Fitness Trackers

Digital activity sensors are no longer confined to research labs; they're in the wild and they come in lime green. They offer the promise to improve our health and even to affect the ways that we interact with others.

By Andrew Miller
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Wireless fitness trackers are ready for their closeup. Today, you can buy a digital pedometer from companies like Jawbone, Nike, Withings, and Fitbit, with new models released seemingly every week. There are even crowd-funded trackers, like the Misfit Shine. Smartphone-based apps can now estimate daily movement, expanding availability even further. This new generation of fitness sensors is robust, colorful, and networked. Friends can cheer you on when you take your Nike Fuelband for a run; you can track your minute-by-minute data with the FitBit. Pervasive fitness tracking has truly "exited the cleanroom" and entered the wild [1].

As a research community, human-computer interaction (HCI) has been preparing for this day. We've been studying how people interact with on-body sensors for almost a decade now, using custom prototypes, expensive niche devices, and early digital pedometers. But these all required a certain degree of handholding from the research team, and the turnaround time from sensing to reporting back was hardly instantaneous. As in any human-centered investigation of the future, the present kept getting in the way—people just weren't used to wearing computers in their pockets, much less sharing their daily lives online. The "qunatified self" movement—in which people self-monitor as much as they can of their daily habits, moods, exertion, and food—took to fitness trackers early on, testing different form factors and data presentation styles and pushing the limits of the technology as only early adopters can. However, as early adopters, they can tell us only so much about how technologies will be used by the population at large.

Now, all the pieces are ready. Smartphone adoption is broad, and fast becoming near-universal; Facebook has a billion users; and you can buy a networked wireless pedometer with a three-month battery life that will survive a trip through the washing machine. Oh, and it comes in lime green.

This is an exciting time, because it calls for a different set of research skills. Early-stage researchers focused on how to make the technology work, but today's pervasive fitness researchers can also focus on the "why." We can now run longer and larger studies in more diverse surroundings, and we can focus on new problem domains beyond the individual. We can work with health promotion researchers to test the health impact of our systems, and we can work with communities to understand the social and cultural impact of introducing on-body sensors into everyday life.

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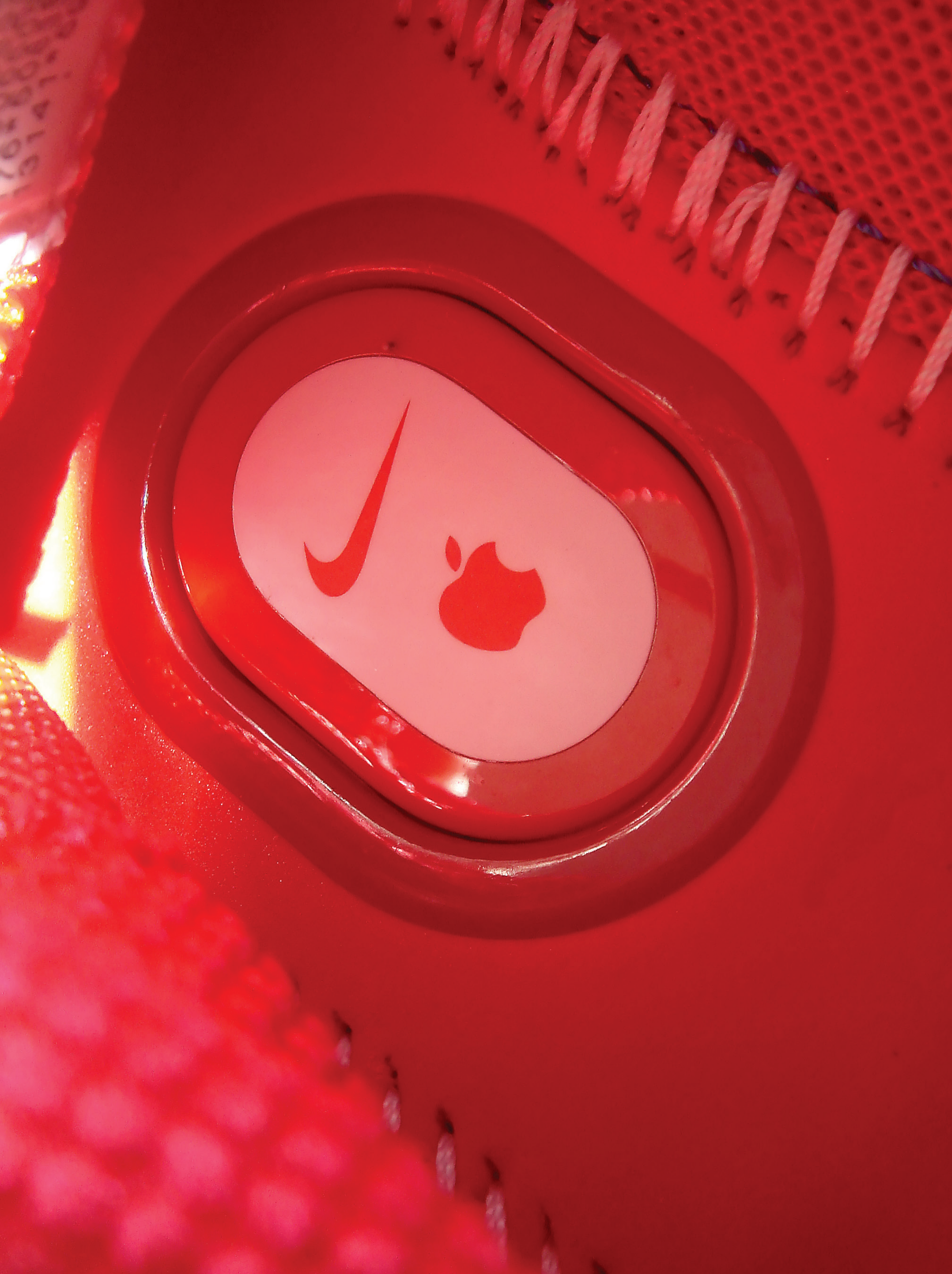
We can also shift our research questions "up the stack." That is, we're now able to study the fitness tracker as more than just a personal data-gathering tool; we can now treat it as a social and cultural artifact. We can embed trackers into new kinds of socio-technical systems, ones far different from those we'd construct for lab studies or feasibility deployments. And we can begin to study how fitness trackers might help people manage their everyday health as individuals and communities.

FIGHTING CHILDHOOD OBESITY

In my research, for example, I work with middle school students (11 to 14 years old) on technologies for obesity prevention. These kids present some unique challenges and opportunities for fit-

Photograph by Brandon Shigeta



ness tracker studies. Like all children their age, they want simultaneously to stand out and to fit in. Their identities and preferences are tightly bound to what their peers say and do. The boys and girls I work with have starkly different attitudes toward competition. And nothing is more boring to these kids than a bar chart of their own physical activity. They also live in poor, urban neighborhoods, where walking outside can be dangerous. Until this year, few of them had smartphones, and demographically they're in real danger of becoming overweight. About 60 percent of adults in their community are overweight or obese. Anecdotally, they appear to be unsupervised after school; many live in single-parent households and several have fathers in prison.

You might think it crazy to conduct a study in such a swirl of social, cultural, and economic factors, which could overwhelm or derail a fitness tracker study. Instead they become features of the design space. I knew my system had to be social: It had to provide a way for kids to motivate each other while being minimally demotivating to less-active kids. It had to be school-based: Creating an after-school program and working with administrators and teachers enabled me to work with a group of kids who saw each other daily, making it possible to get them together for weekly deployment meetings. It had to be designed with the their help: I'm not their age and I don't live in their community, so I involved kids from the school throughout the design process. Finally, the chosen fitness tracker had to be robust and kid-friendly. Fortunately, a few months before my deployment Fitbit released the Fitbit Zip, so I was able to focus on the social and behavioral effects and leave the hardware hacking to others.

Even crazier, it appears to have worked. The system I created, StepStream, pulled students' individual daily step-counts into a social network site. Kids earned activity points they could spend on a social game, and they met weekly to chat on the site and play the game. They also had access to the site between meetings and wore their pedometers throughout the month-long deployment.

This study truly was "in the wild." Kids took their pedometers everywhere; a quarter of them even wore the pedometers to bed despite the lack of sleep tracking in the pedometers themselves. (When was the last time someone wore your research project to bed?) I'm also learning interesting things about the interaction of the social features, individual motivation, and online/offline interactions that would not have shown up in a more controlled setting.

However, the fact that these wireless fitness trackers have been commercialized doesn't mean the supporting infrastructure has disappeared. During my most recent deployment, I had to drive to the school three times to reset the base station after a power outage. Of the 42 pedometers I handed out, I replaced or repaired more than 20. And the server I was using to host the system suffered a 19-hour outage (fortunately, mostly overnight). When it restarted, the server was in a different time zone, forcing me to adjust the timestamps for 14 days of system logs.

As far as health outcomes, we still have a way to go. Forty participants in a month-long study seems long to HCI researchers, but to the public health community it's a small pilot study. Changes in physical activity behavior may take months or years to stabilize, and require deep psychological changes. Participants have to change their identities to see themselves as healthier, more active people. The gold standard in health research—the randomized controlled trial (RCT)—demands a longer intervention and more technological stability than most HCI studies can promise.

But we are making great progress from a computing research standpoint. Ubiquitous computing theory from a decade ago is finally impacting people in daily life. For example, in his 2001 book *Where the Action Is*, Paul Dourish made the case that tangible and social computing were on a collision course, and were actually two sides of the same coin: embodiment. Embodied technologies, per Dourish, are situated in the physical and social world that we inhabit, and the more embodied they are the more of our context they share. Fitness trackers are embodied interaction made real. In my research, I situated pedometers within a social context (an urban middle school) and a technical system (a social website), but that's just the start.

For example, the fitness trackers, themselves, could facilitate social interaction more directly or become social actors in themselves. The Fitbits used in my study fed information in one direction: into the cloud. The devices couldn't react if two participants were near each other, or behave differently when placed on the hip versus the chest. They did display Tamagotchi-style faces in reaction to recent activity levels, but these proved inscrutable to the kids and, in any case, only reflected individual activities.

Today's fitness tracker research will also help us prepare for the next wave of wearables and on-body networks. The hardware hackers haven't stopped; they've just moved to more exotic tech like all-day heart rate monitors and stickers that sense your blood pressure—all communicating to each other and to a remote activity profile in the cloud. But until that day comes, there's plenty to be done now.

Fitness tracker research is at a crossroads. As computing researchers, we can now study how these technologies will be used in the daily lives of millions, and our research has the potential for meaningful impact on important societal issues. To push the state of the art forward, we must adopt different methods, taking a more "in-the-wild" and human-centered approach to our research. This research may offer fewer clean proscriptions, but its rich descriptions of technology in use will position us well for the next phase: seeking out collaborations beyond computing. Experts from domains such as healthcare and education know how to show efficacy, but will need our guidance to understand the role of technology as it reshapes their research as well.

It's a comforting thought: We're at the crossroads, but we're not alone, and we don't have to do it all. We can ask new kinds of questions and work with new collaborators, one step at a time.

Reference

[1] Carter, S. et al. Exiting the cleanroom: On Ecological validity and ubiquitous computing. *Human-Computer Interaction* 23, 1 (2008), 47–99; doi:10.1080/07370020701851086.

Biography

Andrew Miller is a Ph.D. candidate in human-centered computing at Georgia Tech. He holds an M.S.-HCI (also from Georgia Tech) and a B.A. in cognitive science from Occidental College.