Understanding User Values of Wearable Computing

Research-in-Progress

Xuefei (Nancy) Deng
Information Systems & Operations Management
California State University, Dominguez Hills
Carson, California, USA
ndeng@csudh.edu

Natasa Christodoulidou
Management and Marketing
California State University, Dominguez Hills
Carson, California, USA
nchristodoulidou@csudh.edu

Abstract

Wearable computing facilitates a new form of human-computer interaction and enables user mobility and connectivity. It has demonstrated its usefulness in niche applications, but its prospects in the mainstream electronics industry remain to be seen. Our understanding of wearable computing’s impact is limited. In this study, we explore user values in using wearable technology of Google Glass. Adopting the value sensitive design framework, we conducted an experiment study and collected detailed narratives by 75 college students. Our initial means-end chain analysis of data revealed a set of six values – assurance; autonomy; communication; efficiency, learning capability; and productivity in daily life—and different interplay between technological functions and user values. The diverse usage led to a digital learning environment – a “Digital Information Space” – that embodies user values and is constantly constructed by users. The study introduces the value-oriented perspective to technology adoption and offers design implications for wearable computing.

Keywords: Wearable computing, wearable technology, user value, value sensitive design, means-end chain analysis, information and communication technology, Google Glass

Introduction

Wearable computing facilitates a new form of human-computer interaction. This type of information and communication technology (ICT) enables mobility and connectivity so that users can readily access information online and communicate with others instantly when they are mobile. A wearable computer is defined by three key principles, mobility, augmented reality, and context sensitivity (Billinghurst and Starner, 1999). Although the earlier wearable computer was awkward and obtrusive, such as the one designed and worn by Steve Mann from the MIT Media Lab, with an immerse head-mounted display, video cameras, and 10 pounds of computer equipment (Mann, 1997), the hands-free, and mobile computing devices have attracted increasing attention from industry and research labs. For example, Boeing Computing Services started a pilot project in 1996 to explore the usage of wearable computers by their mechanics on site to access all the electronic documentations about an aircraft for problem diagnosis and to communicate with engineers in the office for fault repairing. Meanwhile, the First International Symposia on Wearable Computers (ISWC) was held in 1997, attracting researchers from both industry and academia.

Wearable computers have demonstrated its usefulness in niche applications that require the users to be mobile and to have hands-free access to information and computing power, such as applications developed for military, medical emergency response, warehouse inventory, and vehicle maintenance (Billinghurst and Starner, 1999). Moreover, some researchers believe that wearable computers will enhance people’s quality of life and will affect every aspect of one’s life (e.g., Billinghurst and Starner, 1999; Mann, 1998). Yet, the prospects of wearable technology in the mainstream consumer electronics industry remain to be seen.
Anecdotal evidences show that wearable technologies are gaining increasing popularity among consumers. Wearable glasses and smart watches are two examples of popular wearable technologies. In the medical field, doctors use wearable technologies such as Google Glass for seeking help from experts anywhere in the world during a complex procedure (Sultan, 2015). According to CCS Insight, a global technology analyst company, wearables shipments jump to 75 million in 2015 (a jump to 158% from 2014), and Apple Watch accounts for over a quarter of wearables shipments in 2015 (CCS Insight, 2015). As a result, more and more technology companies are pushing for wearable items that range from smart watches with integrated cellphones to smart glasses (Martini, 2014). Meanwhile, doubts and concerns are rising in relation to the usefulness of wearable computers (e.g., glasses). One concern is about patient privacy when transmitting confidential data through wearable computers without encryption (Pelletier, 2014). Another concern is about personal safety when using wearable glasses on public transit due to the worry that the $1,500 face computer might be "yanked" from one's face (Honan, 2013).

Different from desktop computers and portable computers (e.g., laptops) that are separated from users, wearable computers and users are inextricably intertwined such that the computer could form a true extension of the user’s mind and body (Mann, 2014). In this regard, it is important to understand the values that a user attains from using the wearable computers. The call for focusing on human values has been echoed by information systems (IS) scholars in studying the mobile technology adoptions (e.g., Jarvenpaa and Loebbecke, 2009; Jung, 2014, Kim and Han, 2009; Turel et al., 2007; 2010). Yet, there is limited academic research on exploring user values of wearable technologies. The increasing concerns about the potential impacts of the wearable technology motivated us to explore this technology’s impacts from user view. Thus, in this study, we intend to address a general question: what do users value in wearable computing?

To achieve the research objective, we adopt the value sensitive design (VSD) framework to inform our research inquiry. Developed by Friedman and colleagues (e.g., Friedman, 1996; Friedman, et al., 2003), this design framework highlights the importance of accounting for human values in the design of computer technologies and of empowering human beings in their interaction with technology. Motivated by the increasing popularity of wearable technology and associated concerns, we conduct an exploratory study to understand the user values associated with the wearable computing of Google Glass. Google Glass is a wearable computer that resembles eyeglasses and allows users to connect to the Internet, send messages and make phone calls by voice or touch commands. Developed by Google’s X lab, it embodies all the functionality of a smartphone with the hands-free, voice-command feature and a see-through lens displaying everything from text messages to maps to video shots (Goldman, 2012).

We use higher education as our research context, seeking college students’ perception of the wearable technology to enhance the college student’s learning and educational experience. This research-in-progress has good potential to make contributions in two areas. Theoretically, it will extend ICT adoption studies on user-value perspective. Practically, our enhanced understanding of user values in wearable computers will allow users—a key stakeholder—to voice their concerns and to share their values of wearable technology. Our study is guided by theoretical foundations of wearable computing, value-oriented ICT adoption and value sensitive design, which we review below.

**Theoretical Background**

**Wearable Computing and ICT Adoption**

A wearable computer must be mobile; it moves wherever the user goes. Consequently, it enhances, rather than replaces, the real environment where the user is situated (Billinghurst and Starner, 1999). Wearable computing is defined in terms of three operation modes and six attributes (Mann, 1998). According to Mann (1998), wearable computing facilitates a new form of interaction between human and computer through three operational modes – constancy, augmentation and mediation— such that the computer runs continuously to interact with the user (constancy), the computer serves to augment the intellect or senses of the user while the user is doing something else (augmentation), and the computer may serve as an intermediary when the user is interacting with untrusted systems (mediation). From the human's point of view, wearable computing creates a new human-machine synergy enabled by six attributes: unrestricted to the user (one can do other things while using it), unmonopolizing of the user’s attention (it does not cut off a person from the outside world), observable and controllable by the user (one can attend to and take control of the computer at any time), attentive to the environment (with increased
situational awareness), and communicative to others (as a mobile, personal communication medium). The three operation modes and six attributes of a wearable computer thus become important factors influencing its adoption by users.

ICT adoption has been well studied by IS researchers, as demonstrated by the commonly accepted Technology Acceptance Model (TAM) (Davis, 1989) and subsequent studies adopting and/or extending this model. However, wearable computer is a type of mobile technologies (e.g., mobile phones and mobile TV) that are designed to meet personal goals and support activities that may differ from those performed in organizational work. Increasingly, IS scholars are attending to a value-oriented view in studying the adoption of personalized mobile technologies and services. For example, Jarvenpaa and Loebbecke's study (2009) of mobile TV suggests that mobile technologies radically transformed the daily structure of people's life and provided highly personalized services, generating value for consumers. Studies by Turel and colleagues (2007; 2010) explored the overall value of mobile services and revealed a set of user values, including performance, emotional, money, social, and visual/musical appeal. Recently, Jung (2014) explored why users were attracted to smartphones, and revealed diverse benefits that users obtained from their smartphone use, including improved communication, socialization, information acquisition, and productive daily life. These studies adopt a value orientation to examine factors contributing to ICT adoption. For example, when users perceive utilitarian and social values, they are more likely to adopt mobile services (Kim and Han, 2009).

Value Sensitive Design

Value sensitive design (VSD) is a value-oriented design methodology commonly adopted in Human-Computer Interaction (Friedman 1996; Friedman and Khan 2003). It seeks to understand how human values, derived subjectively, can be accounted for in the design of computer technologies. Examples of values include welfare; accountability; autonomy; and freedom from bias. Friedman and Kahn (2003) provided a classification of values: human welfare; ownership and property; privacy; freedom from bias; universal usability; trust; autonomy; informed consent; accountability; identity; calmness, and environmental sustainability.

VSD research commonly relies on case studies in discussing how to account for human values in ICT designs. For example, Friedman et al. (2006) studied three technologies -- Web browser; high-definition, plasma display; and urban planning simulation system – and revealed a set of values for multiple stakeholders, including: information and control of web browser; physical and psychological well-being and privacy in the public areas; and diverse range of values by different stakeholders (e.g., environmental sustainability, business expansion opportunity). In their study of using three technologies by three groups of stakeholders, Le Dantec, et al. (2009) highlighted the importance of attending to local expressions of values in design, that is, the values present in the technology use context. In addition, they argued that user values should be empirically revealed before being used to design or refine systems. Consistent with the argument, we conduct this experiment study to reveal user values of wearable computing in the context of higher education. We now turn to these research considerations.

Research Methodology

We conducted an experiment study to investigate which features of Google Glass are appreciated by users and why using those Google Glass features are important to them. Consistent with interpretive approaches to IS research (as outlined, for example, by Galliers and Land 1987; Orlikowski and Baroudi 1991; Walsham 1995), our research objective was to investigate how human actors (college students) made sense of new technology adoption in their learning environment, rather than to hypothesize or test cause-and-effect relationships. Our goal was to develop an analytical generalization regarding user values and their experiences with the wearable computer technology. This generalization could prove useful for further research on other types of wearable technology (e.g., Apple Watch). Below we describe the mean-ends chain approach, our experiment design and data collection, and data coding and analysis.

Means-End Chain Approach

The means-end chain (MEC) approach is built upon the claims that consumers achieve goals or values via the attributes of a product, and those goals and values subsequently become the means to realize a higher goal or value (Gutman, 1982; Olson and Reynolds, 1983). An MEC approach has been well accepted by researchers to discover hierarchical structures of consumption values. There exist three levels of
abstraction in the hierarchical structures of consumer knowledge: attribute, consequence and value. According to Reynolds & Rochon (2001), attributes refer to product qualities or features – physical or abstract characteristics perceived by consumers, consequences are personal outcomes resultant from personal usage or consumption, and values are the beliefs that people hold about themselves, and drivers for their motivations. The means-end chain analysis has been commonly used by scholars in consumer research in an effort to understand consumers’ preferences toward products or services (e.g., Klenosky, 2002; Reynolds and Rochon, 2001). In the information systems filed, researchers have introduced this method to study users’ goals in virtual worlds (Jung and Kang, 2010) and understand their usage of smartphones (Jung, 2014).

To adopt the MEC approach in our exploration, we asked the three open-ended questions often used in a laddering interview (Gutman, 1982) to understand the attribute-consequence-value chain in the wearable technology context. The MEC analysis usually consists of two stages: coding and generating a goal structure. Consistent with prior studies (e.g., Jung, 2014; Jung and Kang, 2010), we classify responses into attributes, consequences, and values, and then produce a hierarchical structure of attributes-purposes-values, based on informants’ responses to the open-end questions. The three questions are: (1) what functions of Google Glass will you most likely to use for your courses and related activities at college? Please list 2 functions; (2) why will you use the 2 functions you listed above? What do you obtain by using the functions? Please explain; (3) regarding the reasons you provided in the question above, why are those reasons important to you? Please explain.

Rather than using interviews to gather data, we adopted the paper-pencil version (i.e., laddering questionnaire) to achieve the efficiency of data gathering and to provide informants opportunities to reflect upon their responses (Jung and Kang, 2010; Pieters, et al., 1995). To allow us to perform data triangulation, we asked an additional question: “please provide a scenario (example) that you and/or your instructor may use Google Glass to help you learn course materials more effectively.” Coded examples of the attribute-consequence-value chains are provided in the data coding and analysis section (See Table 1 in the next section).

**Experiment Design and Data Collection**

Undergraduate students at a suburban university in the U.S. were recruited to participate in the experiment for extra course credit. The experiment was carried out in two phases. During the first phase, each student watched three short videos on Google Glass, and then completed a survey on paper to provide demographic information and to respond to open-ended questions on perceived usefulness of Google Glass. During the second phase, student teams were assigned; each team was provided with a pair of Google Glass and a handout of task requirements. Randomly assigned into 4-member teams, students were required to figure out how to use a pair of Google Glass to perform three tasks: to take turn to use the Google Glass to 1) take a photo of the other team members, 2) record a brief video of other team members, and 3) to email all the photos and videos to a designated email account. Students learned to use Glass on a trial-and-error basis, but they were also allowed to access to the supporting aids they needed, including printed documentations and online search. When they finished the assigned task(s), they completed another survey regarding their reflection on their Google Glass use, their teamwork and performance. After the experiment, all students' photos and videos were downloaded from each pair of Google Glass to a password-protected computer, and were then deleted from the glasses to protect the experiment participants' confidentiality.

A total of 75 undergraduate students from 5 different classes participated in the experiments. Most of the students are in their junior years or senior years, majoring in business administration. In the sample of 75 respondents, 44.6% are males and 55.4% are females. The participants’ age ranges from 22 to 64, with a mean of 27.9 and median age of 26. The distribution of the household income categories is: less than $25,000 (25.7%), $25,000-$49,999 (31.1%), $50,000-$74,999 (17.6%), and $75,000-99,999 (25.7%). The distribution of ethnic backgrounds is: Hispanic or Latino (63.5%), Black/African American (14.9%), Asian (10.8%), white (8.1%), and others (2.7%). At this suburban university, more than half (56.8%) of the participants are the first college students in their family.

**Data Coding and Analysis**

The coding is performed in multiple steps. First, the first coder followed an open coding procedure to classify the data into the set of categories, trying to retain the original words/phrases from informants’
responses. For example, "With one picture, I can access more information than if I write them down in bullet points," the function is "take picture" and the consequence is coded as "Information access". Then the two authors discussed the initial list of categories and discussed a list of high-level categories to represent a set of similar codes. After discussing the initial coding scheme, the two authors independently coded a random sample of 21 responses, discussed the coding, and resolved any coding disagreements. As a result of the coding discussion and resolving disagreement, the two coders refined the coding scheme. The inter-rater reliability of the small sample coding is satisfactory, with a Cohen's Kappa Index of 0.935, suggesting an acceptable level of agreement between the two coders (Ryan and Bernard, 2000). Table 1 presents a sample matrix to illustrate our coding by following the means-end approach.

<table>
<thead>
<tr>
<th>MEC question</th>
<th>Attribute Statement</th>
<th>Consequence Statement</th>
<th>Value Statement</th>
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<tr>
<td>Users’ Responses to the 3 MEC questions</td>
<td>I would use google glass to look up information on the internet while I am doing homework. I would also use the google glass to take notes through picture or video.</td>
<td>I think being able to look things up instantly online will make it easier than having to use a computer or laptop. Also, by being able to take notes through pictures and video it will give you the ability to stay focus on the class content being discussed.</td>
<td>I think technology is evolving very fast and being able to obtain the internet by the click or voice command can make everything easier. Also, being able to take picture and video instantly can give you the ability to capture just about anything.</td>
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<td>Coding</td>
<td>(1)Google Search (2)Video/Photo</td>
<td>(1)Information search (2)Facilitate learning</td>
<td>(1)Autonomy (2)Learning capability</td>
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From this iterative process of initial data coding and analysis, six value categories were revealed and summarized in Table 2 in the initial results section. This initial result was based on the coding and analysis of the subset data of 21 responses out of 75 total responses (We thus reported our initial finding and submit this work as “Research-in-progress”).

**Initial Results: User Values and Emerging Themes**

Our initial data analysis reveals a set of six user values, namely, **assurance; autonomy; communication; efficiency, learning capability; and productivity in daily life**. These values are associated with the students’ expectation for learning, as they reflected on the functions and features of wearable computers, and perceived how those attributes would produce desirable outcomes in higher education. The means to realize these values varied greatly, however. Below we describe each value (summarized in Table 2).

<table>
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<tr>
<th>User Value/definition</th>
<th>Example</th>
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<td>(1) Assurance Assuring people’s rights to access the resources when needed, and securing the availability of resources to avoid disruption in our learning environment (Modified from Schein 1985).</td>
<td>“Google glass would be important for me and other students who need additional support during class. I am a visual learner and forget things frequently, but being able to take a video or picture would remind me of the lesson so I don’t forget. It will ensure that I won’t forget what was learned during class and I can review at a later time.” (30 years; Female; First college student in the family)</td>
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<td>(2) Autonomy Ability to decide, plan, and act in ways that are believed will help in achieving personal goals. (Friedman 1996);</td>
<td>“With the computer, I have to concentrate with I’m doing by using my hand. With the glass, I can take advantage of the voice of recognition to do my research while writing or typing what's on the screen of the glass. I don’t need two screen monitors to do this, which is what I do now.” (37 years; Male)</td>
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### User Values of Wearable Computing

<table>
<thead>
<tr>
<th>Value</th>
<th>Description</th>
<th>Quote</th>
<th>Age</th>
<th>Gender</th>
<th>Education</th>
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<tr>
<td><strong>Communication</strong>&lt;br&gt;The ability to inform others and being informed during the learning process (Derived from the study).</td>
<td>“To me the ability to <em>communicate</em> using google glass would be the most important for students and their professors. Being able to reach classmates &amp; professors would be vital to the learning experience at [as] students.”</td>
<td>22 years; Male; First college student in the family</td>
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<td><strong>Efficiency</strong>&lt;br&gt;The ability to complete a task fast when working on multiple tasks (Derived from the study).</td>
<td>“While reading what I’ve researched on the glass, I can do other work like writing. This is important to me because it’s <em>efficient</em> and it saves me time doing more things at once.”</td>
<td>37 years; Male</td>
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<tr>
<td><strong>Learning capability</strong>&lt;br&gt;The capability to gain new knowledge about a subject (Derived from the study).</td>
<td>“Being able to use google glass to document real time events as well as the video function to take notes can be helpful. Some students are hands-on learners, so documenting an experience that they participated can help and improve their learning.”</td>
<td>34 years; Female</td>
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<td><strong>Productivity in daily life</strong>&lt;br&gt;The ability to manage daily routines and schedules more efficiently (Modified from Jung 2014)</td>
<td>“I am a very forgetful person. Maintaining a schedule &amp; calendar always in the corner of my eye can help me be more organized with my time.”</td>
<td>21 years; Male; First college student in the family</td>
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<td>The value of assurance is derived from the digital memory operated and controlled by users. Digital memory is captured and stored from recording functions. Users’ appreciation for the sense of assurance is nuanced in terms of how and why the recorded lectures would enable them to learn more effectively:</td>
<td>“Recording an actual lecture is very important because it helps me go back and not missed what the lecture was about. Writing on the paper is a lot tougher than recording the actual class. I can study the whole lecture again and this will make me more understanding of the whole lecture.”</td>
<td>37 years; Male</td>
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<td>Autonomy is achieved by using the hands-free feature and digital memory. The example in the table shows that student is released from using two computer screens when multitasking. Another student shared this joy of having the hands-free option:</td>
<td>“I am always looking for answers to questions and having a hands free option is perfect when multitasking in order to not fall behind.”</td>
<td>30 years; Female; First college student in the family</td>
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<td>Autonomy can also be achieved by using the recording function to record a lecture and review the lecture at a time, place, and pace convenient to the students. This is reflected in the following remark:</td>
<td>My instructor reviews on the white board the concepts for our final exam. I use google glass to record the entire class review as I saw it thru my eyes. When I am ready to review my own time, I review at my own pace.</td>
<td>33 years; Male; First college students in the family</td>
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<td>Efficiency is achieved by the hands-free feature and digital memory. Efficiency emerged as an important value shared by the students in the study. The example in the table shows how the hands-free feature of Google Glass facilitates multitasking, allowing users to accomplish tasks faster. In addition, efficiency can be realized when students use the record function to retain the digital copy of a lecture, allowing them to concentrate on course content instead of spending time unnecessarily on taking notes:</td>
<td>“I'd use Google Glass video recording-to record lectures instead notes taking. It's faster than writing/taking notes. You obtain a faster way of learning/work completion.”</td>
<td>33 years; Male; First college students in the family</td>
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<td>Communication is improved with new perspectives. Communication is a common value that all students shared. The multiple functions of Google Glass were perceived to improve multiple forms of communication in the college learning environment. Students overwhelming appreciated the ease of</td>
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communication enabled by the hands-free feature, the messaging, phone, and Google Hangout. Their responses also revealed the dynamics of communication on a college campus; multiple forms of communication existed in the college learning environment: between students and professors, and among students themselves. Moreover, the content to be communicated may not be limited to the class lectures; it could be course-related materials recorded by a student from outside of classroom, but shared with the professor for discussion in class, as one student envisioned:

“I can share certain recorded videos of topics about a class to the instructor. This could be a great topic to discuss in class. One example is a survey or market research, interviewing and recording a specific subject or target market in public, and use it as a case study.” (37 years; Male)

In addition, when students videotaped a lecture, the recipient of recorded lecture is not limited to students only. The instructor could benefit from the recorded video shared by students, as one explained:

“Google glass would aid the instructor in explaining content. For notes taking an instructor can allow student to take pictures of the notes written on the board. Special personal notes could be sent to students individually. It also can give the instructor a way to see the way the instructor is teaching the class from the point of view of their students.” (29 years; Male)

User value of learning capability is enhanced via multiple functions. Learning capability is highly valued as students perceived that their learning could be enhanced by multiple functions on the Glass, including Google search, record video/take photo, and messaging/email. Putting those functions together on a hands-free device opens students’ eyes for opportunities of exploring new knowledge domains. As one elaborated when explaining how he planned to use Google Glass:

“Research information on google search related to the course. Share pictures from whenever I am with my classmates that relate to the course. The reasons stated above are important to me because it will allow me to have the capacity of learning more important information that is surrounded around me. These are important because I will be able to explore different things that I never thought I would with such easy access and hands free.” (23 years; Male)

Productivity in daily life is accomplished via multiple attributes. Users may achieve the value of productivity in their daily life as they perceived that Google Glass would allow them to manage their daily routines and tasks more easily. The messaging/call/email functions on Google Glass are frequently cited as helpful tools to allow users manage their busy schedule. More specifically, this value of productivity is achieved through multiple means – applying multiple functions from Google class. This is evidenced in a detailed narrative:

“If I am on the go, using google glass would be more efficient and faster to book appointments and meet ups. My last year at the university involved a lot of group assignments. I had to create a lot of meet ups and appointments through phone, email, or personal contact. Google glass merges all functions into one, making those tasks easier to complete. Google glass could also keep track of appointments and alert ahead of time.” (29 years; Male)

As presented above, each value can be realized by utilizing a function alone or by a portfolio of functions. Nevertheless, putting all the major functions (i.e., hands-free, voice-command, search, record, email, phone, message, calendar, and hangout) in one wearable device enables individual users to extend their activities in a physical environment (e.g., classrooms, buildings) to an online, digital environment, an individually constructed environment that provided student users opportunities to reinforce their learning obtained in a physical classroom.

Discussion: The Digital Information Space and Wearable Computing

The wearable computing enables a new learning environment, which we refer to as “Digital Information Space.” This digital space emerges from activities and practices of people living, working, and interacting by using wearable computing devices in the physical space, in our study context, the university campus. Unlike the physical space that can be measured in geometrical terms, the physical space enabled by wearable ICT has no limits, as shown in the use scenarios suggested by student users. For example, in the case of a student video-recording his interview in a supermarket and sending that video to the classroom to enliven the class discussion of a marketing case study, the reality of the university classrooms is augmented (Mann, 2014). In organizational studies, space is often associated with the physical distance
that separates people at work in physical office buildings, and thus considered as a constraint or barrier that hinders people’s interaction and collaboration (e.g., Allen, 1977). This new digital space has the potential to reduce that barrier by bringing them close in the digital space, allowing them to continue their interactions and communications beyond the physical boundary of their organizations.

In addition, the digital information space is constantly constructed, resulting from the mobility of the wearable ICT and the Internet connection availability. The voice command and hands-free features of the wearable technology allow mobile users to create a digital space instantly with their colleagues, friends, and family by starting a video call or sharing a calendar of events. Wearable technology such as Google Glass is capable of enhancing day-to-day experience, not just in the workplace, but in all facets of one’s daily life. Through its capability to provide the user with a personalized, customizable information space, owned, operated, and controlled by the user, wearable computing empowers the user (Mann, 1998).

Further, the affordances of wearable computing can be demonstrated from the stored and shared memory. A user collects and records information via video, audio, text messages, and emails so that one is free from recall bias. Meanwhile, a user of wearable computing could benefit from shared memory as the user has a recall of information that others do not need to experience personally. Both types of memory enhance personal productivity and improve team collaboration (Billinghurst and Starner, 1999).

This study provides two important implications in higher education practice. First, it offers insights into adopting and managing the wearable ICT (e.g. Google Glass) in distant learning and personalized teaching (e.g., one-one-sessions during office hours). Utilizing the functions of wearable technology enables students and professors to interact in a more productive and effective way, especially for students who are involved in distant education or need special attention. Wells (2014) suggests that teachers use the device to make first-person video guides in real time that will mimic the regular classroom experience. Second, small group collaboration in classroom can be improved by using the wearable ICT. Recorded and uploaded group sessions provide channels for absent students to obtain missed course material and facilitate the others to review lessons and reinforce their learning.

Having examined the positive implications of Google Glass, we are obliged to share some of the probable limitations. First, this wearable technology’s use is limited by its short battery life: without recharging, Google Glass battery life can last up to 2 hours. Moreover, without WiFi availability or phone connectivity, the technological functions are rather limited to the audio and video recording. While wearable technologies may claim to offer the advantage and the possibility of multi-tasking, it is possible that for many individuals this can be distractive and performance may deteriorate measurably (Norman, 2013).

The Road Map of the Study

Our next step is to complete the data coding and analysis of the narratives by the remaining 54 informants, with a focus on relating the revealed user values to the six technology attributes of wearable computing articulated by Mann (1998). Then, to triangulate the analysis of the user perceptions, we will code and analyze data collected from the second survey of the experiment, which focused on the actual usage behavior associated with and performance resulted from using the wearable technology. Given the unique composition of the student population at the suburban university in terms of diversity, we envision the research project to include analysis of the ethnic and gender differences in using wearable computing. After analyzing the entire data from the two surveys described earlier, we hope to better articulate our contribution to studies on value-oriented ICT adoption and wearable computing.

Adopting the user value-centric approach allows us to generate some insights into developing the wearable devices to enhance adoption and usage. It opens a window for us to see potential challenges in redefining the relationship between computer and user. Meanwhile, using the means-end chain analysis allows us to understand the perceptions and values of the wearers, an integral part of the wearable computing. Upon completion, we hope the finding of the study would provide useful guidelines for accounting for user values in refining the design and development of wearable technology for the niche market of higher education as well as for consumer electronics industry in general.
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