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Wearable Computing: Interface, Emotions and the Wearer's Culture

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Abstract

Wearable computing offers an interesting subset for the mobile computing field. While Google Glass might not yet have found the mass audience it sought, other, simpler, wearable devices have made an impact. This paper presents results of a four-week long experiment in how subjects interact and emotionally respond to the Fitbit Flex. Users tracked daily totals of steps, distance traveled, minutes active, calories burned, and time slept. They also found their own personal uses for the Fitbit interface. Users were asked to be aware of and report their emotional reactions by keeping continuous, daily journals.

A popular and relatively inexpensive mobile device offered an opportunity to study an interface used with regularity over a defined and sustained time period. The interface and the user interacted; the device's constant presence had the potential to bind it to the wearer's emotional life. The wearable device prompted and reinforced emotions already present in the culture in which the users were immersed. There was also agreement among participants that the device altered users' behaviors.

Keywords:
HCI, wearable computing, Fitbit, interface design, mobile computing, affective computing

1. Introduction

Worn on your wrist, the Fitbit Flex tracks your steps 24 hours a day. Because it has a comfortable, unobtrusive design users tend to continue wearing it without noticing that it is present. From the steps tracked, Fitbit computes distance travelled, calories burned, number of

active minutes. Activating an additional setting enables it to track sleep patterns. Users can set daily step goals, with a default goal of 10,000 steps. Once Fitbit detects that the goal is met, the user receives a congratulatory vibration on his/her wrist. The user can also access a Fitbit website, where a dashboard provides daily reports. In addition, an available sync links to many smart phones. Through this capability the user can receive continuous activity tracking information. It is also possible to use social media to keep in touch with friends or make new friends through data sharing.

Fitbit ($100) competes with the Nike+SportWatchGPS ($140), Jawbone Up($130), and Basis Band($199). All four of the products use similar technology: a 3-axis accelerometer. An accelerometer is a device for measuring acceleration and mass. Typically an accelerometer will contain internal captive plates. Some are fixed. Others are attached to tiny springs that move internally as acceleration forces act upon the sensor. Acceleration is determined by measuring changes in capacitance.

In wearable computing the challenge is to capture accelerometer data and present it to the user. The device must provide continuous, mobile information, either through a built-in display or by communicating with the user's phone. In some cases users prefer to check in with the interface intermittently via laptop or desktop.

While the technology behind these wearable computing devices is similar, it is the interface that distinguishes them. The most advanced displays are the Nike+ Fuel Band and BasisBand, which use watch-like displays. Both give their users such information as time of day, steps taken so far that day, and calories burned. All the wearables sync wirelessly to your smartphone or computer. Jawbone and Fitbit require the user to connect to view its data, but provide the same information through a dashboard. All four are worn on the wrists. Enthusiasts differ about the

relative comfort and style of each device.

Fitbit is generally recognized to have the fastest wireless sync available (Goode, 2013). Users also disagree on comfort levels, with only the Nike device singled out for lack of comfort. However, the latter also had the most comprehensive display. Cost, detailed above, varied within a range from $100 - $200. Fibit, at $100, or slightly below, is generally the least expensive wearable activity tracker.

As an example of wearable mobile computing, activity trackers present an interesting research opportunity. They are popular, available and relatively inexpensive. And they offer a chance to study an interface that people actually use several times a day over sustained time periods. Further they tap into weight and health, two topics that are emotional and compelling for many age groups.

This paper reports on a four week experiment in which eighteen subjects volunteered to wear Fitbits and to keep a daily Fitbit journal. All subjects were sophomore and junior undergraduates enrolled in CS232, Human Computer Interaction, at Sacred Heart University in Fairfield, Connecticut, U.S.A. Fitbit was chosen over other wearable devices for two reasons: its popularity and related publicity ensured that it would attract sufficient volunteers, and its price ($100) was at a low enough point to render financing possible.

That financing was effected in the following manner: Each subject contributed $35; one student surveyed local retailers and found a store willing to offer a $15 per unit discount based on multiple purchases; an independent grant funded the remaining $35 per device.

Fitbits were distributed in one sitting. There was no introduction given. Subjects were instructed to open the package and figure out the device on their own, with guidance from whatever instructions were provided by the manufacturer. In the daily journals the subjects were

told to write down every thought that came to them regarding the Fitbit interface and user experience. Journals were turned in weekly. Content analysis was used to track user response to the Fitbit interface.

2. Wearable Computing

In their 2012 book *Building mobile experiences*, Bentley and Barrett discuss wearables,"…we are not merely shrinking in size a Web experience, but creating an entirely new platform for communication and interaction. And this 'new platform' is life as it is lived: private, social, and irreducible to formulaic expression." If a wearable is part of the life platform, then studying it should be immersed in that platform. One technique advocated by the authors is a quick debriefing after the user experience has completed.

Such a technique would not work for the Fitbit experiment. One could not constantly be in touch with and questioning eighteen different subjects. But we also had to take into account the fact that a Fitbit is constantly present. One 2014 review noted that it is "Scoble-proof: You can wear it in the shower" (Honan). A wearable is present. The user does not type in an address or flip a switch to have the experience. Rather, that experience is constantly there.

In a sense, then, a wearable device is one continuous HCI experience. One question for research is how to evaluate that experience in terms of its life integration. Where does the interface end and the person begin?

At the beginning of HCI studies, the philosophical cognition model was thought to be sufficient. It was assumed that we could apply computational terms to a model of how the mind works. This led to emotion being treated as an add-on to cognition. This would enable us to obtain meaningful, analyzable data about the affective nature of any HCI experience.

Broehner et al. argue that emotion should be viewed as interaction. They focus on an

emotional HCI as one in which a person's social setting, culture and interaction play a part in the human computer interaction. They conclude that an HCI system should play a supportive role. It should help users understand the full range of their emotional experience (Boehner, DePaula, Dourish, & Sengers, 2007). For wearable computing we might infer that the user will actually have an emotional experience with the device. Anger, annoyance, joy and surprise can be part of the Fitbit experience. That a wearable computer can be closely bound to emotions is partially made possible by its constant presence.

So far research on wearable activity trackers has concentrated on validating their accuracy. Takacs et al. (2014) concluded, "No significant differences were noted between Fitbit One step count outputs and observer counts, and concordance was substantial (0.97 – 1.00). One goal of the current research is to see whether subjects assume accuracy or if they question it. If they do question the accuracy, does it change their affective experience?

3. First Impressions

Palen and Bodker point out that emotion in HCI is both experiential and social (2008). With that in mind the first place we check the emotional context of Fitbit is to look at the subjects' opening day with the interface. In fact, although the emotional responses varied, almost all the subjects had some emotional feelings at the beginning. One reported that he was excited to anticipate getting the Fitbit. After opening it, he added, "I'm pretty let down". Another word used more than once was "confusion". Typically this referred to some aspect of setting up the device.

More positive responses focused on how the interface reacted. One student liked the fact that she was told "Nice choice" when Fitbit asked which model was being registered. Also reported was her realization that the interface "had my inner HCI demon screaming". This

referred to a button that covered up part of the text on an instructional web page. The subject in question was insulted by the amateurish nature of Fitbit's interface design.

A single subject reported concerns about Fitbit's accuracy. One might infer that Fitbit users assume the creators would be competent, but no one mentioned such an assumption. In general the user experience seemed more important than data integrity.

The expression most often used was "annoyance". There was a sense of insult that Fitbit did not care more about explaining itself to its users. We are not sure what part price played in this annoyance. The subjects did not view Fitbit as being the least expensive fitness tracker available; rather, they felt that $100 was a lot to pay for a device of this kind. Since all subjects were between the ages of 19 and 21 and also were full-time students, the $100 price point might have precluded consideration of any more expensive devices. Most subjects did not appear to be aware of the alternatives available in the wearable fitness tracker market. Evidence of this comes from the fact that Fitbit was referred to as a "great idea". Whenever a journal reported some malfunction or HCI awkwardness, there was a perception that a machine costing $100 should either offer more or work better.

Initial emotional reactions to Fitbit varied in both direction and intensity. While emotions were an integral part of the experience, they were not quantifiable. Rather the emotional reaction arose naturally out of the first interaction with both the HCI itself and whatever support was provided for it. It would have been possible to quantify emotions by changing the experimental design. We could, for example, have observed reactions as the package was opened and the Fitibit interface initialized. Those observations could have been calibrated and reported on a numeric scale. Similarly users could have been asked to rate their experience on something like a Likert scale. To do that, however, would have inserted an artificial element into the emotional

experience. It seems more authentic to actually let the subject describe the experience. In general we agree with Palen and Bodker: emotions are a part of the always there background. To foreground them in an analytical, as opposed to descriptive way, would have resulted in isolation that impoverished the descriptive experience.

However, from the journals an interesting emotional HCI experience emerges. The subjects came to Fitbit emotionally prepared. The word "excitement" appears in seven out of eighteen journals on the first day. One user went farther: "I was so happy when I received it that I was in tears." We describe these emotions as "background" because they are there separately from any HCI interaction.

After opening the box and beginning installation, a different sort of interactional emotion is evident. Now words like "disappointment" and "disappointed", "cool design", "awesome", "lackadaisical", "lacking" and "confused" appear. These emotively-laden descriptions are all in reaction to the opening and set up experience.

Descriptively it seems that people come to the Fitbit HCI with emotional feelings. Those feelings are either dashed or validated by the beginning experience. Since the journals are written continuously, it is reasonable to assume a good degree of reporting accuracy. From studying the Day 1 experiences, it appears that this two-part model of emotions works for Fitbit. Users describe their emotional state in relation to the HCI. After using the HCI once, they describe a modified emotional situation.

It is not clear that the first emotions could be described as "background", since that term generally applies to an individual's overall emotional state. Although the subjects sometimes referred to themselves as "busy" or "tired", those words would be tough to describe as purely emotional. Instead it appears that the pre-Fitbit emotional state exists in relation to and in

reaction to the anticipation of experiencing the HCI. After the first experience there are new emotions. But these too exist as a reactive experience to the HCI. Although the Fitbit emotional reactions might be considered intense because of anticipation, it is not unreasonable to say that other HCI experiences would have their own emotional content. We speculate that the difference is one of intensity, not quality.

4. Goals

Boehner et al. argue that an interactional approach to emotional computing view those emotions as ultimately grounded in the users' culture (2007). These emotions realize themselves through the interface experience. The Fitbit experiment lends credence to the interactional model. When a person signs up, Fitbit establishes what appears to be arbitrary goals. The most important of these is to take 10,000 steps every day.

Modern fitness theorists tell us that a person takes about 2,000 daily steps just by existing. Before encountering the Fitbit number, we had accepted the wisdom that about 8,000 steps per day was a good health target. Now Fitbit comes along and tells us we should aim for 10,000. As noted below, only one person in the experimental group utilized the option to change his goal.

From an affective computing standpoint, the interesting part of this is not whether the goal is 8,000, 10,000 or 12,000. It is that the subjects accepted this goal and reacted emotionally to it. Perhaps "reacted to" is not the best description. Perhaps Fitbit enabled the subjects to understand the emotional gratification they would receive from reaching an accepted goal/standard. That standard comes with the patina of health enhancement. Here are some comments from the journals:

– "Got my steps! Hallelujah! Do a little dance! My third time getting my steps!

– "Hit 5000 steps for the first time since having the Fitbit! It is rewarding to see the dots go up as

you progress towards your goal. Can't wait to hit 10,000! The band is fitting into my lifestyle well, is easy to use, and I am thoroughly enjoying it."

– "I can see why it's sort of addicting, because now I'm trying everything to reach 10,000."

– "I met my goal and was satisfied for the day."

– "As I move about my day I look down at my wrist to check my progress, look at my phone just to see how far I've gone…"

– "So close to getting my steps today!! Soooooooo close! 500 steps away!"

–"I went to my local track to do some catching up with my Fitbit since I know I'll be slacking a little bit due to all the work and finals that I have coming up."

–"Today I was not able to fill the steps and I felt so guilty I literally couldn't fall asleep…"

No one questioned the 10,000 step goal. No one asked whether it had any basis in fitness research. It is tempting to say that Fitbit was accepted as an authority because of its $100 price (viewed as high by the students) and the fact that its HCI works. But something else is going on here. Sacred Heart University is a place that values fitness. 27% of undergraduate students are on a Division 1 athletic team. The Pitt Fitness Center is a focal point of campus life. Further, it is a campus steeped in the Catholic tradition. Part of that tradition is to celebrate success. Having a goal, sharing it, and achieving it are causes for that celebration.

In short, interactions with Fitbit cause emotions to come to life. We can say that the emotional structure is already there in the students' life stories. Having a Fitbit experience awakens and intensifies the emotions already present in the culture.

5. Buzz

Although gamification theorists sometimes act as if they had invented the virtual reward, the technique has been employed for many years in game design. Perhaps Nintendo does it best.

Going back to the beginning of the Super Mario Brothers series, Nintendo embedded virtual rewards in any number of on screen objects. The idea is taken a step farther in the Mario Kart series. At the conclusion of a race your driver might cry or might be happy, depending on how well you did against the opposition.

Fitbit initially tried this strategy by sending its users notes of encouragement and reward icons as they approached or exceeded goals. This strategy was not viewed with approval by our subjects. One wrote, "I got an e-mail from Fitbit explaining a new icon reward that I can show off on social media…I for one thought it was slightly immature…".

While the icon reward strategy was not popular, one other reward was mentioned at some point by every subject. That reward is the vibration that comes from Fitbit when one reaches his/her daily steps goal. Now, a vibration can hardly be called a virtual reward. However, it definitely is part of the wearable computer interface.

The first interface characteristic to note about the vibration, or "buzz" as most subjects call it, is how readily the young computer scientists accepted the standards that Fitbit stipulates. For example only two subjects mentioned changing the goals established by Fitbit. One wrote,"After setting my daily goals for the various tasks the device holds, I'm noticing as days go on I am checking my Fitbit more and more." The other noted that he had lowered the step goal because he wanted to feel the buzz.

One person, who did not like the device, wrote, "Looks like Fitbit hasn't really suede [*sic*] me much to work out more. Looks like I've only reached my step goal a total of 5 times out of the month haha." Even though he did not reach his goal, this person did *accept* the goal established by Fitbit. In this sense the interface established itself as the expert. One thinks of Huizinga's game theory. When someone plays a game, he/she agrees to enter the game's world

and abide by its rules. Almost all subjects viewed the Fitbit HCI as establishing the rules of the fitness tracking game. They willingly enter the Fitbit world. "You'll be happy to know that I finally made this Fitbit buzz took some extra work out of the ordinary…and I actually treated myself to extra dessert knowing that I accomplished my goals tonight…"

The Fitbit buzz is a virtual reward made physical. It makes Human Computer Interaction come alive on your skin. "And I got the buzz today!…I stopped right in my tracks…I told my friend right away. I felt super accomplished!" This is the same sense of accomplishment we observed when talking with gamers who had bought a new game and played it for many hours straight through to completion. One enters the game's world and accepts the games praise when achieving its goals. To say that these goals are artificial is irrelevant. They are real in terms of the game.

The Fitbit buzz is much like Huizinga's soccer game. You can be alone on the field and kick the ball into the goal over and over. The action has no meaning. But when you kick the ball into the goal during the game, it acquires tremendous significance.

6. Emotions from the Machine

"…I really wish that Fitbit were more encouraging and almost annoying to a certain point."

All those participating in the research had some feelings toward the machine. Similarly there was agreement that the Fitbit HCI altered behavior. Everyone reported doing something different, from taking late night walks, to parking farther away from the store, to using stairs instead of elevators, to establishing steps-per-day competitions on social media, to drinking more water to be in better shape for exercise.

Are emotions internal? Can one accurately describe and classify them? Are they unique to the individual? In one sense the answer is yes to all these questions. However, that does not help

us to understand how these emotions are connected to computers. For that we think an interactional, cultural model is more helpful. Our young group of journalist/researchers had reactions that were individual, yet tied to the culture in which they exist. We doubt that eighteen students at Massachusetts Institute of Technology would have the same reactions as did the Sacred Heart students.

Our conclusion is: the machine HCI did indeed bring out emotions. However, the particular emotions themselves are grounded in the cultural values and story of the subjects.

One subject concluded, "I am now starting to realize that this little Fitbit is starting to slowly take over my life, I feel like I am being watched at every moment and something is always pushing me."

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