# Designing for Behavior Change in Everyday Life

**Sunny Consolvo and James A. Landay**
*Intel Research Seattle and University of Washington*
**David W. McDonald**
*University of Washington*

**UbiFit uses on-body sensing, real-time activity inference, and a personal, mobile display to encourage people to incorporate regular and varied physical activity into everyday life.**

Do you tend to punish yourself when you do something that is "bad" for you, but not reward yourself when you do something that is "good" for you? How do you turn a good behavior into a good habit that helps you achieve your long-term goals?

More and more companies are designing persuasive technologies that promote socially positive behaviors like healthy living (B.J. Fogg, *Persuasive Technology: Using Computers to Change What We Think and Do*, Morgan Kaufmann, 2003).

During the past several years, we have been designing, developing, and evaluating technologies that encourage one type of healthy behavior—being physically active (S. Consolvo, D.W. McDonald, and J.A. Landay, "Theory-Driven Design Strategies for Technologies that Support Behavior Change in Everyday Life," *Proc. 27th Int'l Conf. on Human Factors in Computing Systems*, ACM Press, 2009, pp. 405-414).

The focus of our work has been the UbiFit system—a persuasive technology that uses on-body sensing, real-time activity inference, and a personal, mobile display to encourage people to incorporate regular and varied physical activity into everyday life.

## SYSTEM OVERVIEW

The UbiFit system uses three main components—a glanceable display, interactive application, and fitness device—to encourage regular and varied physical activity.

The glanceable display is a stylized image that resides on the background screen of a mobile phone. Every time individuals use their phone, the image conveys basic information about their physical activity behavior and goal-attainment status, as well as a subtle but persistent reminder of the commitment they have made to being physically active.

The interactive application, which also runs on the mobile phone, includes detailed information about the individual's physical activities and a journal in which to add, edit, and delete activities.

Finally, the fitness device automatically infers information about several physical activities. Because the glanceable display and interactive application are on the mobile phone, UbiFit is available essentially whenever and wherever the individual may need it.

### Glanceable display

In the UbiFit Garden implementation, shown in Figure 1, the glanceable display uses the metaphor of a garden that blooms as the individual performs activities. The garden represents one week's worth of activities; the individual sets and attains goals on a weekly basis.

Flowers of different colors represent different types of activities: cardio (pink), strength (blue), flexibility (white), and walking (sunflowers). Each flower represents a single event—for example, a 40-minute run and a 3-hour bicycle ride each receive one pink flower, a 22-minute walk receives one sunflower, and so on.

When the individual meets a weekly goal, a large butterfly appears. Small butterflies represent recent goal attainments. Yellow butterflies indicate that the individual has met the primary goal, and white butterflies indicate that the individual has met the alternate goal. The alternate goal encourages the individual to perform at least some activity during busy or otherwise difficult weeks.

At the end of the week, the display resets to an empty garden that includes a small butterfly for each goal met over the past three weeks.


Published by the IEEE Computer Society

## Interactive application

UbiFit's interactive application, shown in Figure 2, includes details about the physical activities inferred by the fitness device and a journal to add, edit, or delete information about activities, including those not inferred by the fitness device.

With the interactive application, the individual can

- view a daily list of activities performed today and any prior day;
- add, edit, or delete activities for today and yesterday;
- view progress toward the weekly goal(s); and
- add a comment to the daily activity list, such as "sick" or "ran the Dawg Dash."

If the individual has not manually journaled recently, the system asks whether there are any activities to add.

## Fitness device

To automatically infer physical activities, UbiFit employs the Mobile Sensing Platform. As Figure 3 shows, the MSP is a pager-sized, battery-powered computer with sensors that facilitate a wide range of mobile sensing applications (T. Choudhury et al., "The Mobile Sensing Platform: An Embedded System for Capturing and Recognizing Human Activities," *IEEE Pervasive Computing*, Apr.-June 2008, pp. 32-41).

UbiFit uses the MSP's 3D accelerometer and barometer to infer walking, running, cycling, using an elliptical trainer, and using a stair machine. It transmits a list of activities and their predicted likelihoods to the mobile phone four times per second over Bluetooth. The interactive application aggregates and "smoothes" this data into human-scale activities such as a 40-minute run, 3-hour bicycle ride, or 22-minute walk.


**Figure 1.** UbiFit Garden implementation on the background screen of a mobile phone. (a) Garden at beginning of week. (b) Garden with activity but little variety. (c) Garden with activity and variety.

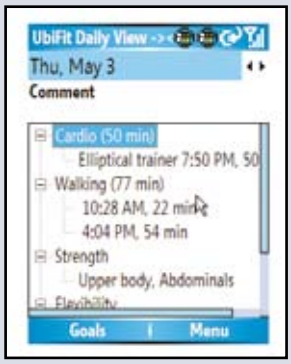


**Figure 2.** The UbiFit interactive application includes details about physical activities and a journal to add, edit, or delete information about activities.

**Figure 3.** UbiFit employs the Mobile Sensing Platform as a fitness device to automatically infer physical activities.

Researchers have recently performed similar activity inference with the built-in accelerometers on some smartphones (T.S. Saponas et al., *iLearn on the iPhone: Real-Time Human Activity Classification on Commodity Mobile Phones*, tech. report UW-CSE-08-04-02, Dept. of Computer

Science and Eng., Univ. of Washington, 2008). Such an approach would remove the dependence on a separate fitness device for systems like UbiFit.

## EVALUATING UBIFIT

In developing UbiFit, we used an iterative design process that included three evaluations—a survey, a three-week field trial, and a three-month field experiment in which one group of participants had access to the full system, another had no glanceable display, and a third had no fitness device—and extensive beta testing by members of the research team, friends, and family (S. Consolvo et al., "Flowers or a Robot Army? Encouraging Awareness & Activity with Personal, Mobile Displays," *Proc. 10th Int'l Conf. Ubiquitous Computing*, ACM Press, 2008, pp. 54-63).

Reactions to UbiFit were overwhelmingly positive. Everyone who used the glanceable display thought that the garden (or a different metaphor) was essential, and most who had not used it wished they had when they learned about it.

The garden's effectiveness was further supported by statistically significant findings from the field experiment indicating that participants who had the glanceable display maintained their weekly activity duration on average throughout the study, while the activity duration for those who did not have the display declined over time.

## RESEARCH INSIGHTS

Persuasive technologies that support everyday behavior change, such as increasing and maintaining physical activity, must accommodate the individual's changing needs or they will likely fail. From our work with the UbiFit system, we have identified five design considerations for such technologies.

### Engagement

Changing everyday behaviors is a long-term endeavor. A persuasive technology must sustain the individual's interest and accommodate changes in goals and abilities. Even a fun display like UbiFit Garden could get boring over time. To effectively provide ongoing support, the technology must keep individuals engaged in the behavior.

### Relevant behaviors

A persuasive technology should account for the range of relevant behaviors that contribute to the behavior change and not artificially limit support to those it can automatically infer.

**Persuasive technologies must accommodate the individual's changing needs or they will likely fail.**

A prior study (S. Consolvo et al., "Design Requirements for Technologies that Encourage Physical Activity," *Proc. 24th Int'l Conf. Human Factors in Computing Systems*, ACM Press, 2006, pp. 457-466) found that some participants stopped performing healthy activities such as bicycle riding because the pedometer they were using did not provide proper credit for those activities; likewise, several participants focused on optimizing their step count rather than increasing their physical activity.

### Irregular activity

Individuals often will take occasional breaks from performing a target behavior, which can help them maintain the behavior long-term. For example, an individual who is promoted at work will often temporarily suspend activity to get up to speed on new responsibilities. Further, adults average two to four colds per year, which could result in a reduction in physical activity.

Participants in the UbiFit studies were surprised at how often breaks like these came up. During such breaks, a persuasive technology should sustain their interest without punishing them to help them get back on track as soon as possible.

### Social implications

Because everyday behaviors occur in various situations, a persuasive technology must effectively integrate into daily activities that span both personal and work life. The technology will inherently encroach upon the individual's social world and developers must therefore consider the social implications for everyday experiences.

Several UbiFit study participants admitted to leaving the fitness device behind if they were going to be in a situation where they did not want to be asked about it—for example, when presenting in meetings or teaching class, while out on a date, or going to church. Understanding, appreciating, and designing for a wide range of social situations are critical to the success of an everyday behavior change technology.

### Social networks

Encouraging activity through social networks is a sharp two-edged sword. While the social support of friends and family can be a powerful motivator to change behavior, it can also lead to backsliding toward old habits.

Many UbiFit study participants recalled past attempts of trying to engage friends and family in exercise, all of which ultimately failed to help them sustain a physically active lifestyle. Similarly, in a prior study (S. Consolvo et al., "Design Requirements") that used groups of friends to motivate one another to increase their daily step count, bickering among group members led to occasional disengagements with fitness.

How to effectively use social networks to support everyday behavior change represents a promising, yet difficult and open research challenge.

As we continue to explore the space of using technology to support everyday behavior change, we are expanding our investigations beyond physical activity to include other behaviors, including stress management, eating well, and being "green" (J. Froehlich et al., "UbiGreen: Investigating a Mobile Tool for Tracking and Supporting Green Transportation Habits," *Proc. 27th Int'l Conf. Human Factors in Computing Systems,* ACM Press, 2009, pp. 1043-1052). We are also examining the potential privacy implications of persuasive technologies.

***Sunny Consolvo*** *is a member of the research staff at Intel Research Seattle and a member of the DUB (design:use:build) group at the University of Washington. Contact her at sunny.consolvo@intel.com.*

***James A. Landay****, Intel Research Seattle's Strategic Advisor, is an associate professor in the Department of Computer Science and Engineering and a member of the DUB group at the University of Washington. Contact him at landay@cs.washington.edu.*

***David W. McDonald*** *is an associate professor at The Information School and a member of the DUB group at the University of Washington. Contact him at dwmc@.u.washington.edu.*

*We thank our many colleagues who helped develop and support the UbiFit system, particularly Pedja Klasnja and Tammy Toscos, who were instrumental in running the field studies. We also thank the studies' sponsor, Intel Research Seattle, the participants in the UbiFit studies, and the many reviewers, friends, and family who have contributed feedback. Portions of this work were supported by the National Science Foundation.*

**Editor: Bill N. Schilit, Google; bill.schilit@computer.org**