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Project Glass: An Extension of the Self

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"Our goal is to reduce the time between intention and action." The first time I heard Google CEO Larry Page say that phrase, we were talking about the then-secret Project Glass. However, this idea runs throughout Google's products.

As an example, go to google.com and type "weara" as if to start searching for "wearable computer." After just the first five letters, Google suggests possible completions (including "wearable shoe trees"). By the time the letters "wearable com" are entered, Google has matched "wearable computer" as the first completion result and has already loaded results in the page below the search box. Often, the information the user needs will be on the screen before the query is even finished. These techniques save seconds in the interaction, completing the intention and making the Google search experience more pleasant. On a mobile device, however, fast interaction can be the difference between a successful interface and a device that's left in the pocket.

HOOKED ON HUDs

For the past 20 years, I've been wearing my computer as an intelligent assistant in my daily life. Wearable computers and head-up displays (HUDs) have existed since the 1960s in some form, but as far as I know, nobody has been using them daily for as long as I have. Ever since my first month of use in 1993, I've been hooked.

The device enabled a compelling new lifestyle in which I felt more powerful, independent, and (most important to me) in control of my time. I founded the Wearable Computing Project at the MIT Media Lab with students who shared the wearable computing vision, and we soon realized that the functionality of most mobile consumer electronics (music playing, video playing, voice calls, taking photos, recording video, and the nascent practices of Web surfing and text messaging) would eventually converge on one portable device.

Fifteen years later, smartphones would take on this role, but they lack immediacy. The process of retrieving a device from the pocket, unlocking it, and navigating the interface requires around 20 seconds. This delay between "intention and action" correlates with how much a system is used in practice.[1] I speculate that users perceive how interruptive the retrieval and navigation process is and tend not to use devices when it will require too much interruption.

For example, at the end of my first faculty meeting at Georgia Tech in 1999, the group was trying to schedule the next meeting. I was shocked to realize that I was the only person who was accessing his calendar in real time, even though I knew other professors had PDAs and paper-based day planners in their pockets. For me, the HUD had removed the barrier to accessing my computer, and there was little effort involved in referring to it throughout the day (as opposed to the pocketed devices others were using). Even with the specialized hardware, however, I found it important to optimize the user interface for fast interaction for each function I intended to use. Otherwise, using the function was too much trouble, just as with the PDAs my colleagues were neglecting.

REDUCING ACCESS TIME

One frustration I had during that time was with Web search interfaces. During face-to-face meetings with a colleague or student, I could refer to my calendar and personal notes quickly enough to avoid interrupting the flow of conversation. However, if I needed some information during a brainstorming session, searching for it on AltaVista required me to pause and interrupt the conversation completely. I had to focus on the screen, page through 14 different hits until I found a likely link, click on the link, and then scan through the page searching for what I wanted, succeeding only about half of the time. The time between intention and action was so long that I gave up doing Web searches during a conversation unless the information was absolutely critical. Fortunately, I met two guys who were working on the problem.

When Larry Page and Sergey Brin first introduced themselves to me at a conference in 1998, they asked for a demonstration of my wearable and then described their own research. While graduate students at Stanford, they had created a new algorithm, PageRank, that promised to provide better ranking of hits from Web searches.

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I remember saying that if their algorithm could provide the information I needed in the first four hits, it could change the way I use my wearable computer. If fast enough, having Google search on my eye would remove the barrier to accessing the world's information, making it available to me during conversation and collaboration or simply when I wanted to satisfy my curiosity.

Today, I use Google search on Glass in a wide variety of contexts, both personal and professional (Figure 1 shows a photo of the Glass HUD). Google's search displays excerpts of the most related content for each of its hits, which means that the result of the search itself often provides me with the information I need without even clicking on a link—something that I find critical in my usage on a HUD.

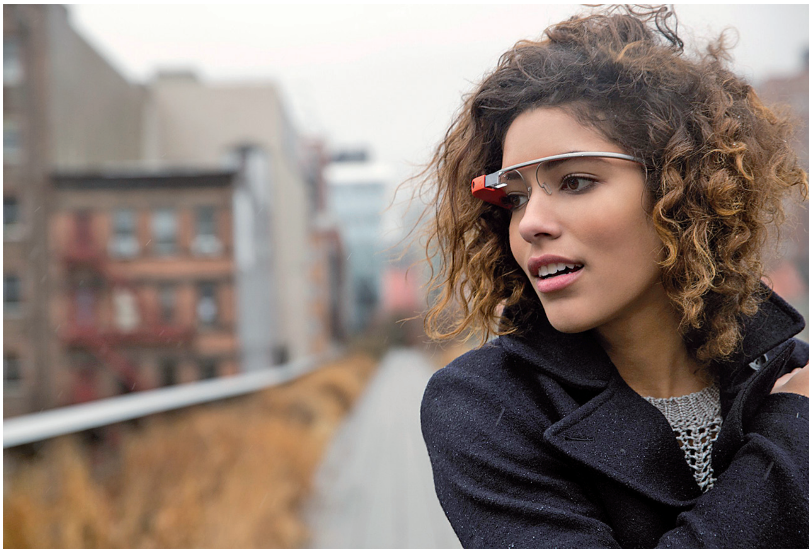

Figure 1. The Glass head-up display (HUD). (Figure courtesy of Google.)

Before I took a leave of absence from Georgia Tech in 2010 to join Babak Parviz, Steve Lee, and the "Google guys" in creating Glass, my research group ran many user studies focusing on how and why a user might want a wearable computer with a HUD. We became more convinced that the major advantage was the reduced access time. When the time between intention and action becomes small enough, the interface becomes an extension of the self.

An example is a man riding a bicycle. If a car cuts him off, the rider doesn't think, "If I squeeze this lever on the handlebar, it will pivot about its axle, pulling a cable. Using a sheaf, that cable will direct the force under the bicycle and pull on a pair of calipers that will then squeeze against the sides of my back tire, and the friction will stop me." Instead, the rider simply reacts and stops—the bicycle acts as an extension of the rider. To me, this example demonstrates the difference between doing research on human-computer interfaces and doing research on interfaces that are extensions of the self. If we can make mobile interfaces as quick and natural as riding a bicycle, then we make the user more powerful in a fundamental way.

While researching this principle, one of our inspirations was the wristwatch. The wristwatch requires around two seconds to access,[2] which seems to remove the barrier to use (what my colleague Brad Rhodes calls the "two-second rule"). Consider an interesting experiment that helps illustrate the point. Next time you see someone glance at their watch, wait a beat, and ask again what time it is. Often, I see the wearer glance back at the watch, as if the time has changed somehow. Why doesn't the user just say the time? Surely he has just read it!

In fact, the user's intention in looking at his watch may have been to see if he was late to his next appointment. He checked the time, realized he has another 10 minutes, and dismissed the issue from his mind without retaining the actual numbers. When asked to report the time, it is easier to check again than try to reconstruct it. The wristwatch has become an extension of the self. The wristwatch provides utility with such a minimum investment of user attention that the wearer has delegated that function to the device, freeing his mind for more important tasks. In fact, time is such an important function in our modern lives that we've made a clock the default screen for Glass (see Figure 2), and I would argue it's the most used feature on the device.

The important question is, can we make more wristwatch-like interfaces that provide a maximum amount of utility for the minimum amount of user attention? We call using such interfaces *microinteractions* and discovered that these can be enabled through a coupling of HUDs and gesture or speech input (see the "Microinteractions" sidebar for more information). For example, a flick of the wrist could be recognized by a wristwatch to trigger the display of a contact list in a HUD. The challenge is creating interfaces that don't falsely trigger during the user's everyday life. There's a delicate balance between gestures that are simple enough to be both memorable and socially acceptable yet distinct enough to be recognized accurately.[2]

While gesture can be used silently and perhaps subtly when working with others, speech input requires that the wearable be brought into the conversation. For example, when discussing methods to create multitouch tabletop surfaces, the wearable user might need a specific piece of information

WEARABLE COMPUTING

Figure 2. A user on a hot-air balloon ride, wearing Glass. A clock is the default screen for Glass, so the user sees the time in the upper right corner. (Figure courtesy of Google.)

Figure 3. Having a see-through display provides cues to conversational partners regarding the use of a HUD. Looking closely at the HUD Starner is wearing here, made by Mark Spitzer in 1997, you can almost read the text on the screen. (Photo courtesy of Sam Ogden; used with permission.)

MICROINTERACTIONS

Unfortunately, smartphones have very limited potential for microinteractions, which leads to users being mired and head-down in their touch screens. Once the user has invested the 20 seconds needed to retrieve the device and navigate to the appropriate function of the user interface, she tends to devote even more attention to the device while she has it in hand.

For example, when reading an incoming SMS, which should be a microinteraction, the user is soon lured into a scan of the email inbox. To make matters worse, smartphone user interfaces require significant hand-eye coordination, with the user's eyes typically cast down toward the floor. The user's attention is "tunneled" away from the world around her, into the virtual. However, this attention-tunneling problem is alleviated once an interaction becomes "micro," with an interface designed to get the user in and out of the interaction as quickly as possible. Even better, a head-up interface, when used for a microinteraction, keeps the user's eyes pointed outward toward the world, which also helps avoid attention tunneling. Compared to current devices, wearable interfaces will help the user pay attention to the real world as opposed to retreating from it.

to continue the conversation and say, "Let me google the refractive index of acrylic."

A particular advantage of this technique is that it both communicates the request to the computer and informs the conversational partner as to the wearer's use of the machine.[3] I prefer such interactions, because they encourage socially appropriate use. Through this technique, other functions of the wearable computer—such as taking a picture or recording a video—become transparent to bystanders. Having a see-through display provides further cues to conversational partners as to the use of the HUD (looking closely at the display in Figure 3, made for me by Mark Spitzer in 1997, you can almost read the text on the screen).

Soon, Google Glass will be worn by many more users as part of the Glass Explorers Program. This deployment will be the largest ever of its type, and we expect to learn more in a few months than my teams have learned in the past 20 years. I encourage you to participate in exploring this new lifestyle, enabled by Glass.

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