Ubiquitous Computing in Office Environments

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Devices in an ubiquitous computing system, by definition, communicate with one another via networking and internet connections. The purpose of such communication is to improve the functionality of each individual device, and also to make the user's job easier (1). An example of an ubiquitous computing system would be hotel televisions which report to the guest all room-service charges, television charges, etc, as well as reporting these charges to the front desk and to whichever other back-end systems within the hotel require this information. This form of automated data transfer vastly improves the functionality of the system as a whole and increases the usefulness, and, indirectly, the value of the machines involved. Since the increased functionality of such systems will inevitably lead to higher efficiency, it makes sense to begin including them in the workplace environment. Doing so would increase efficiency of the workers, and, therefore, the overall wealth and value of the company. What kinds of specific benefits and/or problems may be encountered in an effort to bring more ubiquitous computing systems into the workplace?

Mark Weiser, a leading mind in ubiquitous computing in the 20th century, has stated, essentially, that ubiquitous and calm computing must have a relationship (2). In other words, forms of ubiquitous systems must inevitably be calm systems. The definition of a calm system, according to techtarget.com, is a system which attempts to remove a high level of information overload by allowing a user to focus on important information, but also keep less-important information in his peripherals (5). The example used to describe such technology is a telephone conference call versus a video conference call. The video conference call allows a person to see non-vital information, if he so chooses, such as people entering and exiting the room on the other end, which the telephone call does not. The knowledge that such information is there, even if it is unimportant, seems to be subconsciously calming for the user.

The original Star Trek series, produced by Gene Roddenbury in the late 1960's, often shows the main characters interacting with a computer via voice interaction. In their interactions with the computer, they will often ask it for information, interrupt it, and request that it focus more deeply on some subject it just mentioned. This type of system would fit the definition of a calming technology, because it gives the user the desired specific information, as well as maintaining less important, but still valuable, information in the background for access at any time. Such a device would likely be invaluable in many office work-spaces (lawyers could easily review specific cases, accountants could easily confirm both that their math is correct and that it follows current tax law, and stock brokers could more efficiently evaluate trends in the stock market).

The development of such systems as the one mentioned above would likely see the advent of some specific problems. One such problem may be the availability of information and access speed to the information. Currently, most computing systems which offer file storage offer it on a hard disk drive, or a spinning disk which can be written to and read from by other components of the machine. Because the disk spins, there is a certain delay in the time taken to access any specific portion of the disk. If there are many users trying to access different information all at once (as in a busy law firm), the speed at which information is sent and received may drop noticeably. There are a few possible solutions to this problem. One such solution may be to use a solid state drive in the ubiquitous system (though these are currently quite expensive, and are able to hold much less data in the same space as a hard disk drive). Another solution may be to add a few extra gigabytes of random access memory, or RAM, to the system, and develop an operating system that personally "gets to know" each regular user. The system would then attempt to load information into a certain amount of RAM (maybe one gigabyte per user) by predicting what types of information may be useful for the user. In addition to past searches by the user, the user's own personal device, which interacts with the mainframe containing all of this information, may check the user's top-priority assignments for the day or the week in order to narrow the information loaded into RAM on the mainframe for use by the user. In order to save resource space, the user's computer may also be able notify the mainframe when the user is on break, has not been using mainframe information for a given period of time, or is leaving for the day. This type of user-input prediction has become an important aspect of trending ubiquitous systems, as well as some non-ubiquitous software and internet services, such as the Google search engine (3).

Another form of ubiquitous computing which would be highly valuable in the office environment would be a system which could interact well with users using speech as a form of communication. It may seem like science fiction: a future where one may walk into the office and work side-by-side with a machine, communicating with it in the same manner as one human does to another, but there are already operating systems for mobile devices, such as the iPhone, which offer a user interface in the form of speech. A member of an ubiquitous system intended for user interface with humans would not only be enhanced by such a feature to its operating system, it is likely to become the standard of ubiquitous systems everywhere. As speech-interpretation software improves, so does the chance that office employees will soon be speaking to their machines in order to make work easier and more efficient.

For bosses with busy schedules in the office, there may be more to this ubiquitous system than simply a machine to spit out information for work-based decisions. The "higher-ups" in the work place may have their own personal digital secretaries, which would take messages flawlessly, as well as schedule meetings well, so as not to interfere with one another. Software of this sort would require an immense amount of planning and forethought, as the design would be intended to mimic real life, and the algorithms involved would surely be

complex. It is more likely that such a program would not be a member of the base operating system, but rather a helpful application to run on the user level of the machine.

In order to really meet its definition, ubiquitous computing would also need to eventually become mobile. Employees should be able to take their offices with them wherever they go. They may need to work overnight at home, or bring a presentation to their boss's office. Mobile devices are already being used in ubiquitous computing elsewhere to solve similar problems. For example, in many settings where music is an important aspect of regular activities, such as churches or concert halls, the main sound systems can be controlled via tablet, by applications which allow the user to interact with the environment from a hand-held device. If technology were to continue in this way, it would not be unlikely that new office buildings would be designed to integrate such applications into their ubiquitous environments, thus allowing employees to communicate with their offices from anywhere in the building, or, across the internet, anywhere in the world.

A large concern of many involved in the ubiquitous computing game is that of personal privacy. Concerns about privacy make it hard to implement ubiquitous systems in public places, such as an office. Due to its freeing nature, such systems may easily be compromised by fellow employees. The worker in the office next door to yours may decide it would be fun to turn your lights on and off from his tablet, or to set up fake meetings with the boss for you. He may even decide to take more harmful or personally violating actions, like checking the browser history on your personal tablet used to interact with your working environment. In order to prevent such problems, there must be some form of security implemented within the system itself. Similar forms of security exist in multi-user systems, where one user's application may not interfere with another user's memory space, and one user may not see the protected files of another.

A necessary privacy feature beyond this would be that of physical security. One user may enter another user's office and proceed to use his machines without permission. This security issue could be solved by implementing voice recognition software in the operating systems of the interface devices, which would require a password said in a certain voice for system access or would require all commands to be given in a verified user's own voice.

There is also a concern for privacy in terms of government interference. Unfortunately, recent events suggest that it would be unlikely that certain government organizations would determine not to use and possibly abuse this new form of potential data collection, no matter how noble their intentions may be. Dr. Marc Langheinrich suggests that it would be rather difficult to create a system of complete anonymity, and, as we all know, there is no computing system which is impervious to exploitation and attack. He purports, rather, that a system called “privacy boundaries” should be implemented in the deployment of ubiquitous computing

systems, which would allow users mainly to track their own personal data as it is stored, accessed, and removed from databases and other such systems. He also states that one goal of this system would be to promote self-responsibility. In other words, those who use these systems should not only take responsibility for how their data is distributed (watching where it goes and how it is used), but they should also be responsible in respecting others' privacy(6).

Some more issues of which future ubiquitous systems developers must be aware are the problem of sensor integration, the ability for older and new systems to interconnect and for newer machines to integrate well with older systems, and reliability of operating systems (7).

Sensor integration poses an issue because software is far more advanced than hardware at this current moment. Since ubiquitous systems will need to interact with the environment, they will require nearly perfect sensors if they are to collect data and analyze it well. A way around this may be to design operating systems to use certain ranges of data input, doing things like taking means, medians, and modes. Of course, this could then raise the question of the operating system's reliability. The more functionality and code the operating system contains, the more likely it is to break. Clearly, a high level of understanding of statistics and probability will be required by those working on ubiquitous computing systems in the future.

Clearly, ubiquitous computing is the way to go in the future. With ubiquitous computing, companies can both raise efficiency and lower employee stress in the office. Ubiquitous systems in the business world will make it easier to communicate across the planet for business endeavors. Of course, there will be some problems with ubiquitous computing, especially in setting up new systems and providing privacy and security for users, but the challenges faced are likely to generate new and innovative solutions which will lead technology into a future where man and machine interact almost seamlessly to solve problems and improve life for everyone on Earth.

Sources:

(1) http://searchnetworking.techtarget.com/definition/pervasive-computing

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(6) http://www.vs.inf.ethz.ch/publ/papers/privacy-awareness.pdf

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