Wearables of 2025: Designing Personal Informatics for a Broader Audience

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Abstract
Personal informatics research has often focused on early adopters of wearable technology who are young, educated, and technologically savvy. However, the field has turned a corner and these are no longer the plurality of self-trackers. In this workshop paper, we discuss the importance of researchers and designers considering a broader audience. We also discuss some open questions for the research community.

Author Keywords
Personal Informatics; Inclusion; Impact; History.

Introduction
Li et al. first studied early adopters in 2010, informing their five-stage model of personal informatics [15]. Development of the model was supported by a survey of 68 early adopters of personal informatics tools: predominantly young, educated, and technologically savvy. In the five years since the publication of the five-stage model, we believe personal informatics has reached a tipping point. Personal informatics will soon be ubiquitous, as foreshadowed by the pervasiveness of self-tracking in modern smartphones and the widespread interest in tracking for health reasons [12].

Although some subsets of the personal informatics community remain predominantly young, educated,

Figure 1. Developed in 1965, the manpo-kei was the first widely used pedometer.

Figure 2. The Microsoft Band, released in October 2014, includes a heart rate monitor, GPS, and a UV sensor. It reports step count, fitness activities, and sleep statistics to self-trackers.

and technologically savvy (e.g., the Quantified Self community [4]), these characteristics will soon no longer describe the plurality of self-trackers. Despite broader adoption of personal informatics tools, critics argue that personal informatics tools do not meet the needs of important groups, including those who "need them most" [11].

Wearables are rapidly growing in popularity, with a myriad of startups and recent products from major technology companies, including the *Apple Watch* and the *Microsoft Band*. We believe that one reason they struggle to meet broader needs is that new products are often being designed based on the lessons learned from early adopters of personal informatics, rather than for a broader audience. In this workshop submission, we review the state of wearable design and discuss research that suggests paths forward, as well as gaps that future research should address.

We begin with a brief review of the history and development of wearable technology. We identify the strengths and weaknesses of current design decisions found in commercial wearables and research prototypes. Finally, we conclude with a discussion of some open questions for the research community. We believe this will help provoke thoughtful discussion at the workshop.

History of Wearable Technology

Wearable technology has existed as a concept for centuries. Step tracking traces back to Leonardo da Vinci, who designed a waist-worn mechanical contraption that responded to walking [6]. Step tracking received widespread use with the manpo-kei (万步計, literally the "10,000 steps meter"), developed in Japan in 1965 (Figure 1) [24]. These pedometers relied on mechanical methods and did not explicitly support people in reflecting on historical data.

Personal Informatics was first coined by Li et al. as "a class of applications to help people collect and reflect on personal information" [15]. At the time, these applications were growing in popularity as research prototypes (e.g., [5,16]) and as commercial products (e.g., *Nike+*). Some people even took to designing hardware to record every aspect of their lives [14].

Wearables in 2015

We argue that wearable technology has now reached a critical mass in mainstream, and is no longer strictly for technology-focused enthusiasts. Apple, Garmin, Intel, Microsoft, and Samsung have all announced or released wearable bands and watches that include a variety of personal informatics features (Figure 2). Personal informatics has also been expanded by niche companies with new tracking domains (e.g. *Vessyl*, *Hapi Fork*). People commonly use multiple wearable devices over time [13], and they change what devices they use as they become interested in tracking new data and as devices break or are lost [22].

Designing for the Future

In this section, we consider the influence of a variety of demographic factors on design in personal informatics. We discuss some problems currently preventing widespread adoption in each demographic category, and offer opportunities for future research and design.

Gender

Including gender-specific knowledge can help avoid overlooking important needs. For example, Apple

Figure 3. Fitbit partnered with designer Tory Burch to produce a line of bracelet and necklace casings for their pedometer.

Figure 4. Garmin's GPS watch line remains large, bulky, and masculine in appearance.

Figure 5. The Pocket Pikachu encouraged children to exercise by converting steps to in-game benefits.

HealthKit is pitched as being able to track "all of your metrics you're most interested in" but did not include the ability to track menstrual cycles upon launch [7]. As noted by Consolvo et al., hip worn sensors cannot necessarily be clipped to all outfits, such as dresses [5]. The suggested workarounds of clipping the sensor to a bra strap or undergarment are not ideal as they limit a person's ability to access the display. Maitland and Chalmers recommend that designers of behavior change applications avoid stereotyping and consider whether their application is trying to target a gender-based or a gender-balanced intervention [18].

Designing wearables for women cannot simply be an application of "shrink it and pink it". To be truly inclusive, we must consider both the physical (e.g., ergonomics, reproductive health, sex-related disease profiles) and the emotional (e.g., social/cultural norms, varying personal gender expression).

Commercial wearables have only recently begun to acknowledge gender differences, with most devices taking into account only basic physical differences (e.g., wrist size, stride length, metabolism). Although a few wearables have been designed to appeal to women (e.g., Figure 3's Fitbit designer lines, Misfit wearables), many devices remain large and masculine (Figure 4). Although we expect form factors to improve as hardware advances allow smaller devices, the limited selection of gender-conforming options undoubtedly has a significant effect on current adoption.

Age

Current wearable devices are skewed heavily towards young to middle-aged adults in their advertising, functionality, industrial design, and companion app design. There are significant potential benefits to explicitly targeting people outside of this age range. For example, childhood obesity and activity levels are linked to negative health effects later in life. Child-appropriate wearables could provide both parents and medical professionals insight into a child's activity levels, as well as noteworthy patterns affecting activity. Richer activity data coupled with clearer recommendations could assist parents in monitoring their child's health, as well as providing a more concrete way for older children to take ownership of their own health (i.e., preteens and teenagers).

A few commercial pedometers have been marketed to children, such as the Pocket Pikachu (Figure 5). But these do little more than track and report steps taken. StepStream provides a good example of designing wearable technology for adolescents and considers approaches to receiving social support from parents and teachers [19]. Humana's American Horsepower Challenge used pedometers as part of an effective school-based physical activity intervention and game [8,21]. Similarly, Chick Clique showed that social support can be effective and encouraging among groups of teenagers [23].

The Digital Family Portrait is an example of an early personal informatics tool creating a way for adult children to maintain peace-of-mind regarding elders without undermining elder autonomy [20]. Passive tracking relieves much of the burden on individuals, allowing them to devote more energy to maintaining relationships (undoubtedly beneficial for both parties). A new generation of older adults is more willing to engage with technology than those past, which presents new design challenges as these people embrace wearables. Although some general principles of designing for older adults likely apply to wearables (e.g., bigger screens, easy to press buttons), the specialized needs of this demographic have not yet been integrated into personal informatics.

Education Level

The current trend in personal informatics is to present data in relatively raw, unprocessed form. The majority of commercial apps present predetermined metrics (e.g., steps taken, calories burned, minutes exercised) paired with abstract summary metrics (e.g. Fitbit's Activity Score, Nike+'s Fuelpoints). Longitudinal data is presented in graph form, which assumes a certain level of graph literacy (Figure 6). Even those who are confident in their ability to read graphs are likely to be misinterpreting their data and acting on erroneous conclusions [4]. Statistical insights, or lack thereof, should be clearly called out to help people make meaningful decisions (Figure 7) [2,9]. If wearables are to be useful to more people, the information that they collect must be analyzed and presented such that it is understandable and actionable to those people.

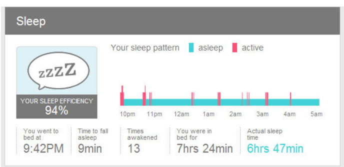

Figure 6. Fitbit presents a night's sleep graphically, but the results remain hard to interpret and take action on.

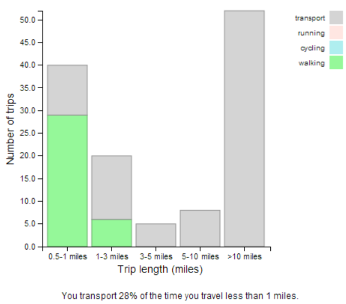

Figure 7. Activity graphs can be supplemented with meaningful captions identifying how to positively change behaviors.

Geography, Context, and Environment

The standard pedometer goal of 10,000 steps per day might be wholly unrealistic on the streets of suburban Los Angeles, but achievable as a mere matter of routine by someone who commutes by walking in the dense urban downtown of Seoul. Devices should take geographic context into account (e.g., urban, suburban, rural) and recommend goals and supplementary activities that are appropriate. The benefits of wearable devices are undermined by encouraging risky behaviors or by setting people up to fail their goals or.

Sensor suites should also be adapted to a person's context and environment. For example, residents of dense urban centers may derive great value from information about air quality [1] or noise pollution [17], but people in other environments may find that data meaningless. Outdoor physical activity is also significantly affected by weather, especially precipitation and high temperatures [3]. To be adopted in areas where outdoor physical activity is infeasible, wearables need to effectively support indoor activities. Although this is starting to become more pervasive, (e.g. Microsoft band supports gym workouts, pedometers work effectively on treadmills), it still remains difficult to track many indoor sports and (e.g. rock climbing, racketball, swimming).

Race and Socioeconomic Status

Though products like Apple Watch are starting to introduce more variation, many current wearable devices are available in limited colors and styles. They largely adhere to a specific upper-middle class, tech-friendly sensibility. They are identifiers for a specific subculture, and therefore exclusive of other subcultures. The industrial design of existing devices conforms to the values of an outspoken tech-forward subculture: sleek, minimalist, largely monochromatic, and LED-laden.

Are current wearables as fashionable to a teenager living in Harlem, an elderly couple in Beijing, or a schoolteacher in Paris? We must consider that style, fashion, and personal expression are highly cultural, and industrial design signals who a device is for and who it is *not* for. Interface design sends similar signals: data reporting and incentives for behavior change in modern wearables target a narrow demographic and assume a specific set of cultural norms.

Going beyond questions of cultural fit, there are also open issues of access and cost. Wearable devices are generally expensive and assume a certain amount of infrastructure access. The majority of devices are designed to be paired with a smartphone, and companion apps are largely useless without consistent Internet access.

There is also a need to drive costs in personal informatics devices lower, both for the wearable device or app and the required supporting ecosystem. Some companies have started exploring products for this market (e.g., Pivotal Living, which promised to launch a $12 wearable). Their problematic launches demonstrate that considerable challenges remain.

Family Status

For single adults, data sharing is largely focused on competition and casual socialization [10]. Data reporting tools largely assume that self-trackers have complete autonomy over their data. These tools promote casual social sharing of data by primarily facilitating communication of short, compressed metrics. Although it is simple to share how many steps you have walked today or this week, reviewing and sharing detailed behavioral data and health metrics introduces further design challenges.

Compare this to the perspective of a parent whose young children have wearable devices. Should a 10-year-old child be wholly responsible for their data? Do parents have de facto access to a child's comprehensive data sets? Through what interface? How does a parent or guardian manage a family's collection of devices?

Discussion and Conclusion

This workshop paper presents a variety of open questions, exploration of which can help researchers and designers design personal informatics tools that reach and help more people.

The primary questions this workshop paper asks is, *how can we as researchers encourage further adoption of personal informatics devices and tools, and how can we help everyone who adopts them benefit from them?* This paper outlines a starting point of different parameters where personal informatics researchers can help designers, and also identifies prior work that makes advances toward this goal.

We have limited the scope of this paper to a non-exhaustive set of important parameters. We hope workshop discussion will identify other key parameters, both those in which active research progress is being made and those that remain underexplored.

Identifying, exploring, and developing best practices for these important design dimensions is not a task for any single researcher, design team, or project. It is instead a set of challenges to be considered across personal informatics research and design. The Beyond Personal Informatics workshop provides an opportunity to engage and promote conversations about these challenges. We look forward to discussions with other researchers on how the broad community can approach and tackle these problems.

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