywords from the upcoming lecture in his third class. He continues walking to the library and his Information System tells him that five results have been found in his search and if he wants them to be read out to him, since he is walking, or stored to read later. He tells the system to read them aloud. As the results are read, he tells the system which ones to keep and which to disregard. These readings have triggered a few more terms that can be used for more searches. He sets up these searches as he walks into the library. He retrieves the other books he needs and checks them out, and goes outside to review and study the books he has just checked out.

Upon completion of his research he still has some time before his next class, so he decides to drop by the virtual sculptural display. He finds out which artists' works are on display. There are four artists this month showing their work in the space. This outdoor gallery space offers the possibility of looking at all works as one collection or as individual collections. Viewers are also able to create their own collection with favourite pieces from past shows, which they can call up and walk through at anytime. Each month there is a new group of artists showcased, but all past exhibitions are retained in the system for review at anytime, and anywhere. However the exhibitions are best enjoyed when viewed in the park-like gallery space. The viewer walks through the exterior gallery space that also contains real sculptural pieces, on occasion, alongside the virtual ones. This is an experimental gallery where innovative outdoor technologies are installed and tested. Along with the sculptural displays, visitors can also experience experimental music created by the School of Music.

The Student's Personal Information System tells him that he has five minutes to get to his



next class, which is a Site Grading course. Today they will be performing a preliminary application of their site grading designs to the real landscape through Virtual Augmentation of the landscape. The students in the class will be loading each others' grading plans by synchronizing each others' Information System to the same grading file. This will allow them to see simultaneously the same grading project laid out on the landscape, which they will be able to walk around and analyse. The student demonstrating her grading plan displays it in different forms; as a grid laid out on the landscape, fully rendered grading plan, cut and fill sections and a comparison between how the site currently drains, and how this drainage will change with each suggested proposal.

Since the potential for developing many more applications for these technologies exists, this is a good time to leave our student and begin reviewing the technological ideas that have already been suggested in this scenario.

Chapter 12

Review of Design Scenario Technologies

12.1 Introduction

This section reviews all technologies discussed in the scenario of the landscape student, in the order that they appear. The technologies in this section are concepts for possible application to the emergent technologies discussed in Part Two.

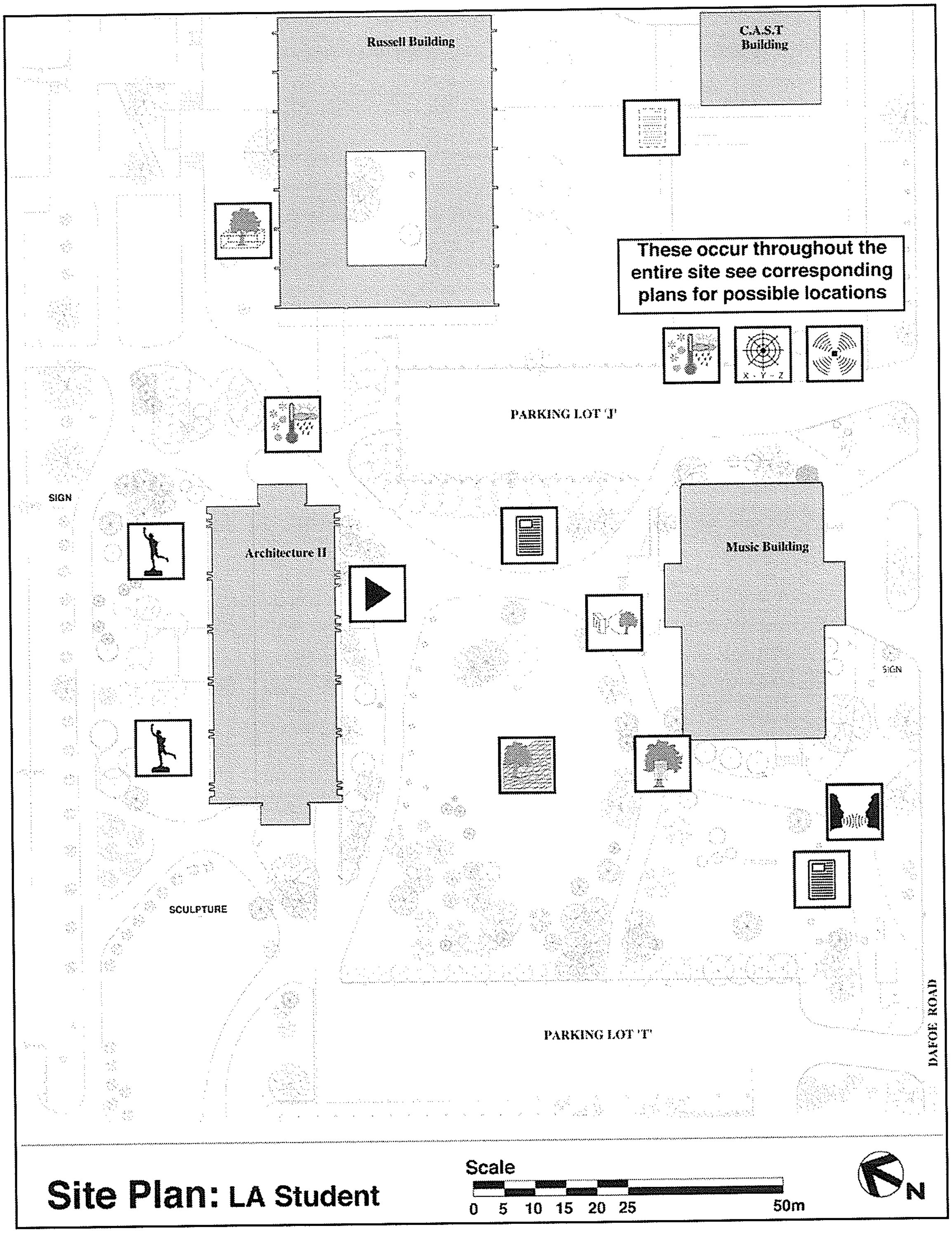
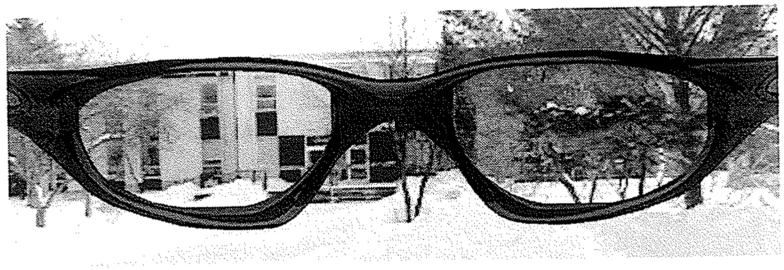


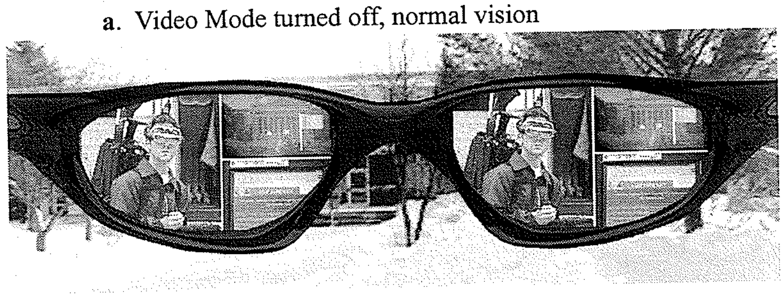
Figure 7. Site Plan with possible locations for technologies discussed in scenario

12.2 Video Mode

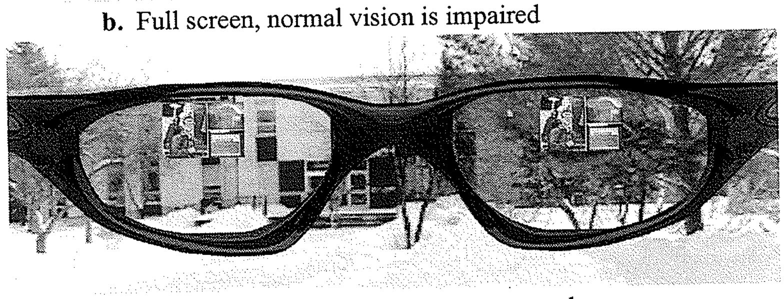
As technology develops further it might be possible to have a display system that fits into a normal pair of glasses. These glasses would be able to display any type of information required. They would also have video display systems that could overlay information onto the view of the real world. One question is how information would be displayed? The "Video Mode" mentioned in the Landscape Architecture Student scenario could work in a number of ways. It could, for instance, display video as a floating display screen at a distance or it could block all vision to allow the user to focus on the video presentation at hand. These glasses would be able to display video with the ability to set its Transparency between 0 to 100 percent. Video display could be used for the play back of any video content available to the user, from a full motion picture, television news, to video clips about activities which have occurred on a landscape site such as historic events, news related events, dates when vegetation was planted or even how vegetation changes over the seasons. Video would be accessed through online streaming or uploaded from the user's own home video system. These video systems would be designed to respect copyrights fully. Uploaded videos on the system and a user's Personal Information System would have to be registered to the user in order to be used together. Since both would be registered to the user, the way he/she uses the data would be unlimited.



a. Video Mode turned off, normal vision



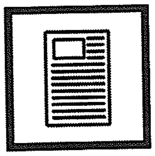
b. Full screen, normal vision is impaired



c. Partial display, peripheral vision restored

d. Transparency of video image increased, allows one to see passed video to see their surroundings.

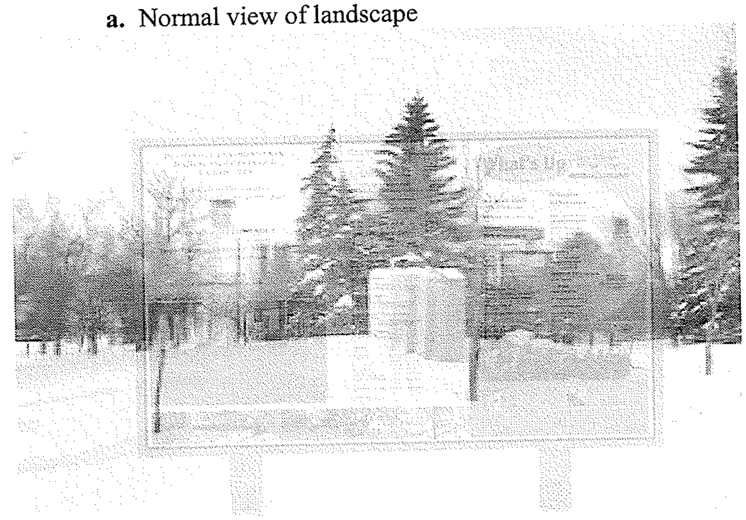
Figure 8. View through video display glasses



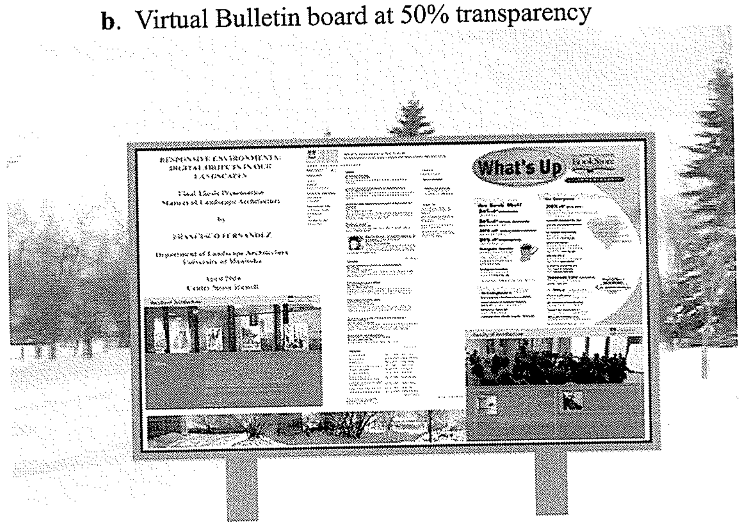
12.3 Bulletin

This system searches bulletin and message boards in a user's current surrounding area. The system could be set to search for data within a certain radius from the user providing local information, as well as to search campus, faculty or department-wide sources for current events and news. Since there is the possibility of accessing substantial amounts of information which a user may not want, a filtration or personal search system could be used. The filtration system would let information through for only those topics selected by the user. This form of data selection would be extensive, allowing for more information to get through. The personal search system on the other hand would only search for the exact data that a user requests. The information could be viewed on real or virtual billboards, signs, posters and other display systems that could be placed in the landscape. Small amounts of information could be presented to the user either through speech or through some text notification system. The system would interact with the landscape to discover its current location allowing the system to connect and search

a. Normal view of landscape



b. Virtual Bulletin board at 50% transparency

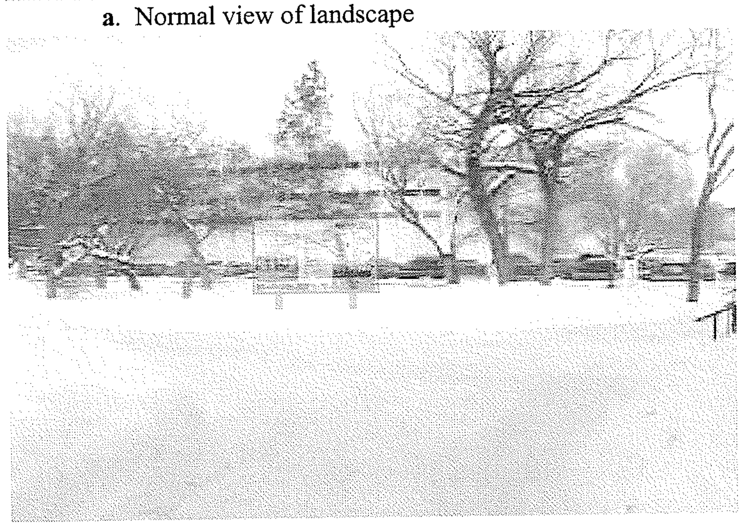


c. Bulletin board fully engaged

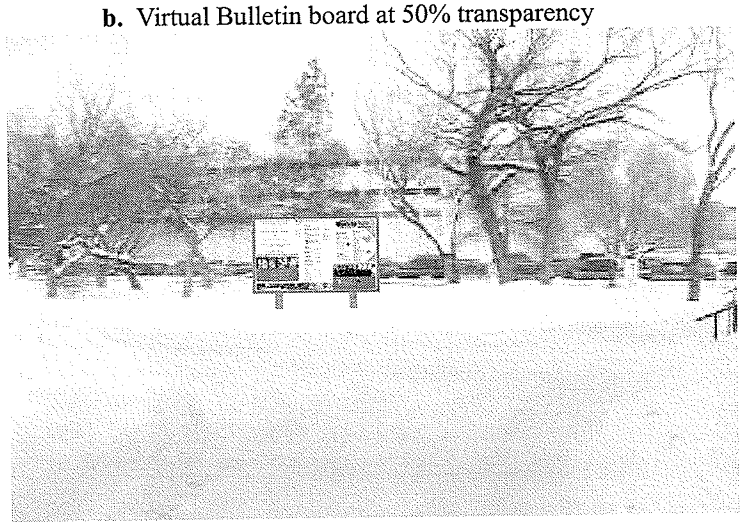
Figure 9. Sample one of Virtual Bulletin board in operation.

the appropriate data base, or the system could send an inquiry to the landscape's Information System which would perform the search, returning the required results. The landscape could be designed with locations where virtual billboards, posters or bulletin boards could appear and offer the requested information to users as they pass by. These would only appear if the requested information were available; if no information were available, the landscape would be untouched. Each user would see their personalized and individualized information in the landscape.

a. Normal view of landscape



b. Virtual Bulletin board at 50% transparency

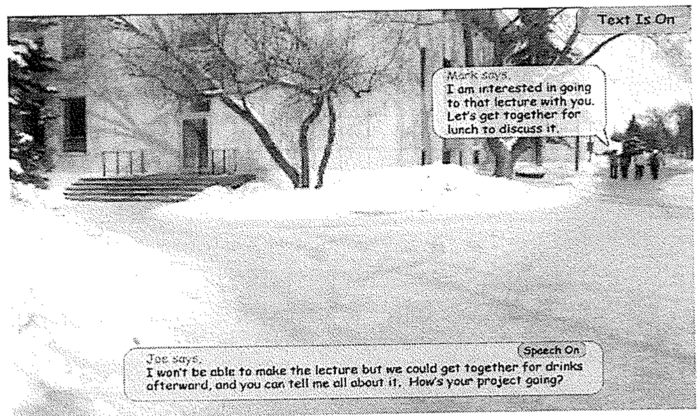


c. Bulletin board fully engaged

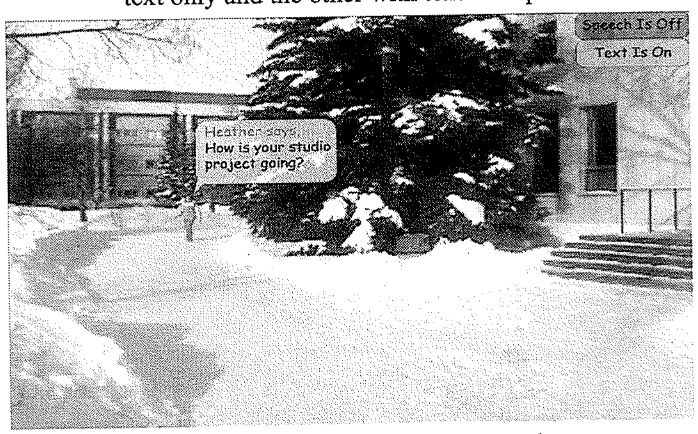
Figure 10. Sample two of Virtual Bulletin board in operation.

12.4 Communication System

This system is a combination of the different systems already used and some yet to be developed. The idea is that future communication systems will allow people to communicate with others in the form they want, when they want. Digital communication systems seem to be merging, giving greater accessibility and flexibility in how people communicate. For example, a user could be verbally communicating (similar to a phone call) with a person who is actually receiving the communication as a text message rather than as audible speech. This could be useful when a person is not able to speak because they are in a meeting and do not want to interrupt the proceedings with a phone conversation, yet still need to receive an important call. A system like this would allow someone to send verbally an email while driving their car or to send a typed memo as a voice mail message without having to read out the text. These communication systems could also become translation systems for people needing to communicate with others speaking different languages. The idea is to allow people to receive and send instantly communications in any form they want. These systems could allow instant communication between students working on a project site together and needing to communicate instantly through speech and text when they are not within earshot. With this type of system they would always be within communication distance. This could be accomplished by creating what are known today as a "chat room" or messaging service where all the members of a project or course could instantly contact each other when they are logged onto the service. The communication system could include a white board system that would allow a user to draw instantly, sketch or upload an image in order to allow the person on the other end to understand a concept or idea. A system like this could allow for greater communication opportunities between people, allowing information to flow quicker and with less effort than with currently used systems.



a. Communication between other two users, one with text only and the other with text and speech



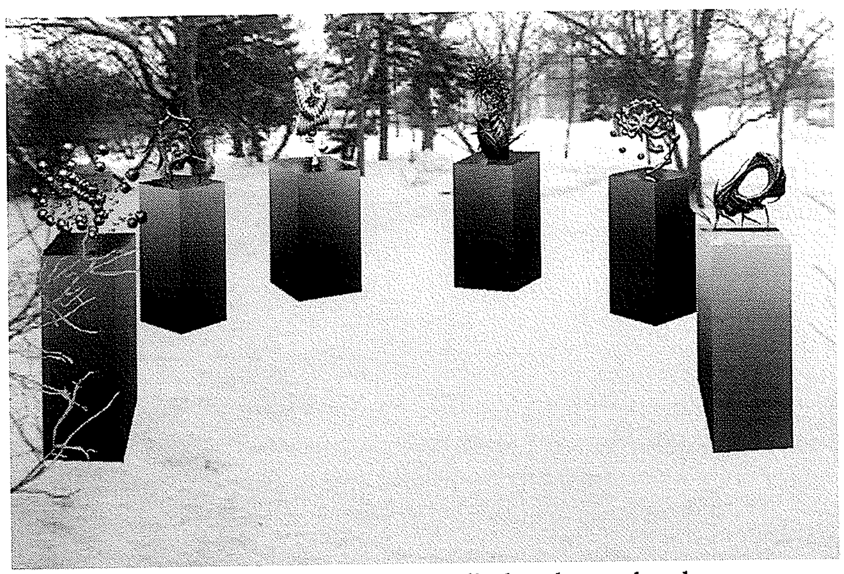
b. Communication with one user, text only

Figure 11. Possible display of Communication System

12.5 Sculpture

The sculpture garden described in the scenario is capable of combining virtual with real sculptural pieces. Some artists may even want to augment a real sculptural piece by combining a virtual element with it. This ability to create and showcase virtual sculptures could allow artists to explore and study different forms, as well as to obtain feedback from visitors to see how these pieces command their feelings and attention. Artists could take this ability to combine the virtual with the real and compose new pieces that could only be experienced with a wearable system creating a unique experience. Once this type of technology has been developed it could eventually become a cost effective way to showcase works that may have been previously inaccessible in their real format due to transportation costs, and booking schedules. This would ensure, for instance, that the exhibits are safe from vandalism. Virtual sculptural displays would be easier to set-up and could be changed or rotated quickly. Different sculptural displays could be set up at different times of the day. The technology needed for these virtual sculptural gardens would be a wearable computer that would be able to receive a signal from the location

a. Notice of a new virtual sculptural display featuring the work of Peter Miller.

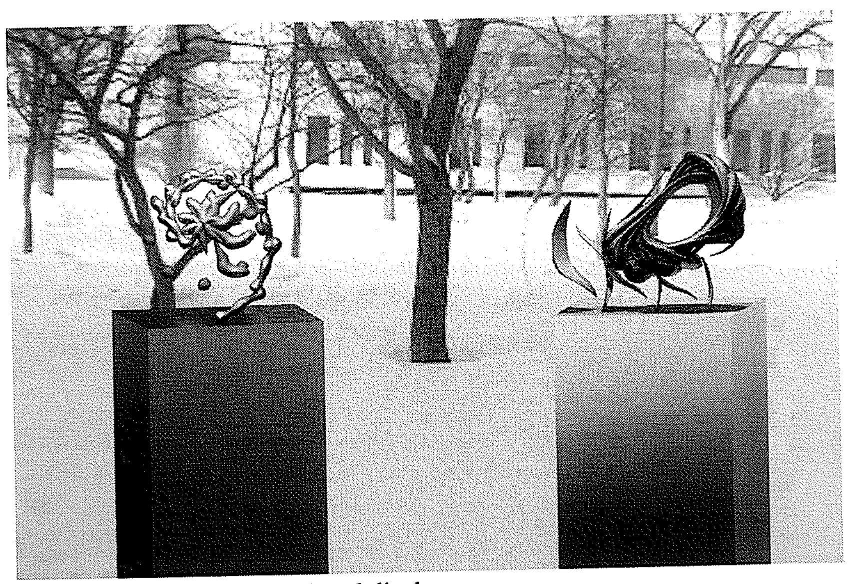


b. Example of virtual sculptures displayed on pedestals

Figure 12. From Digital Images by Peter Miller for Perpetual Ocean, <http://www.perpetualocean.com/sculptgallery.html>, re-printed, by permission from Peter Miller. © 2003 Sydney, Australia.

where the sculpture is to be showcased. This signal might be sent or received from a digital tag that would reference the number of the file for the 3-D sculpture to the location where it is to be displayed. This information would then be collected and displayed to the wearer. All this would take a matter of seconds and the wearer would not even know that it has taken place. The sculpture would be tied to the coordinate of the digital tag and no matter where the wearer might go, the sculpture would appear to remain in the same location. As technology advances, these sculptures may no longer need a physical tag for their coordinates and they may just need to be located on a coordinate grid that would be interpolated onto the real landscape. This would allow the placement of sculptural elements anywhere in the landscape. These sculptural elements might also include information of how the artist was inspired to create them, and could, for instance, be linked to musical pieces that might further augment the artworks.

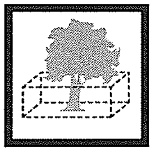
a. Example of large format virtual sculptural exhibit



b. Close-up of pedestal display.

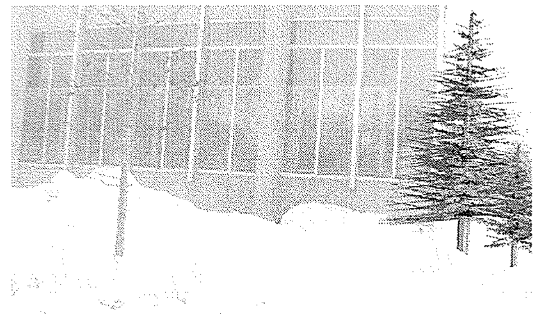
Figure 13. From Digital Images by Peter Miller for Perpetual Ocean, <http://www.perpetualocean.com/sculptgallery.html>, re-printed, by permission from Peter Miller. © 2003 Sydney, Australia.

12.6 3-D Real Virtual

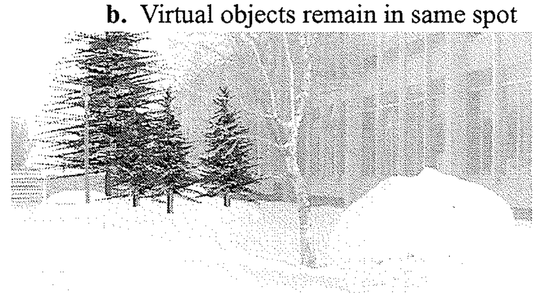


This would allow the combination of virtually created landscape elements to co-exist with real landscape elements. A virtual landscape would look and act like the landscape it is being placed in. All static objects in the real landscape would have their coordinates plotted to tell the system where they exist. Any object that enters the space and emits any type of electronic signal could be instantly located and have its coordinates plotted. Having the coordinates of all real features in the landscape would allow the system to distinguish what elements in the landscape are in front of or behind virtual elements being placed in the landscape. This would allow the system to erase features from the landscape which are not in the intended design and to add those which are. These would allow the system to know where, on the laid-out design, features exist so that the virtual objects would be able to block out the object if it were behind the virtual element or show the real element if it existed in front of the virtual elements. A user's wearable computing system would take the coordinate information and lay it out onto the landscape tracking it in real-time according to the movement of the user. These coordinates might also be tied into climate sensors which would provide information on wind speed and direction, precipitation and other climatic data, which the system would be able to interpret and apply to the virtual elements. If it were windy then the virtual trees would act like the real trees with leaves rustling etc. This type of system would allow for different levels of realism and viewing options since it would not only be to enhance a landscape but would also be used as a design tool to test new designs on the appropriate sites.

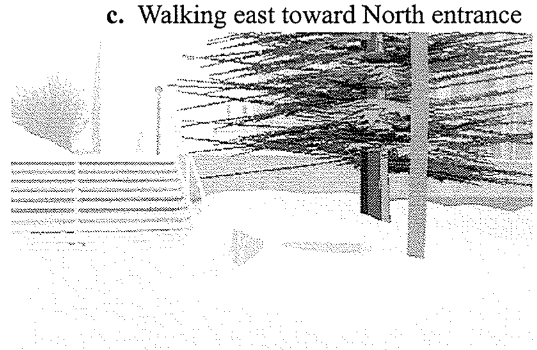
a. North west corner of Russell Bldg.



b. Virtual objects remain in same spot

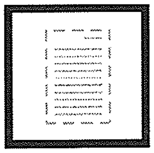


c. Walking east toward North entrance



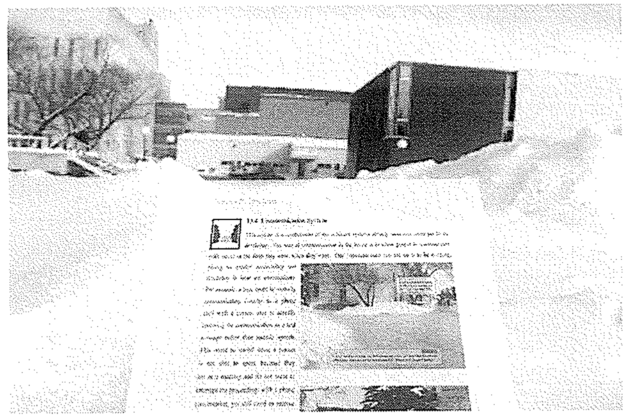
d. Approaching North steps of Russell

Figure 14. Example of how 3-D objects appear in the real landscape.

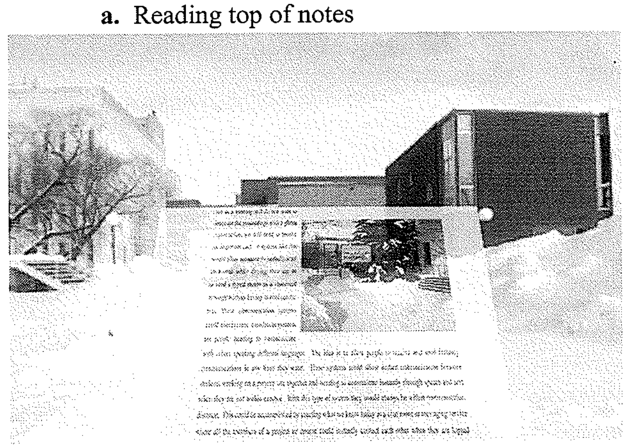


12.7 Virtual Notes

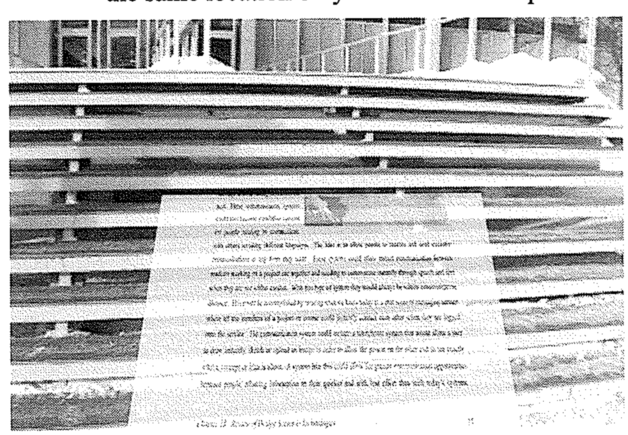
These notes would be read the same as any other printed documents, however only the user of a wearable computing system would be able to see the document that they were reading. For those not using a wearable system, they would be able to access these notes through other devices such as PDA's, Laptop's and Tablet PC's, in whichever form they may exist. However, users of a wearable system would be able to read notes and documents without actually holding any device other than a tracking ring. The ring could allow a user's wearable system to track the position of his/her hand so that these notes could virtually be placed in their hand. The ring would be the coordinate in space related to the location the system uses so that wherever the user wanted to see the document, they would place their hand. Also the user would be able to pick other coordinates if they wanted the notes to rest on a table or other surface. Any information received as a virtual note or document that would be available for reading by the user and could be spoken to the user and modified by the user verbally or manually with the action of writing on the virtual document. Writing on a virtual document might require a digital finger pen. This could be a device that is placed on a user's index finger and which becomes a pointer that could allow a user to select information viewed on their wearable device or to write as if they were holding a pen, pencil or brush.



a. Reading top of notes



b. Reading mid-section, top of sheet remains in the same location only the text moves up.



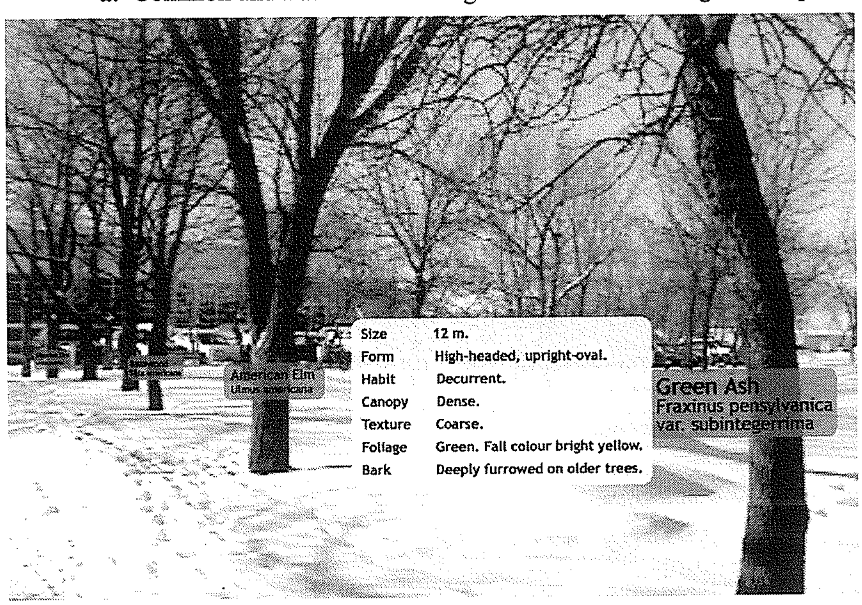
c. Reading bottom section while approaching South steps of the Russell Building.

Figure 15. Example of how virtual notes may appear when used in the real landscape.

12.8 Virtual Vegetation Data

This would be a system that allows the connection of relevant data to a plant or other features in a landscape. This is based on a system of tagging all features with digital tags which are being developed as the replacement of the bar code system. A few different tags may be used. There are tags that will only emit a number or code. These would relate the tag to the data base containing information about the feature it is associated with. Another type of tag would be able to store and interchange information about the feature it represents and possibly about its surroundings. In general the first type of tag would be used. The tag would refer a user of a wearable system or other device to a data base containing the specific data for that plant or object being looked at. This data base would be interconnected with other data bases able to provide more general information about the plant. This additional information might be about the history of the plant species, how it was and is used by different cultures, video of how it changes through the seasons and how it changes through its growth cycle. There can also be statistics about its usage compared with similar trees or plants in the local environment.

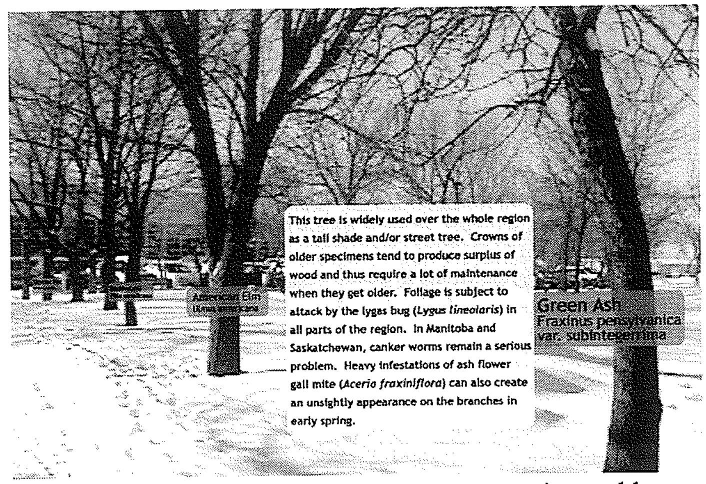
a. Common and Latin name of vegetation in surrounding landscape.



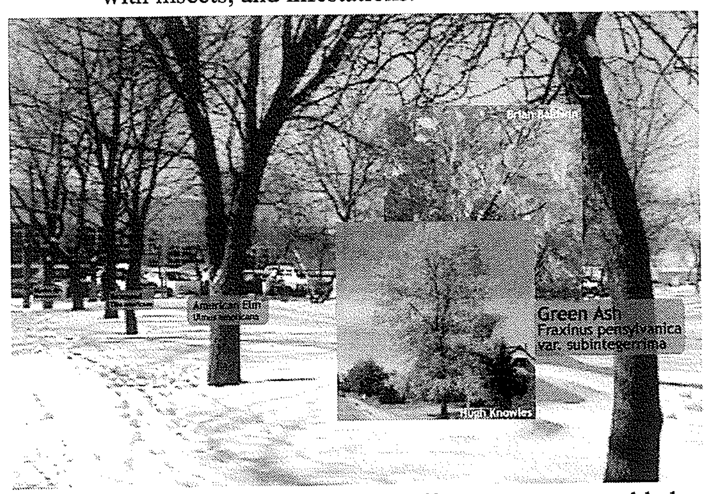
b. General information about selected vegetation.

Figure 16. Examples of what vegetation data might look like displayed with a wearable computing system.

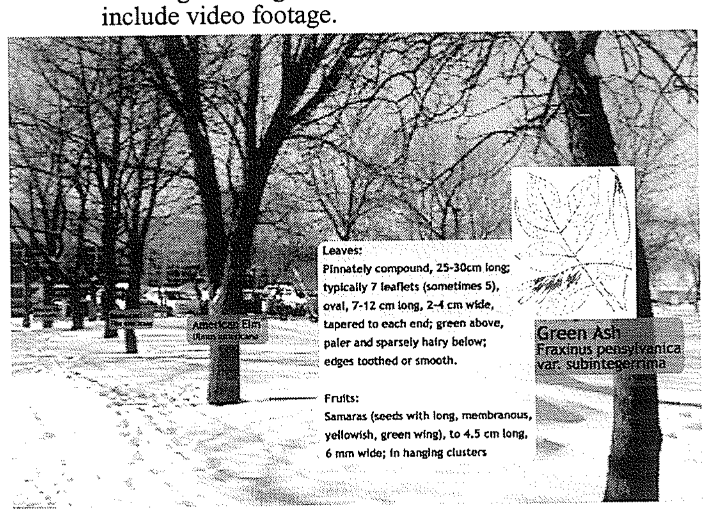
The plant might also be connected to local climate and soil sensors which would give a picture of how the plant might have been affected by the different conditions as it has grown on the site. This information could be initially displayed as a sign attached to the tree or other plant; stating the plant's common or botanical name. The system could be customizable to convey the information the user wants to see first. If a user wants to learn more about a certain tree they could verbally ask for the information or select the tree with a digital pointer or a combination of the two. Any questions the person asks about the tree would generate a search that could span across several data bases. The data could be presented in a number of different ways. It may appear on or beside the feature or on a digital note pad. The possibilities of what data can be accessed and how are limitless.



a. Detailed information about usage, region problem with insects, and infestations.



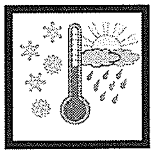
b. Images of vegetation in different seasons, could also include video footage.



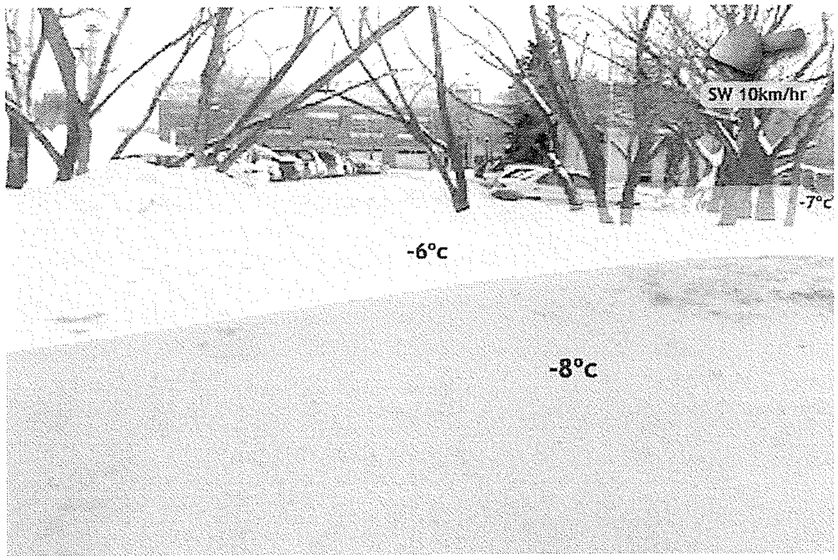
c. Information on foliage, fruits, etc.

Figure 17. Further examples of what vegetation data might look like displayed with a wearable computing system.

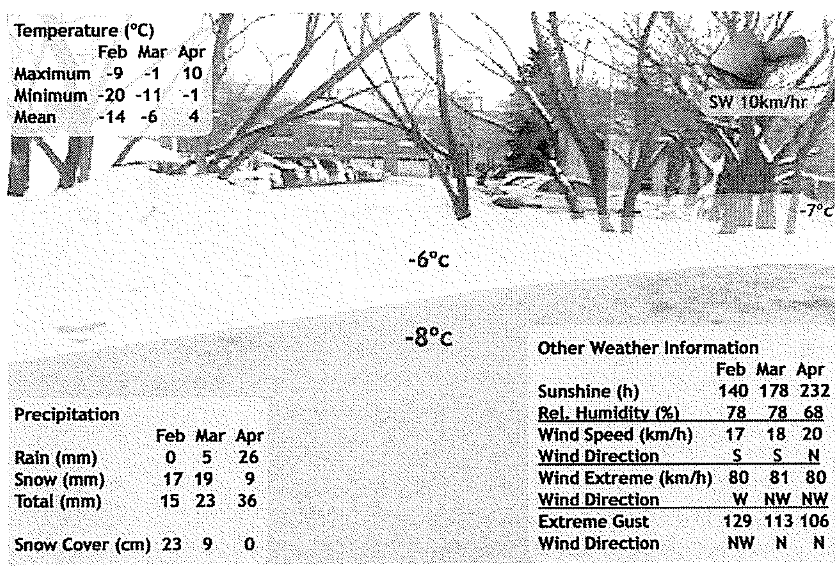
12.9 Climate



With the size and cost of sensors decreasing, these will start appearing more widely to collect the required data. Climate sensors will be able to collect all types of data from the environment. The data will range from general weather and climate readings to data on specific micro climates around buildings and landscapes. The information these sensors collect can be archived and compiled in data bases where they can be accessed when needed. Archived data will be used as a record of what type of climate exists or existed in an area revealing trends that occur there. These sensors would also be able to provide current data. This could be used to assess how virtual landscapes might be affected by current and past weather conditions. Such simulations would inform the study and design of landscape spaces. Data might appear as hard numbers or could be shown with different colours to represent different conditions, viz: hot, cold, calm, windy, dry or humid, allowing for a rapid analysis of an environment.



a. Quick climatic information, temperature, wind direction and speed.



b. Historic data along with current readings for comparison

Figure 18. Examples of climate data displayed with a wearable computing system.

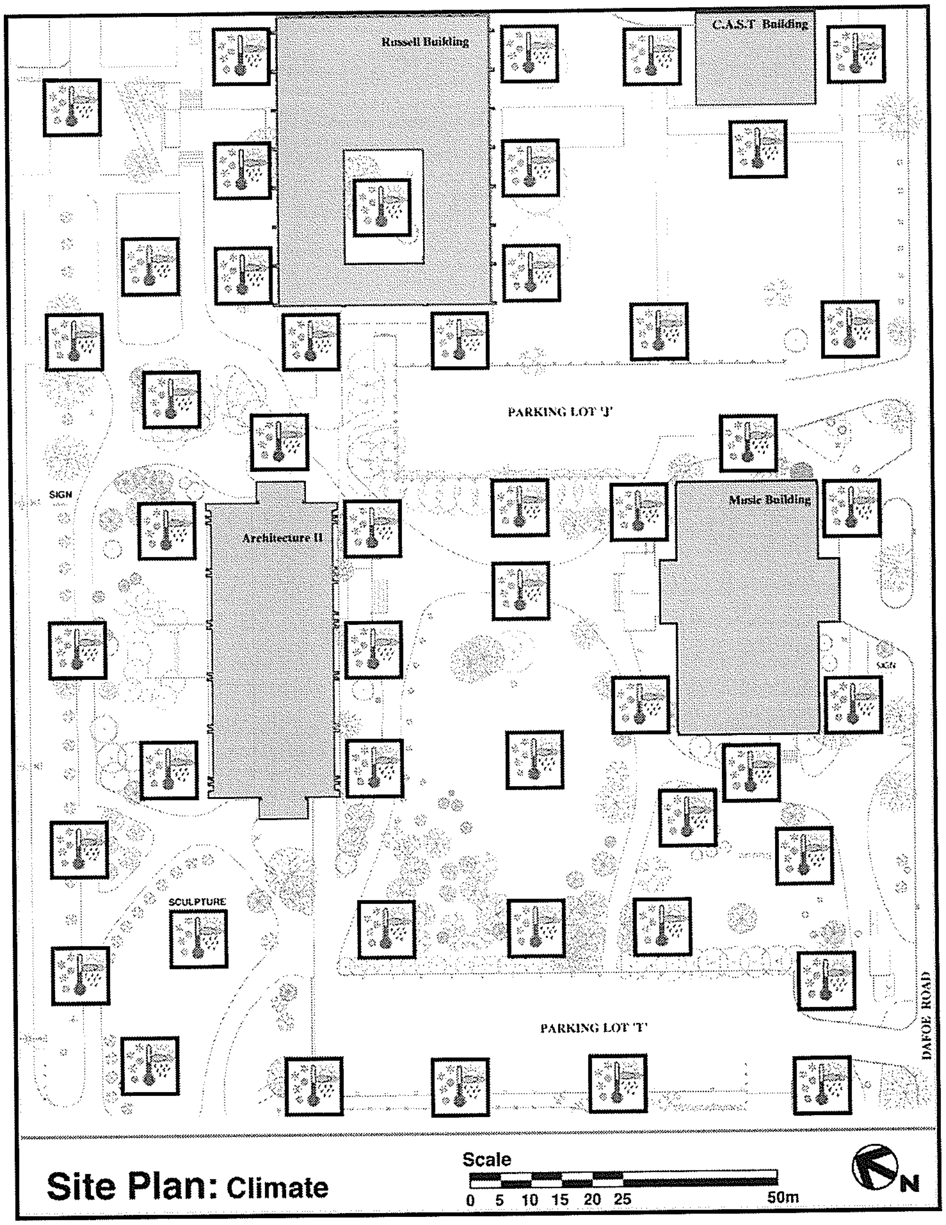
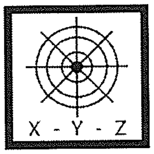


Figure 19. The locations of climate sensors on this plan have been chosen by trying to maximize the number of sensors in the landscape by placing them onto the existing infrastructure. Like buildings, light standards, existing sculptures and select trees. In order to understand the ideal locations for climate sensors, further investigation into the types of information users would require, has to be done. For the purpose of this exploration of potential usage these locations should suffice.

12.10 Locator



Most of the database information discussed here would relate to a particular site or location. The systems being addressed would allow a user to access the information associated with the location they are in. To allow access to location specific information a few technologies would have to be available. These technologies would combine GPS (Geographic Positioning Systems) and GIS (Geographic Information Systems) to display and track information. GPS usually works by taking readings from at least 3 satellites. However, the technologies examined here would create a world that is automatically geographically referenced and which would need very powerful devices and many more satellites. It is anticipated that there would be specific devices located on buildings and in landscapes, whose sole purpose would be to provide coordinates to all devices in the area similar to the way that a satellite does today. These ground based GPS stations would not replace satellite systems currently used for GPS, rather they would assist in providing this information with greater accuracy. These location devices would regularly confirm their coordinates with passing satellites, since the earth is constantly shifting and thus affecting the location of buildings and features in the landscape. All other devices in the landscape would only talk to these devices. When a geographic mapping of a space is needed and there are no location devices nearby, a portable system made up of 3 or more location devices could be placed on the boundaries of the space to be studied, or used for 3-D virtual modeling on the landscape. These portable systems would obtain their geographic coordinates from passing satellites and once they have obtained them, they would be able to send these coordinates to any devices asking for them. These devices could assist in giving exact locations for soil, climate and other types of sampling that may be required of an area. The digital information tags proposed to associate data with vegetation and other features in the landscape could communicate with these location devices to obtain their exact coordinates when initially placed in the landscape and then every time they are asked to provide this information. These coordinates would be recorded in an appropriate database and any changes would also be recorded.

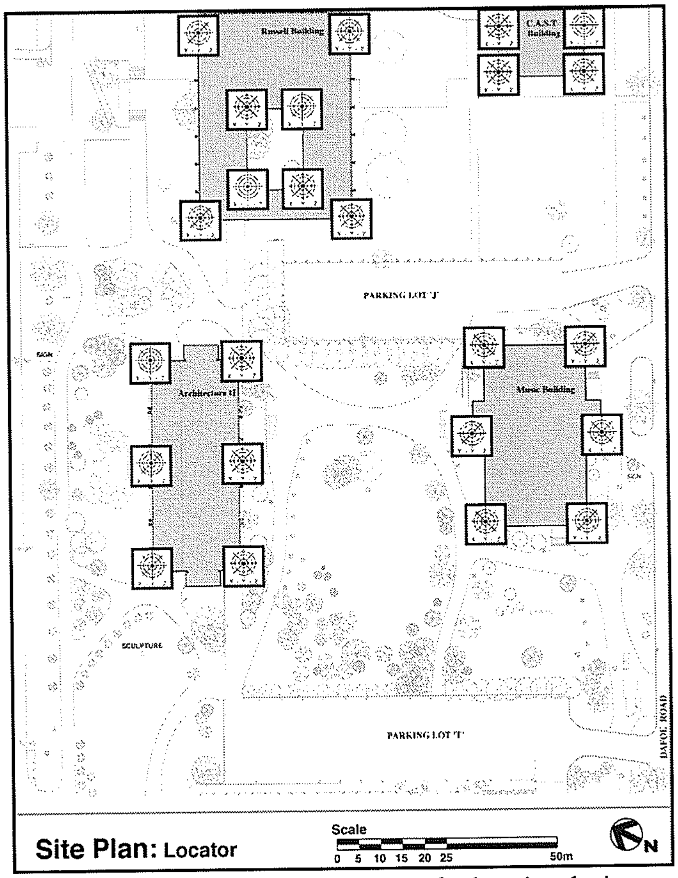
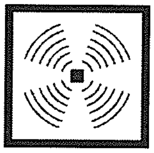


Figure 20. Possible positions for location devices



12.11 Sensors

Sensors would be placed in specific settings to take different types of readings. The types of sensors being considered here are climate and soil sensors. Many more types of sensor could be developed to take any other readings that may be required. These sensors would take whatever measurements they are meant to take (motion, sound, light, etc.) and then upload them to a data base for compilation and accessing when needed. Climate sensors would take temperature, humidity, wind speed and direction and precipitation. Any data that is analyzed and compiled with the ability to inform a user further would also be archived to the database. The other type of sensors this scenario mentions are soil sensors which could collect data on moisture content, chemical make up and nutrient richness. All these sensors would communicate with both location devices and database servers on a regular basis to update the data and their location.

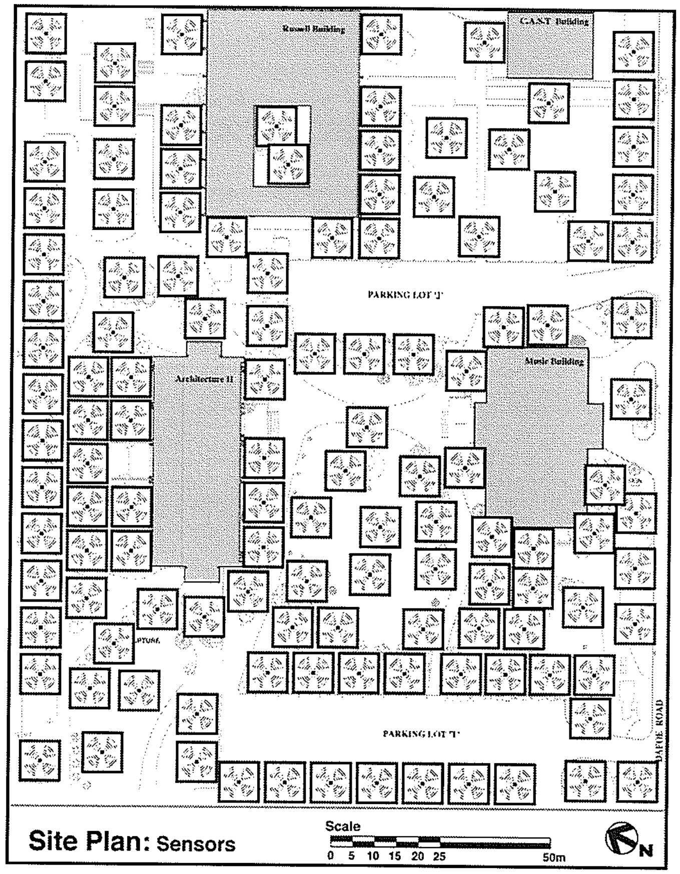
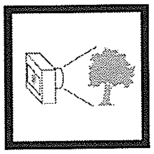


Figure 21. This plan shows all the places that sensors could be implemented, they could also be placed into road and parking surfaces, not shown on this plan.

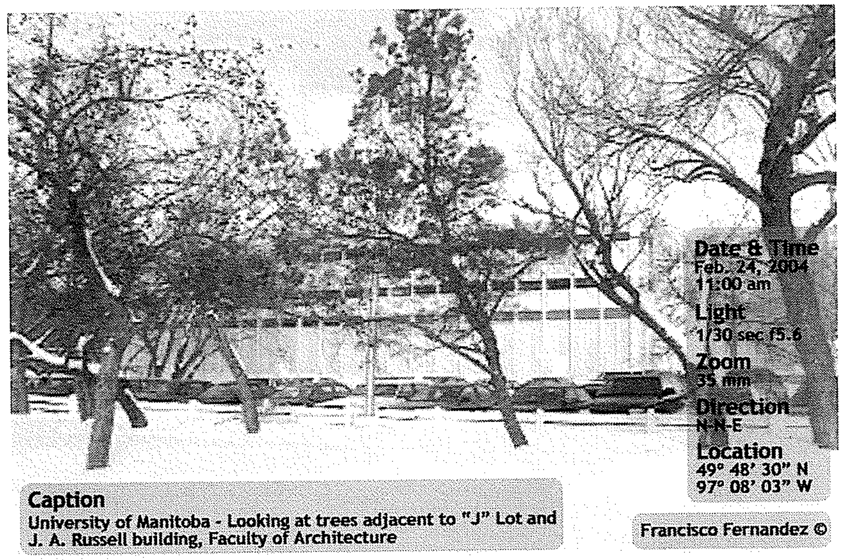
Not discussed in this practicum but of relevance is the development of "Nanotechnology" and "MicroElectroMechanicalSystems". Research in these fields is leading to smaller mechanical and electronic components for use in micro-sensors. Current research includes the development of a wireless micro-sensor which combines a RFID with a temperature sensor to monitor the thermal protection of the U.S. Space Shuttle.[69] This idea of embedding the environment with all types of sensors wirelessly is very viable. What is required is a study of what types of information users might want to collect from outdoor environments, so that appropriate sensors could be developed.

[69] Scott Bramwell, Wireless Micro-Sensors Monitor Structural Health, SRI International, 17 Jan 2003, <http://www.sri.com/working/microsensors.pdf> (7 March 2004).

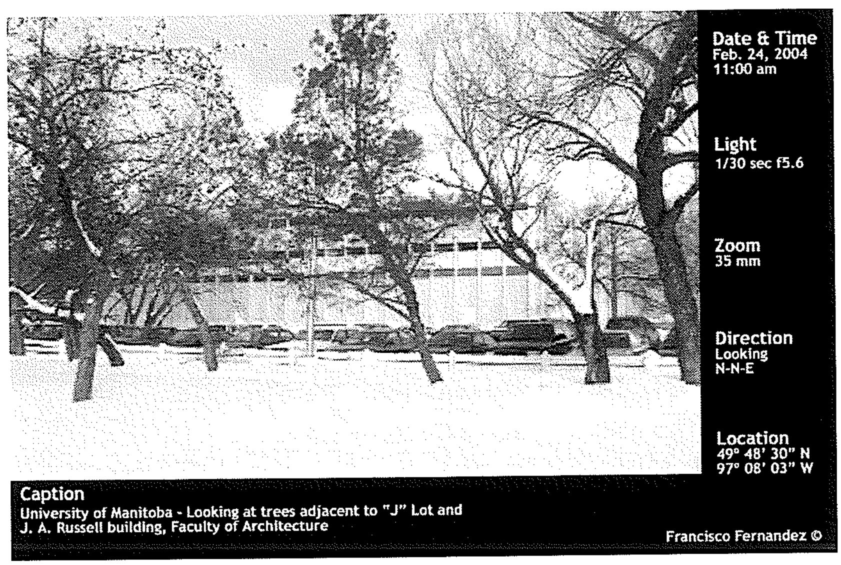
12.12 Photo



Following from the ability to take digital photographs, a next step in camera technology will be the ability to record not only the time and date but also the geographic location a picture is taken from and in what direction. Also the amount of zoom being used, light conditions and verbal description of what the photograph contains. This information could be automatically converted to text. It would not only tie the photograph to a certain location but also to all other pertinent information. The camera could also record who is taking the photograph. All this data would automatically be linked to the photograph for later use. The photographer would have the choice of what data they would want associated with the picture. This could be chosen before the photograph is taken or when it is uploaded to the photographer's image database. There might also be a public database and photographers could choose to showcase their work with full credit and copyright protection being attached to the image at the time it is captured.



a. The photograph could be viewed and developed with or without this data. It could also be printed on to the back of developed images.

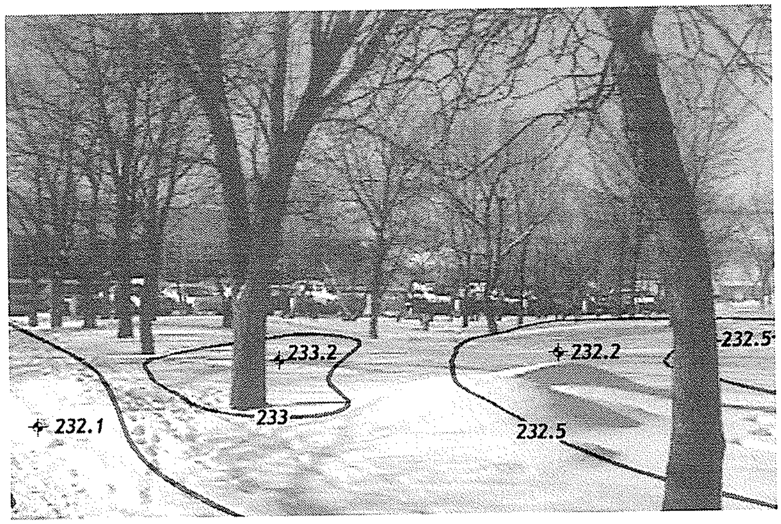


b. Less obstructive way of displaying and printing photographic information.

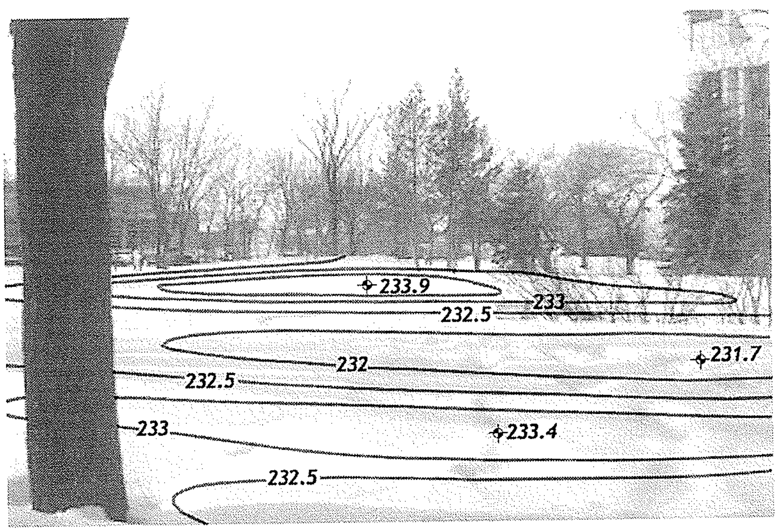
Figure 22. Possible options for viewing and displaying photographic information.

12.13 3-D Grading Layout

With a system that can accurately give coordinate information, data could be tied visually to those coordinates and site plans could be laid out onto the landscape. This would allow a user to locate a virtual 3-D representation onto the landscape in real-time. The system would take the coordinates it collected from the location device and create a grid onto which designs could be applied. Grading plans could show what the grade would look like when fully rendered by taking the original site plan and the newly designed site plan and laying one over the other. The visualization system would then create the appearance of cut and fill on the landscape and would be able to display a cross section through the landscape to help better understanding of how the plan would work. Equally, on the basis of the information provided by the student, the system would be able to show drainage patterns. All these features would be rendered onto the landscape blocking out real objects and creating the appearance of depressions in the landscape where they do not exist. Visually the landscape grading applied would appear real to users of the system, allowing them to view it from every possible angle. All others passing-by would only see the base landscape untouched and unchanged.



a. Real time overlay of basic grading information onto the landscape.



b. Another view of overlay of grading information.

Figure 23. If the information was modeled this would be overlaid onto the landscape rather than just a plan view as seen in these examples.

12.14 Summary of design

As stated in the introduction, the "design scenario" is an exploration of how new digital technologies could be used in the enhancement of a landscape, as seen through the eyes of a landscape architecture student. This scenario was not intended to answer the many questions that arise about the application of digital technologies in human made landscapes but as a vehicle to explore what possibilities these technologies could bring. The technologies reviewed could suggest a basis for future development studies.

The scenario successfully accomplished the intended purpose, of providing a glimpse of how the technologies studied earlier could be used in a landscape. Even though the scenario appears to be occurring in the near future, some aspects of the technologies discussed may not be attainable in this decade. However, if these technologies were explored further it might be possible to develop new applications which were not mentioned in this study. These fields of computer science have great potential and even greater potential if landscape architects become involved in developing applications that would be beneficial to our profession, clients and the public. The scenario, technology review, and every part of this study were intended to open our minds to the possibility of exploring these technologies further.

In conclusion, the possibilities for landscape architecture and the use of these technologies are endless. Landscape architects should develop further scenarios and continuously review available technologies in order to understand how they might be applied to the work of the profession and might, as a consequence, bring significant benefits to the users of outdoor environments.

Chapter 13

Conclusion: Final Thoughts

The intent of this study was to examine how digital information might be embedded in landscapes. This research shows that embedded digital information would not necessarily change the physical landscape, and could help provide invisible layers of information that enhance the understanding and interpretation of the landscape when appropriate digital technologies are used. The emerging technologies covered by this research are not currently being designed to work as one system. However, the possibility of their interconnection was quite evident. There were many other exciting technologies beyond the scope of this practicum, which could be very valuable in assisting the development of the applications that have been examined. Such as new ways to provide energy to drive portable digital devices and wearables. One of those is a pair of shoes developed at MIT that would create and store energy as the user walks. In the future if a portable system is beginning to lose power it may just ask the user to go for a short walk.

As mentioned, an initial area considered as a practicum topic was to explore the immersion of a designer into a 3-D virtual design space. However, an affection for actual outdoor spaces and my new found curiosity of technologies such as Wearable Computers and Augmented Reality led to the realization that rather than design real landscapes in a virtual world, these technologies would eventually allow the design of real landscapes in the real world, virtually, onto the landscape. These technologies might also enable users to access invisible layers of information that would be placed onto the landscape, such as for landscape architecture students, which would only be visible using these systems. With these technologies a landscape architecture student might be able to collect much of the information needed to develop their design from the outdoor laboratory. During their time in the outdoor laboratory they could be reviewing the data they collect to make sure existing drawings are accurate, as well as starting a conceptual design in 3-D onto the existing landscape. Another technology which was reviewed and which could be very useful to the profession is Digital Tag technologies. These could be used to track the progression of trees and other plants from their initial germination at a nursery, to their implementation in the landscape where their Tags could continue to collect data divulging it only when an appropriately equipped user of the space asks for it.

The technologies reviewed inspired the development of a scenario, which allowed for the exploration of possible applications of these technologies. It is an imaginary exploration of what could be. This exploration could lead to innovative ways of teaching landscape architecture to students and to inform the general public about landscape architecture considerations. It could also lead to the development of new tools for landscape architects.

The broad adoption and development of the technologies used in the design scenario may still be awhile away, however, early applications for these technologies can be developed. Digital tags are already used in a few industries and are being further developed and prepared for mass introduction in the use of product tracking. These could be used in landscapes of entertainment such as amusement parks, as digital passes allowing the wearer access to certain rides or activities. Items in museums, historical parks, botanical and sculptural gardens like Leo Mol could have RFID tags attached to them to provide people with cell phones, PDA's, radios or other digital devices the ability to access information about what they are looking at. The information could be encoded either as text, photographs, video or audio commentary, and as they freely move to different locations the appropriate data could be provided. Digital tags are relatively inexpensive and many current digital devices are already quite pervasive in our society, all that would be needed is the ability to communicate with the tag and wirelessly receive the corresponding data associated with it. The ability to develop these initial types of environments may not be very far away and may only require the desire to create them. In addition, the maintenance, infrastructure and revenue models seem to support such applications.

The next step in the development of these technologies may be the adoption of wearable computers by society to carry out daily computing tasks while we are on the move. These first systems could be used in the same environments mentioned above, however with the addition of Augmented Reality, a visitor to these sites may be able to rent one of these devices in order to enhance their experience and knowledge by seeing vanished structures or other elements once in the landscape. An example of this would be the ability to rebuild Upper Fort Garry virtually and placing it where it historically was located. Tourists would be able to see what the Fort looked like from within the current park to various locations surrounding the site. Augmented Reality could be applied to various sites within the city to develop Augmented Tours of Winnipeg. The St. Boniface Cathedral could be rebuilt to display the many different stages of construction and destruction it has been through with a historical account of activities from those periods. Other Augmented places could be Fort Gibraltar, Market Place, Lower Fort Garry, The Forks, and the Legislative grounds. These spaces might have a server with the required data for augmentation, which might be wirelessly transmitted to the user, or a rented system may already have the data pre loaded. As these technologies further get adopted into society as assumed, new services may be created allowing for wide spread use of these systems in all our outdoor environments as expressed in the design scenario.

These new systems are being developed to work in a manner that is more intuitive, allowing people to use them wherever they choose and with greater ease. Human desire for more information, more readily, more widely available may be leading to a world where there are abundant interconnected information systems available outdoors. Although the technologies studied in this practicum are mainly being designed and researched for interior application with the exception of Wearable Computers and some Augmented Reality applications – it is anticipated that there will be demand for their use outdoors and that appropriate applications will be designed and developed. These technologies will be able to affect how landscapes are perceived and seen when in use and my belief is that the profession of Landscape Architecture should get involved early in their development. Now is a good time to start exploring and become involved so that the profession is not left behind in trying to understand and figure out what to do with these technologies if they effect outdoor environments negatively. These technologies may also become valuable tools for the profession, if exploration and development starts early enough, landscape applications could be available when AR technology use becomes widespread. The possibilities for future development and use of these technologies are limitless.

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Illustration Credits

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Figure 1. Relationship of technologies – Illustration by author.

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Figure 2. Examples of RFID digital tags and reader:

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Figure 3. Examples of Wearable Computers:

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Figure 6. Schematic of Responsive Environment system for outdoor laboratory – Illustration by Author.

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Figure 7. Site Plan with possible locations for technologies discussed in scenario – Illustration by Author.

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Figure 8. View through video display glasses – Illustration by Author with images from Höllerer, T., S. Feiner, and J. Pavlik, eds., Embedding Multimedia Presentations in the Real World, In Proc ISWC '99 (Int. Symp. On Wearable Computers), San Francisco, CA, October 18-19, 1999, 2. <http://www.cs.columbia.edu/graphics/publications/iswc99.pdf> (9 April 2002).

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Figure 9. Sample one of Virtual Bulletin board in operation – Illustration by Author.

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Figure 10. Sample two of Virtual Bulletin board in operation – Illustration by Author.

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Figure 11. Possible display of Communication System – Illustration by Author.

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Figure 12. Virtual Sculptural Garden – Illustration by Author with Digital Images by Peter Miller for Perpetual Ocean, <http://www.perpetualocean.com/sculptgallery.html>, edited and reprinted, by permission from Peter Miller. © 2003 Sydney, Australia.

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Figure 13. Virtual Sculptural Garden – Illustration by Author with Digital Images by Peter Miller for Perpetual Ocean, <http://www.perpetualocean.com/sculptgallery.html>, edited and reprinted, by permission from Peter Miller. © 2003 Sydney, Australia.

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Figure 14. Example of how 3-D objects appear in the real landscape – Illustration by Author.

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Figure 15. Example of how virtual notes may appear when used in the real landscape – Illustration by Author.

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Figure 16. Examples of what vegetation data might look like displayed with a wearable computing system – Illustration by Author.

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Figure 17. Further examples of what vegetation data might look like displayed with a wearable computing system – Illustration by Author.

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Figure 18. Examples of climate data displayed with a wearable computing system – Illustration by Author.

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Figure 19. The locations of climate sensors on this plan have been chosen by trying to maximize the number of sensors in the landscape by placing them onto the existing infrastructure. Like buildings, light standards, existing sculptures and select trees. In order to understand the ideal locations for climate sensors, further investigation into the types of information users would require, has to be done. For the purpose of this exploration of potential usage these locations should suffice – Illustration by Author.

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Figure 20. Possible positions for location devices – Illustration by Author.

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Figure 21. This plan shows all the places that sensors could be implemented, they could also be placed into road and parking surfaces, not shown on this plan – Illustration by Author.

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Figure 22. Possible options for viewing and displaying photographic information – Illustration by Author.

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Figure 23. If the information was modeled this would be overlaid onto the landscape rather than just a plan view as seen in these examples – Illustration by Author.