What Can a Dumb Watch Teach a Smartwatch? Informing the Design of Smartwatches

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ABSTRACT

With the release of Android Wear the Apple Watch, we are seeing a resurgence in the industry of smartwatch offerings. While there has been research on the technical feasibility of smartwatches as well as research proposing novel watch interactions, there has been relatively little work trying to uncover what user-centered values a smartwatch might offer to its wearer. We detail a user study of 50 everyday watch wearers focused on eliciting usage practices of traditional *dumb* watches. We discuss themes uncovered in our participants' perceptions of watch features, aesthetics, and the daily patterns of wearing and not wearing a watch. We also present participant perceptions of smartwatches and draw upon their mobile phone use. Using this data, we discuss possible smartwatch apps and the implications these findings might have for smartwatches.

Author Keywords

digital watch; smartwatch; user study; survey

ACM Classification Keywords

H.5.m. Information Interfaces and Presentation (e.g. HCI): Miscellaneous

INTRODUCTION

Smartwatches are a form of wearable computing that is gaining traction in the consumer market. Companies ranging from startups to well established consumer electronics and mobile phone companies have developed and are selling smartwatches. Pebble recently announced they sold their one millionth device[1] and market research suggests over 700 thousand Android Wear devices were sold in 2014[2]. Today's smartwatches have several things in common. For example, in general they are positioned as a companion to a smartphone. They pair to a phone using Bluetooth and expose various pieces of phone functionality such as notifications. Another similarity amongst various smartwatches is the ability to install and run applications. As such, these watches are not locked into a fixed set of functions such as their electronic counterparts, traditional digital watches.

While the technical capabilities offered by these devices are quite impressive, there are still many open questions about what end users might want from a smartwatch. The "smart" component of these devices is being fulfilled by smartwatch apps and connections to smartphones. For instance, many of them provide notifications from phone apps. Alternatively, just as a smartphone was a mobile phone with enhanced capabilities such as apps, a smartwatch might be seen similarly as an improvement with computational capabilities beyond traditional watches. The "watch" aspect of a smartwatch is provided by watchfaces and time keeping capabilities.

When we turn to the research literature, there is little published work to draw upon to inform possible smartwatch design. In contrast to other domains, there is not a well established user base of smartwatch wearers to study using user centered practices common in HCI. Furthermore, many current smartwatch users are early adopters that might not be indicative of a broader population or longer term use. So as researchers in this domain, how might we inform the design of these types of devices while they are still in their formative stages of adoption?

In this work, we explore how people use their current digital watches so as to transfer those learning into the smartwatch domain. Clearly there are differences between the intended use of smartwatches and current digital watches. However several aspects related to wearing these devices could be similar and current watch practices might serve as a useful lens as we further develop and research smartwatches. This paper's contribution is to uncover the existing practices of watch wearers to inform the development of smartwatches and applications. We do this through examining data collected from a survey of 50 participants that wear a digital watch daily and who also own a smartphone. In this paper, we build off our previous formative investigation of this data [10] and here we provide a deeper analysis and cover a wider range of issues about watch usage. We provide data on participants' perceptions of the features of their current watch, what they liked and did not like about their watch, and how key features were used. We also discuss participant reflections about their current smartphone usage as a way to formulate grounded insights into possible smartwatch applications.

[1] `http://www.theverge.com/2015/2/2/7947799/pebble-1-million-smartwatches-sold-new-hardware-coming`
[2] `http://www.canalys.com/newsroom/over-720000-android-wear-devices-shipped-2014`

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RELATED WORK

The wrist has long been a compelling location to place wearable technology. For instance, Martin reviewed the history of personal time pieces and reported that women first adopted wrist watches in the late 1800s while they became common with men after World War I [12]. Symbol developed and deployed a wrist (and finger) worn computer with a barcode scanner to help manage logistics in the shipping industry [20]. Turning to smartwatches, Narayanaswami *et al.* developed the IBM Linux watch [14, 15]. Much of the challenge at that time related to pushing the limits of what was possible with the technology such as miniaturizing a general purpose computer into a watch form factor. And even then, there were a variety of wrist worn consumer devices on the market [15]. Around the same period, HP and Swatch embarked on a smartwatch effort [19]. The eWatch began exploring the role of sensors on watches for activity recognition and for using the watch for notifications [13].

With a lot of this technical work in place pointing the way towards platforms for research, applications and novel user interfaces for the wrist were explored. For example Blasko *et al.* examined touch input on watches [3]. The notion of touch was revisited by Ashbrook *et al.* with a focus on round displays [1]. Text entry for small watch sized displays is also being researched [16]. Research has also proposed devices with multiple segments more like a bracelet [11] as well as smartwatches without high resolution graphical displays that are more reminiscent of analog watches [21]. Several more advanced interaction techniques such as gesture [6, 18] and non-visual displays [8, 9, 17] have also been explored.

Given all of this research investigating possible smartwatch technology and user interfaces, there is a comparative deficit of research understanding practices associated with watches. While there are industry reports projecting the future smartwatch growth and companies are developing smartwatches that might have internal data and guidelines, we are not aware of any publications directly investigating this problem.

USER STUDY

We conducted our user study as an online survey with 50 participants. We asked our participants a series of free response questions designed to uncover information about their current usage practices of their digital watch. We explicitly recruited participants that wear a digital watch as their primary watch and who use a smartphone. We targeted this demographic as it seems like a plausible segment of users that might adopt smartwatches. First, they already wear a watch and therefore the shift in behavior of swapping out their watch is likely smaller than trying to convince someone that does not wear a watch (or stopped wearing one altogether) to wear a one. Likewise, we selected digital watch wearers instead of analog watch users given some of the superficial similarities between smartwatches and digital watches. Smartwatches and digital watches both have electronic displays (albeit with very different characteristics). Likewise, digital watches often have several modes which could both inform the differing needs of watch users and provide insights about how the users manage different modes. In this way we are framing the adoption of smartwatches as a step along the co-evolution of technology and user practice. There are likely other methods and user populations that could provide additional insights, but given the lack of research in this space, we focused on getting key initial insights with this study.

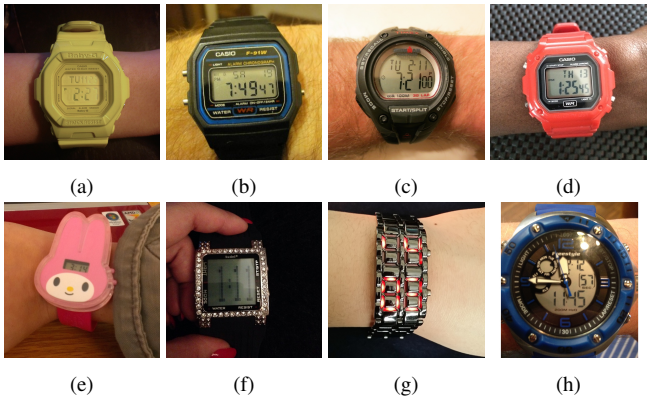

Figure 1: Example photos obtained from our participants.

Of our 50 participants, 18 were female. Participants ranged in age from 21 to 52 with a median age of 28. We conducted the survey using Amazon's Mechanical Turk and used it to limit the study to participants living anywhere in the United States (6 stated they were born outside the US). The study was conducted during a single week in February 2014 (before the debut of Android Wear or the Apple Watch). The survey took about half an hour to complete (median time 31.2 minutes) and we paid each participant $4 for a completed survey. We ran participants until we had 50 responses that met our criteria (e.g. we exclude participants with feature phones or that uploaded photos of watches from the web).

For our procedure, we asked for consent and obtained basic demographic information. Next, participants took photographs of the watch they were currently wearing and uploaded them through our web survey form. We asked participants to take a picture of each of the different modes their digital watch offered. Using those photos, we then asked participants to describe the function of each watch screen and how often it was used (several times per hour/day/week/month/year or never). We also asked a series of more general questions about the participant's watch. We inquired about the watch brand, what participants liked and did not like about how their watch looked, the features most important to the participants, if they owned multiple watches, their patterns for wearing and taking off their watch, etc. We elicited feedback about the default watch faces of three commercially available smartwatches at the time: the Pebble, the Sony Smartwatch 2 (SW2), and the Samsung Gear (Figure 2). For each watch, participants selected their preferred watch face and explained their selection. Finally, we asked participants to perform some grounded speculation about possible smartwatch use. Here we had participants recount a recent use of their smartphone and then describe why that content or application might be useful on a smartwatch.

To ensure quality responses, we included questions that can be explicitly verified [7]. For this study, our biggest indicator for participants complying with our study design were the pictures participants took of their watch. This created a relatively high barrier that was hard to bypass. Also in practice, many of the photos taken had a very similar style that was easy to visually verify. For example, a few participants tried to submit images found on the web and these were rather easy to identify and exclude. We also checked that the photos were taken at the time of the survey (both through the EXIF metadata if available as well as the time shown on the watch face).

We should note that this study is fundamentally about uncovering user practices. Most of our data is free response and the findings we present are intended to uncover the breadth of behaviors and practices of our participants. We do report numbers for completeness where we can, but they are not intended to be statistically representative. For example, if one person pointed out in a response an aspect about his alarm, that does not mean other participants who did not mention the alarm did not use or know about it. As such, the absence of data is not a negative indicator of behavior or use. However, using this approach, we did obtain information about a diversity of practices.

FINDINGS

We present our findings based on several different themes that emerged from the data. These themes resulted from synthesizing the responses across multiple questions. First, we provide an overview of our participants' watches and then present our participants thoughts about the functionality of their watch. Next, we describe the non-functional concerns raised by our participants. Finally, we discuss the patterns of wearing and not-wearing a watch.

Approximately two-thirds of our participants' watches were represented by two brands: Timex (18) and Casio (15 with 1 analog/digital hybrid watch) (Figures 1a–1d). While these brands were the most popular, many different styles are represented in our sample. The distribution of watch brands has a long tail with many brands only owned by at most a few people. We had 3 Polar watches, 2 Armitron, 2 Freestyle (both analog/digital hybrids, Figure 1h), 2 generic or unlabeled watches and one each of Audel (Figure 1f), Champion, Diesel, DKNY, Elgin II (analog/digital), Guard, Samuri Inferno (Figure 1g), and Sanrio (Figure 1e).

Five participants indicated they received their watch as a gift. Of the remaining 45, the median estimated price was $35. The 25th percentile is $20, the 75th percentile, $50. The minimum was $5 and the max was $250. These estimates are likely only marginally accurate but do provide some sense of cost. Of note is that this price range is much lower than current smartwatch prices.

Of our participants, 20 indicated they owned only this one digital watch and 11 explicitly reported only owning one other watch. A few participants indicated they had many watches with one saying they had over 20 while another indicated having a "drawerful." In discussing why they owned more than one watch, most participants reported that at least one of their other watches was "dressier", for "special" or "formal" occasions, or was "high end." Many of these participants also pointed out that these watches were mechanical or analog and not digital. The other reason offered by our participants for owning more than one watch was because of durability. For example, they said their digital watch might "get banged up a bit" or that their other watch was not ruggedized. These participants seem to be rather hard on their watches in everyday life and did not want to subject their other watches to such treatment. Here we see a potential mismatch between current smartwatch offerings and digital watch practices. If a smartwatch fulfills the "dressier" end of the watch spectrum, it might only be worn occasionally. At the opposite end of the spectrum, participants might be reluctant to subject their smartwatch to everyday wear and tear given the cost.

Watch Modes and Functions

Next, we examine the functionality of our participants' digital watches by analyzing the photographs participants took and associated user provided descriptions. We also present our findings about participants' preferred smartwatch faces which indicate desired functionality.

Watch Photos

Most participants uploaded between 3 and 5 pictures of different watch faces (25th to 75th percentile). In total, participants uploaded 213 pictures of their watches' modes. We analyzed the responses that indicated frequent use (several time per hour or several times per day). There were 65 such pictures in our data set across all of our participants.

Not too surprisingly, all 50 of our participants reported using the main time mode of their watch frequently. We examined the photos and associated descriptions provided by participants to understand the time and date information used on our participants' watches. 7 of the watches show only the hour and minute, while the other 43 also show seconds. 24 watches display the month and day of the month, while 14 watches omit the month and only show the day of month. 41 of the watches display the current day of week — either as an abbreviated string or using an iconic representation. A bit more unexpected was that there were only a few other watch modes used frequently. There are only 15 other pictures of modes used multiple times per day or more spread across our 50 participants and these included the timer, stopwatch, alarm, and timezones.

At the opposite end of the usage spectrum are the features participants indicated they never used or used only a few times per year. We had 91 pictures in this category. For some of these, the participants indicated they did not know what the feature did at all or were guessing. For example, one participant said "I have no idea what this mode does. It's called 'Timer.' I guess I've never used it. Until I took this [sic] pictures, I would've sworn the watch only had two modes."

Together this data about the participants' watch modes points towards a long tail in watch usage. Even though today's digital watches offer a moderate number of modes, most participants only used a subset of them. The most used feature – time – was also represented in several ways. The different

(a) (b) (c)

Figure 2: The most popular watch faces selected for the Pebble (a), Sony Smartwatch 2 (b) & Samsung Galaxy Gear (c).

time representations, and more generally watch features, were valued differently by our participants whereby some information was critical to some people where for others it was not even mentioned. Similarly, the lack of various pieces of information was sometimes pointed out as a negative aspect and sometime as a feature. Overall these data point to the need to support a diversity of time representations and features to cover the various desires articulated by our participants with a common theme being that many participants only wanted and used a subset of a watch's capabilities.

Which Smartwatch Face?

In practice, our data about preferred smartwatch faces also provided information about desired watch functionality and its importance. While some smartwatches allow for customized watch faces, for this study we focus on the faces provided by the manufacturers. For all three smartwatches, the most preferred watch face showed the time and date (Figure 2). For the Pebble, 29 participants picked the face that shows the date and time (Figure 2a). Participants commented that this face was easy to read, it was quick and glanceable, and provided both the date and time. A few people mentioned that they felt this face was simple or non-cluttered. One participant appreciated the month being displayed as a full word. Another participant selected this face, but stated that it was lacking the day of the week.

A similar pattern occurred for the Sony and Samsung watches. The preferred Sony watch face shows similar information (Figure 2b), albeit with a different styling, as the preferred Pebble watch face. Correspondingly, many of the reasons given are similar and highlight the digital nature, the simplicity, displaying the date with time, etc. Some of the participants made note that this watch face also shows the day of the week, "I LOVE a watch that gives me day, date and time all at once." Similarly, 23 participants selected the Samsung watch face showing the time, day of week and date (Figure 2c).

The second most preferred watch face for both the Pebble and Sony are analog representations. 13 participants selected Pebble's analog watch face. These participants highlighted the analog nature of the face and commented that they appreciated the classic look. A few people also liked the extra date and day information shown on the otherwise analog face. One participant expressed their preference this way, "I like the mechanical look, but with the digital backing. Neat combination." The Sony watch offers a pair of similar analog faces that were together selected by 7 participants.

The Samsung Gear is the only smartwatch in our set with default faces which show non-time information. 11 participants chose the watch face that shows the time and an upcoming calendar appointment. These participants noted the benefit of the calendar reminder on their watch while others interpreted this screen more generally, appreciating the display of incoming notifications. Many of the participants liked the additional functionality, but they also started to raise possible trade offs. One participant commented that they liked the weather watch face, but it was missing the date and selected another instead. Other participants raised concerns about complexity of some of the designs. For example, one participant commented they selected the watch face shown in Figure 2c because "it has no confusing writing or symbols." This sentiment also echos the desire pointed out above from several participants to exclude information about the time from the display instead preferring simplicity.

Looks and Non-functional Concerns

We asked participants to describe the aesthetics of their watch. The most common positive theme mentioned by our participants (10 individuals) was that the design of their watch was "sleek", "simple" and "not flashy." In contrast, while discussing negative aspects, other participants used words like "blocky", "bulky", "clunky." In looking at the data, this notion is rather subjective and potentially individualized. Examining the photos taken, it would seem that what constitutes "sleek" by one person might not be deemed so by another. More generally, the form of the watch was seen as a positive by some participants but in different ways. Two participants liked the small form of their watch while two others were at the opposite end of the spectrum liking the watch because it was large (e.g. "heavy and bulky" or "the width ... is also really attractive").

The color of the watch was often indicated as a positive aspect by many participants. Several participants commented generically about liking the color of their watch. A few participants mentioned liking the particular color scheme. Silver and black was referenced by 4 participants, black, brown, and white watches were also called out.

Two participants commented that the color of their watch was a differentiating factor. One liked the bright red because "it's eye-catching" (Figure 1d). A participant with a white watch liked the color because "[it] wasn't the standard black plastic or silver metal that they usually are." Uniqueness was a quality valued generally by a few participants. One participant wore a pink novelty watch "because of the cute bunny shape" (Figure 1e). Another liked his "Samurai Inferno Red Hot Watch" because "it doesn't look like a traditional watch" (Figure 1g). Finally, one participant said he liked his watch because it "looks like NO other watch I have ever owned."

Some participants highlighted how their particular watch looked on them making comments such as "it goes with everything I wear" or it "looks great on me." Another partic-

ipant appreciated the "two tone metal construction, which means it matches whatever accessories I may have on." A few people thought their watch did not look good enough for some settings. One said it was "too sporty to wear to work or the office, not great for the more professional setting." One person mentioned it would be "nice if it could blend better with 'nice' clothes/outfits."

Overall, the variety of concerns our participants raised about the aesthetics and form of their watches should be expected given the on-body nature of this technology. However, these watch characteristics point to potentially conflicting user requirements. While some smartwatch manufacturers are offering several colors of watches (like Apple) and even different shapes (such as the round Motorola Moto 360), it is likely that there will need to be much larger variety offered to fulfill differing needs and desires.

Wearing Habits

We asked participants about their habits of wearing and taking off their watch. There seemed to be three different patterns in the data: never removing their watch, taking off their watch while they slept and possibly during their shower, and people that did not wear their watch at home.

First, 7 participants stated they never took off their watch or only did so for exceptional circumstances. 6 more said they only ever took off their watch in the shower and then put it back on immediately thereafter. Together, these people basically always wore their watch. Second, 16 participants indicated they took off their watch while they slept. Of these, half also said they did not wear their watch in the shower. These participants seemed to take their watch sometime before bedtime and put on their watch as part of a morning routine. Finally, 12 participants said they removed their watch while at home and only wear it when going to work or going out. One more extreme version of this was a person that said she did not wear her watch most weekends. In general, these people treated their watch like other items such as keys and the watch would be taken off when returning home.

The different daily habits for wearing and not wearing smartwatches points towards implications for smartwatch power sources. Many current smartwatches have battery lives that last from maybe a day to up to a week or two. For the group of participants that never took off their watch, when are they going to charge their watch? Is there an expectation that smartwatch wearers will need to alter their behavior with respect to not taking their watch off? At the other extreme are the participants that do not wear their watch while at home. These people would presumably get no benefit from a smartwatch during a large portion of their day. Or again, the smartwatch would need to be compelling enough for these people to decide to change their daily habits.

INFORMING SMARTWATCH APPLICATIONS

Next, we turn to data that suggests possible smartwatch applications, and probably more importantly, motivations for those apps on smartwatches. Here we have two primary sources. First, in describing the various features of their digital watches, some participants provided context as to how their watch was being used to address some task. These activities might serve as fertile ground for exploring smartwatch apps that move beyond the basic capabilities of digital watches. This approach would be to transfer user practices from the dumb watch to the smartwatch. Our second source of inspiration for smartwatch apps is rooted in our participants' smartphone usage. Here the approach is to take what is currently a smartphone practice and investigate possible suitability for a smartwatch.

Dumb Watch to Smartwatch

Our participants described several common scenarios where they employ their digital watch. Many of our participants used their digital watches while exercising. They enumerated a wide variety of exercise activities including interval training, cardio, running, track, jogging, biking, swimming, and ice skating. The watch was used track of duration of exercise and for specific tasks such as adhering to rest intervals. Another common watch use was for various cooking activities and seemed to be used generically as a kitchen timer. There were also specific instances mentioned such as keeping track of time while baking, simmering pasta sauce, and timing the duration of whipping. Digital watches were used as a morning alarm by some participants. For some this was their primary alarm, while for others it was a backup. It was used by some participants as a reminder for leaving the house in the morning. Watches were also used during the work day, for example, to let them know when their work break or lunch is over.

Our digital watch data also has several more idiosyncratic usages. These included keeping track of timeout disciplines for kids while out of the house, using the watch as part of playing games with friends, keeping track of their son's track events, using timezones to know when to call friends in other countries/timezones, etc. Watches were also used by our participants for a wide span of very specific work functions including "to time heart beats at work" and to "keep track of different timings while doing research on birds in the field."

Smartwatch Implications

As we examine these specific uses of digital watches, we can consider how these activities might be transferred to a smartwatch and indeed some of these are starting to show up as smartwatch apps. Overall, the app store approach being used seems well supported by our data whereby different developers can tailor specific applications to a wide range of needs. For example, while exercising is a common category discussed by our participants, the variety of activities people perform and the differing needs within those specific activities points toward either very generic time keeping applications or many special purpose apps. The predominance of cooking as a use for the watch is also unexpected. This domain would likely require further investigation as many kitchen appliances offer various timing capabilities. It would be interesting to see why some people chose to use their watch.

The use of the watch alarm to wake up is not all that surprising. However, it is interesting to note that for some people the watch served as a backup to their primary alarm. This notion of independence also came up with one of our participants

using the watch instead of the phone to conserve the phone's battery. These examples point to an opportunity whereby the smartwatch becomes a redundant device that can be used in case the user's phone does not fulfill its intended purpose.

Finally, our participants are using their watches for reminders such as for breaks or when to leave in the morning. Naively, it would seem that these types of functions might be fulfilled with some sort of digital calendar. However, that might be too heavyweight and there might be an opportunity for some very lightweight calendar or reminder capability. The quick and easy access afforded by the watch might make this type of interaction appropriate. For these tasks, our participants knew what they needed to do and the watch provided the trigger at the right time.

Smartphone to Smartwatch

Next, we examine our participants' discussions of smartphone use and how that use might inform smartwatch applications. This part of the study required our participants to speculate about technology and applications they did not have direct experience with. Even with this limitation, we feel our data provides a plausible starting point for additional research into smartwatch applications. This data also provide insights about our participants' mental models for smartwatches and indicates how participants think smartwatches work or how they might want them to work. Here, our participants enumerated many applications that are being explored on smartwatches including weather, navigation, photos, text messages and email, phone notifications, music control and calendar reminders. What is useful here is that our qualitative data does provide some insights into the possible benefits participants thought these apps might provide on a smartwatch.

One common application suggestion was for weather such as the current weather or the forecast. Here, 7 participants suggested the promise of better access time with a smartwatch, 3 participants discussed the watch would provide a secondary location to see the weather, and one participant mentioned a desire for push notifications about weather sent to a smartwatch.

Turn-by-turn GPS navigation was discussed by 7 participants, mostly for driving. They suggested the possible benefits of a watch as allowing one to glance at the watch to see the next turn instead of looking at the phone. Two people thought that using a smartwatch instead of their phone would save power on their phone, presumably because the phone's display would remain off. While turning off the display does save power, the phone would likely be using its GPS which is still a significant power draw. As a result, power savings might not be as large as anticipated.

Text messages were mentioned by 21 participants. Here the benefits seem to center around the ability to quickly see notifications as messages came in (10 participants). Text messages were one area where participants highlighted the burden of pulling their phone out (3 individuals) or the benefit of not carrying their phone (4 people). Email was also discussed in a similar light with 18 participants raising it for possible smartwatch usage. Here participants discussed both seeing who the message was from and what it was about (the subject) as well as the need to decide to escalate the interaction and read the full email or respond. Another person offered a different benefit for accessing email on a smartwatch. He thought that it would be nice to use a smartwatch so he would not need to "cancel [the] current apps open, [or] stop what app is running on my phone at the time." Thus, the smartwatch might allow him to multitask or cause less disruptions to the activity he was performing on his phone.

14 people discussed screening incoming phone calls by glancing at the wrist or to quickly be able to see missed calls without retrieving the phone. One person thought it would be nice to leave their phone at home but still be able to get a call on their smartwatch while outside exercising. Finally, there were many different apps mentioned by one or at most a few people and motivated by quick access or not needing to pull out their phone.

Why a Smartwatch?

As we examine these areas, we see some common themes in why participants thought a given application might be suitable for a smartwatch with respect to current smartphone use. Participants described various benefits of a smartwatch relating to access time [2]. Participants discussed how a watch might facilitate quicker access, be glanceable, or in general be more convenient. While the benefits of a smartwatch might be speculative, the issues associated with smartphone access were concrete. Several participants enumerated all the steps involved in getting their phone out. One participant said "I had to pull the phone out of my pocket, activate it, unlock it, and find what I wanted to see." Others used stronger language about the inconvenience of getting out their phone. It is "frustrating to pull out of my pocket" or "to be honest since I kinda have tighter pants, getting the phone with a case on it out can be kind of annoyingh [sic]." Another participant wore gloves at work: "I have to take off my gloves constantly to check my phone, so I have to wait for a lull in the production line. When one comes up, I pull my phone out from my holster and usually swipe to dismiss the alert."

Four of our participants indicated that they thought access time would be better than their phone because it would eliminate the need for a screen lock and associated pass code. For example, one participant explained "I wouldn't have to use my pass code to access my smart watch since there would be no danger of someone picking it up." The lack of a pass code might be one mismatch between a user's mental model of a smartwatch and the technology that gets deployed. Many corporations have policies requiring screen locks on phones for security. Are such requirements going to clash with smartwatch benefits and require pass code access on the smartwatch? Or is smartwatch functionality that might access sensitive phone information just going to be disabled?

Another potential mismatch between expectations and current smartwatches relates to the tethered nature of the smartwatch. Most of the smartwatches on the market are "smart" because they are linked to a smartphone. For several different usages, our participants discussed the benefit of the smartwatch was because they would not need their phone either directly on-

body or at all. This was expressed in various ways: a smartwatch would "give you one less thing to carry"; "I wouldn't feel so tethered to the phone."; "I could work in the kitchen or elsewhere with the phone nearby or elsewhere in the house without needing to carry it directly on me." These types of comments raise the potential importance of the type of connectivity the smartwatch has to the user's smartphone or cloud data. Likewise these findings imply that for some uses, the value of a smartwatch is that it can stand alone and without a smartphone.

DISCUSSION

Several different aspects of digital watch usage or potential smartwatch apps show signs of a long tail where many apps were pointed out by a single individual. The long tail also extends to the digital watches in our study and basic time keeping. Different participants used the time functions with different frequencies ranging from many times a day to not even knowing their watch had a given function. Likewise, some people wanted specific pieces of information related to the time and date on their watch face while others expressed the desire to leave things off for simplicity.

This desire for simplicity would seem to extend into other smartwatch features as well. For example, some of our participants were concerned about extraneous information shown on the main time display particularly for the Samsung Gear. Our participants also highlighted that a possible benefit of a smartwatch is that it could be simpler than a similar interaction on a smartphone. As smartwatches gain functionality through additional applications, meeting this desire to minimize complexity will be an important consideration.

The desire for different watch features also extended beyond the purely digital aspects of the watch. The color and form of the watch was an important factor for many of our participants. Several participants had "dressier" watches or wanted watches that were more rugged which were explicitly worn in different circumstances. These concerns point to the need to consider the design of the smartwatch in a way well beyond just the superficial capabilities. Likewise, different people are going to have different considerations with respect to how the watch looks and it is unlikely even small number of smartwatch designs would cover such needs. Likewise, changing the watch face, watch band or offering multiple colors is likely insufficient. And while consumer electronics companies are responding to demands of personalization and aesthetics of the devices they sell, the wearable nature of smartwatches might impose even more significant demands more analogous to those seen in clothing and fashion industries.

Our findings also have implications for smartwatch hardware design. Power is a critical resource for any mobile device and given the small size of smartwatches, it is a particularly important factor here [5]. One of the largest power draws on smartwatches is the display. The smartwatches we considered in this study have all chosen different display technologies with different tradeoffs between functionality and power draw. While having a nice colorful OLED might be desirable, it is not without a cost in terms of user behavior. Users that always wear their watch would likely need a smartwatch with a display similar to Pebble's as it offers the lowest power consumption and users would need to charge it the least often. For users that take off their watch daily, presumably the smartwatch could also be charged daily. As such, assuming the watch can last at least a day on one charge, the particular choice of display technology might be less important.

Relationship to Smartphone

There has been some research exploring how a smartwatch and smartphone might be used simultaneously [4]; however, our data points to several other types of possible relationships. First, some of our participants used their digital watch as a backup for various tasks. If this practice is to be supported, having the smartwatch only be a slave to the smartphone could lead to failures. For example, for some current Android Wear devices, if the watch loses power it also loses the time and there is no way to set the time without a paired phone. In contrast, it would be useful to consider how the smartwatch might offer redundancy to the smartphone without adding to the complexity associated with managing a second device. There is also the prospect of using the smartwatch to facilitate multitasking. The smartwatch offers a second device for interacting with applications and content and might offer some interesting opportunities to enable simultaneous access to multiple apps.

The finding that several participants thought that a smartwatch might replace their phone in some circumstances has larger implications for smartwatches. For example, several participants clearly had a mental model that the smartwatch could be used without their smartphone and they would still be able to get text messages or receive phone calls. While it seems unlikely that a smartwatch would make for a good smartphone, our participants raised some scenarios where this capability might be useful. And there are some smartwatches entering the market that have a cellular radio to offer connectivity. However offering integration with the various phone features would be critical for these types of uses. Even things like music might require careful consideration as to how the data is stored and distributed in the context of music on a smartphone and in the cloud. For example, does the smartwatch have enough storage or might it to stream over a network independent of the phone?

Mental Models

As we move into a world with more smartwatches, we might see an interesting clash in terminology and mental models. Already in running this study there are words associated with digital watches and words used with smartphones that have similar end-user meanings. For example, digital watches have multiple modes while smartwatches have different screens. The smartphone has a display while the watch has a face. More broadly, our findings indicate that it will be important to consider the mental models a user might adopt around smartwatches. Are smartwatches a peripheral to the phone, can they stand alone completely or under certain circumstances? How is information and data distributed between the watch and phone and how does it migrate between the two devices? Depending on the designer's intent, the answers to these types

of question have different implications for technical implementations as well as the user interfaces and applications on smartwatches.

CONCLUSIONS

We embarked on this study with the goal of better understanding *dumb* digital watches and associated practices. In doing so, we wanted to use insights grounded in current digital watch usage to inform future smartwatch designs and applications. Our study has generated several useful findings and also points to some questions that need to be addressed with future research. Even for digital watches, which are relatively simple compared to smartwatches, we see a diversity of usage practices and watch needs. There are also several non-functional concerns associated with digital watches that smartwatch designers need to consider. These range from style and social perceptions to durability and price sensitivity. If one wants to build off current practices and support a shift to smartwatches this diversity of needs should be considered.

Our study generated several possible areas to explore with smartwatches. Some of the applications have roots in current digital watches while other potential applications are based on smartphone apps and practices that might transfer to a smartwatch. More fundamentally, these data support opportunities such as lightweight interactions and quick access, decoupling the watch from the phone for redundancy or having the smartwatch stand by itself. Finally, while smartwatches are still relatively novel to the general population, it is important to consider how smartwatch technology choices might match or clash with user perceptions about smartwatch capabilities. Overall, the insights from this study point to many of the key considerations that need to be addressed if smartwatches are to fulfill and surpass the needs of current digital watch wearers.

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