Gadgile Probing: Supporting Design of Active Mobile Interactions

Susanne Koch Stigberg(✉)

Department of Computer Science,
Østfold University College, 1757 Halden, Norway
susanne.k.stigberg@hiof.no

Abstract. Designing for mobile interactions is a difficult task. Designers must understand the multifaceted nature of the mobile context and require an overview of interaction techniques feasible for that context. We propose gadgile probing as a technique to support the design for mobile interactions. Introducing "off-the-shelf" technology in the inquiry phase enables designers to explore not only *what is* but also *what could be* early in the process. We present an example from running and biking. Our findings demonstrate that gadgile probing can complement contextual inquiries providing a good understanding of the context, listing needs and desires of participants, evaluating alternative interaction techniques, and inspiring designers and users to ideate about future technologies.

Keywords: Probing · Probes · Interaction design · Mobile interactions

1 Introduction

Most mobile systems are "stop-to-interact", designed for interaction only when a user is standing still, paying visual and mental attention to the device [16]. Devices for outdoor sports are no exception, even though the use of mobile devices for self-tracking training sessions is becoming default. Limited attention has been paid to the interaction with these technologies. Lumsden and Brewster [15] requested "a paradigm shift in terms of interaction techniques for mobile technology" already in 2003. Ten years later Marshall and Tennent [16] highlight four challenges designing interactions for mobile devices: cognitive load, physical constraints, terrain and other people. This paper describes a technique, called gadgile probing, for understanding these challenges and supporting system design for mobile interactions. These "interactions in motion" shall enable users to perform meaningful two-way interactions with devices while actively mobile [16].

Probes are means to explore new ideas and include participants in the design process [10]. They have been described as instruments that are "deployed to find out about the unknown" [11] or "collections of evocative tasks meant to elicit inspirational responses from people" [8]. Technology probes [11] are simple, flexible, adaptable technologies with three goals: understanding the needs and desires of users in real-world setting, field-testing the technology, and inspiring users and researchers to think about future technology. Even though technology probes are simple and should be used early in the design process [11], it takes time and effort to create them.

A. Marcus (Ed.): DUXU 2016, Part I, LNCS 9746, pp. 333–343, 2016.
DOI: 10.1007/978-3-319-40409-7_32

Researchers must have an underlying understanding of the context to design and deploy these probes. In contrast gadgile probing is a technique that uses consumer gadgets as probes in the inquiry phase. It strives for the same goals as technology probes without any development effort. In gadgile probing we select from “off-the-shelf” technologies with different interaction styles that can be added to explore the context of active mobile use.

To demonstrate the technique we use an example from running and biking there we got a good understanding of the challenges with mobile interactions in sports and inspiration for designing future technologies for that context. The second chapter covers related work in mobile interaction research, followed by a definition of gadgile probing in Sect. 3. A case study on how we used gadgile probing as technique to support the design for mobile interactions can be found in Sect. 4. We conclude with a discussion on gadgile probing in comparison to traditional contextual inquiry methods [3] and technology probes.

2 Mobile Interactions

In the era of the “selfie”, self-tracking training sessions are measured by default. For exercises as well as at competitive levels, a variety of sensing devices are used. Data about the training session is automatically uploaded to online sport diaries to analyze performance and evaluate progress. The impact, on the other hand, of mobile devices on the athlete is poorly researched, in particular interactions with these devices during the workout.

The shift of computing interfaces from a desktop metaphor to the physical environment through mobile computing has been well documented [12]. Unlike the design of interaction techniques for desktop applications, the design of mobile interaction techniques has to address two complex contextual concerns [15]; the users need to maintain focus on navigating in the world around them and the physical context of the surrounding. The latter includes the change in noise levels, temperature or lighting to name a few. Marshall and Tennent [16] have revisited these concerns and highlight four challenges designing interactions for mobile devices: cognitive load, physical constraints, terrain and other people.

Many researchers have explored interaction with mobile devices in distracted contexts, such as driving [1] or walking [17] and noted that there is a trade-off between walking speed and target accuracy for mobile devices [2] as well as manipulating objects using touch is more cognitively demanding than traditional tactile buttons due to increased visual needs [18]. Eyes-free or even hands-free interaction techniques aim to handle these contextual concerns. Experiments in mobile interaction research have demonstrated that novel interaction paradigms based on sound and head gestures [15] or gestures with wearable objects [13] have the potential to address usability issues of interaction with mobile devices in vivacious situations. But such methods must be robust enough to allow inaccuracy in performing a task, and they must provide customized feedback on interaction status so that users can explicitly adjust their actions to compensate for errors [15].

While researchers have noted lower performance in distracted contexts and designed new interaction paradigms for mobile devices, we have not found distinct research connecting these findings to supporting interactions during physical activity such as running or biking.

3 Probing

Probes are not prototypes of new technology, rather they are tools to “find out about the unknown - to hopefully return with useful or interesting data” [11]. They should be used in early stages of projects to investigate new perspectives that can constrain and open future designs [11]. They have been describes as means to collect responses from people, supporting an ongoing dialogue between participants and designers [10]. On the one hand we can interpret probes as data collection tools, complementing contextual inquiries [4]. On the other hand we can interpret probes as participation, supporting reflection by users themselves as part of data acquisition. Participants take responsibility and control of what to do with the probes and what to share with the designers [4]. This combination of contextual and participatory design perspectives is one intriguing aspect of probing.

Since the introduction of cultural probes by Gaver et al. [7] many different types of probing have been developed. Graham and Rouncefield [10] provided an overview over the state of the art of probing. Technology probes are defined by Hutchinson et al. [11] as simple, flexible, adaptable technologies deployed with three goals in mind:

- Understanding the needs and desires of users in real-world setting
- Field-testing the technology
- Inspiring participants and researchers to think about future technology and its use.

Technology probing involves installing a technology into a real use context and observing how this technology is used over a period of time [11]. By this means designers must have an initial idea of what technology would be interesting to probe in the context. In [5] simple step counters are chosen as ready made technology probes to study teenagers motivation for exercising and to find out important lessons for the design of future devices. In [6] a technology probe is applied to measure and assess texting and updating functionality of situated displays. In [19] a mobile technology probe is designed to better understand if and when intimate couples desire to hold hands when apart. In each of these studies designers had assumptions about the design space and preferred technologies. In contrast gadgile probing allows designers to explore several technologies in a context before focusing on one specific technology probe.

3.1 Gadgile Probing

Gadgile probing is not interested in field-testing one technology. It aims to explore how different “off-the-shelf” technologies are used in a context, and how different interaction techniques perform. The outcome is a rich description of technology usage in a specific context providing designers with the needs and desires of users and inspiration for future technologies. Gadgile probing consists of two phases: a technology review phase resulting in a set of available technologies, and a probing phase, there technologies are used in context.

Technology Review. The first step for the designer is to obtain an overview of “off-the-shelf” technologies available for the area of interest. Interviewing area experts, a web search and a visit to the local electronic store can combined provide a good overview. In the second step the designer categorizes these technologies by interaction style. One representative technology for each category is chosen as gadgile probe.

Probing. The gadgile probes need to be integrated in the participants’ natural environment. The participants are encouraged to try out the probes during their ordinary activities. An introduction to each probe may be given. Designers collect data during the probing through the logging functionality of the probe and field observations. In-depth interviews with the participants after the probing provide a platform to discuss participants’ experiences and ideate about future technologies.

4 Case Study

We implemented gadgile probing to understand mobile technologies for outdoor sports. From the technology review we selected three sport devices with different interaction styles: a sport watch, a mobile phone and a sport visor. We met with a total of 8 participants for a typical training session. During the training the participants used the different technologies. Four of the participants tested the probes during biking and the other four during running. After each training session we conducted a 30 min interview with each participant to get feedback on their experiences with the probes as well as their thoughts on and ideas for mobile technologies. To document the gadgile probing we used activity logging on each probe, observation notes and recordings of the interviews.

4.1 Technology Review

In 2006, Nike introduced the Nike+[1] concept - with a special running app for the IPod[2] and a piezo-electric shoe pod. It was possible to measure pace and distance and transmit this data directly to a web platform [23]. Previously athletes used specially designed sport devices such as sport watches or bike computers for monitoring their training. In recent years the use of mobile phones for physical activity has become popular. In 2014 the fastest growing app category in the Google Play Store[3] has been health and fitness, with 100 000 mobile health apps available for Android. Several research prototypes [14, 20] for mobile devices have been developed for investigating the effects of mobile devices on exercise motivation, obesity prevention, and on users

1 http://nikeplus.nike.com.

2 http://www.apple.com/ipod/.

3 https://play.google.com.

overall fitness. These sport applications operate mainly as digital training diaries collecting performance data on the way, using multiple sensors such as GPS, heart-rate monitors, and pedometers. They support four essential training functions: performance feedback, navigational means, competition, and entertainment [14]. Before exercising a sport setting must be chosen in the application. Performance feedback is given visually and as audio [14, 20, 21] directly at the mobile device, forcing the athlete to interact with the device during exercising.

In our case study we explore three different mobile devices: mobile phone, sport watch and sport visor (Fig. 1). We categorized the devices in three different design dimensions; the multi-purpose mobile phone, the traditional and convenient wristwatch, and the fully immersive heads up display.

Fig. 1. Placement and interface of sport clock, sport visor and mobile phone

Multi-purpose Mobile Phone. The Sony Ericsson[4] Xperia active is built for an active lifestyle and outdoor sports. It can communicate with sport accessories and is waterproof. Endomondo[5] was chosen as tracking application from a list of most popular sport applications. The user interface presents three fields for workout data, information about workout and sport type and a big button to toggle tracking. In the top bar two more icons for music and volume are visible. During the workout the user needs to toggle the button to start, pause, resume and stop the workout.

Traditional and Convenient Sport Watch. The Motorola Motoactv[6] combines GPS watch, fitness tracker, and music player. The watch has a touch-sensitive screen and connects to several sport accessories. The user interface displays 6 different workout values (time, distance, speed, heart rate, calories and steps). At the bottom four short lines indicate hidden screens. The user can change the interface by swiping or pressing on the

4 http://www.sonymobile.com/.

5 https://www.endomondo.com.

6 https://motoactv.com.

screen. To start, pause, resume and stop the workout the user needs to press one of the tactile buttons on the side of the watch or the back button on the bottom of the display.

Fully Immersive Sport Visor. The Osynce Screeneye X[7] sports visor is an innovative heads up display that presents training data in the user's field of vision. It can communicate with sport accessories. The display presents two out of 5 different workout features (time, distance, heart rate, speed or temperature). To change the display feature the user has to press one of three tactile buttons on top of the visor. The other buttons are used to start and stop the workout.

4.2 Deployment

We conducted a variety of single user sessions that varied from a one hour run to a bike ride over several hours, to provide participants the possibility to interact with the probes during their natural training. Participants used the probes an equal amount of time during their exercising. Four of the participants tested the probes during biking and four during running. For biking the mobile phone was mounted on the bike handlebar. For running we provided a mobile phone arm strap, but it was the participants' choice where to place the mobile phone on the body. The sport visor did not fit under the biking helmet and was not evaluated during biking to avoid safety risks.

The probing was accompanied by a 30 min semi-structured interview. The first part of the interview covered the probing itself and participants were asked to report on their experiences with the probes, which device they preferred and why, as well as if they experienced any problems. The second part of the interview focused on their motivation for using mobile devices during physical activity. The third part of the interview gathered their ideas for future mobile technologies.

4.3 Findings

The study was conducted during a two-month period. We recruited participants from local sport clubs in Norway and Sweden. A total of 8 athletes (6 male and 2 female) between the age of 27 and 49 participated in the study. All of them own a mobile phone with a touch sensitive screen that they have used for training at least once before. Table 1 presents an overview of the probing sessions. More than 300 min of interview material were collected and analyzed. The results were categorized in contextual findings, technology evaluation and design inspiration.

Contextual Findings. We conducted gadgile probing in natural training settings. Observations, activity logs and interviews with the participants were analyzed and consolidated using open coding alike contextual inquiry process [3]. Two major themes advanced from the analysis: participants' need for self-tracking technologies, and participants' strategies to minimize interactions with technologies during training sessions.

[7] http://www.o-synce.com/.

Table 1. Probing activity per participant

R1	Trail running, switching devices after 4 km lap
R2	Trail running, switching devices after 4 km lap
R3	Long distance run, switching devices after 30 min
R4	Interval run, switching devices after three intervals
C1	Tempo bike ride, switching devices after 10 km lap
C2	Tempo bike ride, switching devices after 10 km lap
C3	2-day long distance bike ride, 100 km per day and device
C4	2-day long distance bike ride, 100 km per day and device

Self-tracking Phenomenon. The possibility for self-tracking provided by many mobile devices creates a need to record many aspects of our lives. This study endorses this need; tracking and analyzing physical activity is as important as performing the activity. 6 out of 8 participants record their training using a mobile device and upload the collected data to online services afterwards. They relive their workout as a track on a map or a diagram presenting different performance aspects. The recorded data becomes an affirmation of their training.

Minimal Interactions. Participants' interaction with the devices during physical activity was very sparse. Mobile devices were used as passive means of logging, with predefined feedback intervals or automatic coaching settings. Even though participants are interested in feedback on demand such as current pace, time, distance and heart rate, they felt that interacting with all three devices were distracting. They had to slow down or even stop to get visual feedback and audio feedback was often misunderstood due to surrounding noise such as wind and traffic.

Technology Evaluation. Participants were eager to try out exercising with sport visor, sport clock and mobile phone. They had no ownership of any of the three devices, allowing them to critique and compare their features more liberally. They reported on functionality, usability and wearability during their workout, supported by previous research [9].

Functionality. All three devices provide similar functionalities such as start, stop, pause and resume a workout recording and getting feedback on time, pace, distance and heart rate. Participants were satisfied with the functionalities and had no problems understanding the different feedback modes.

Usability. All three devices had usability issues. The sport watch was the easiest to use, but the small text on the display was hard to read for some participants. Participants only used the start, stop and lap button on the watch; these interactions needed one tactile button press. During running the phone was setup with automatic audio interval feedback. Participants had to stop running to actively interact with the device and visual feedback was not available due to the placement on the upper arm or in the back pocket. The phone mounted on the handlebar was preferred for biking, providing good visual feedback with a large display and easy access to the touchscreen. The visor gave visual feedback in the field of sight, however participants felt it was hard to see the display when trail running. Changing the display using the buttons on top of the visor was experienced as uncomfortable.

Placement. All participants favored both the visor and the watch placement during running. The mobile phone was experienced as uncomfortable and unreachable for running. For biking the participants preferred the mobile phone placed on the handlebar. The visor did not fit under the helmet and could not be used. The watch on the wrist was hard to interact with during biking.

Design Inspiration. The introduction of the probes enabled participants to think about future technologies. One participant was asking for a voice-controlled small earpiece, a digital coach hidden in his ear. Another participant got inspired by the visor and wanted a similar display integrated into his bicycle helmet. Participants were focused on two main requirements: easier and more reachable input mechanisms and better visual feedback. At the same time the device should not bother during the activity.

The outcome from design inspiration was a simple decision framework with three dimensions: *placement, feedback* and *interaction*. The form factors of the device dictate its placement during the activity. Heavy and large devices should be placed on non-moving parts of the body. Smaller and lighter devices can be placed more freely. Thorough research about placement of wearables can be found in [9]. Visual feedback is preferred by participants, providing information at a glance, but is dependent on device placement. If the device screen is visible, feedback can be given on the device. If the device is placed out of sight during the activity, feedback should be given using a feedback accessory. Interaction is dependent on device placement. If the device is reachable, users can interact directly with the device. If the device is not reachable, an interaction accessory is needed. The use of accessories to enhance device functionality such as heart rate monitor, GPS or foot pod is common in sports. We propose that interaction and feedback with devices could be built on accessories as well.

5 Discussion

Gadgile probing is inspired by and based on contextual inquiry; an interview method to obtain information about the context of use well established in interaction design research. A contextual interviewer observes a user in context as she performs an activity and inquires into the user's actions as they unfold to understand her motivations and strategy. The interviewer and user develop a common understanding of the situation [3]. Active inquiry into the user's world is crucial for the complex nature of mobile context. Contextual inquiry is implemented successfully in numerous workplace situations [22] but there are limitations for mobile context such as outdoor sports.

Observations and inquiries during the activity can be difficult to perform with the user on the move. The interviewer needs to engage in the physical activity and at the same time observe and interview the user. Contextual inquiry enables designers to collect information about the current use situation and associated problems. Visioning possible solutions is detached from the inquiry and depending on the designers' ability to envision future usage. Designing for mobile interaction requires a good understanding of feasible interaction techniques for the context, something that is not explored during the inquiry process.

Probes used as tools for data collection can resolve these challenges and provide a holistic understanding of the context [4]. We designed gadgile probing to enhance the inquiry process. Probes collect usage data on the fly, complementing observations with additional information about use. Gadgile probing introduces different technologies into the inquiry process to collect information about potential new applications and resulting interactions. The findings inform the designer about the feasibility of different interaction techniques. User and designer can compare different technologies and ideate about future solutions, providing valuable input to the visioning process.

Gadgile probing and technology probing have common goals, but are deployed differently. Gadgile probing explores several technologies during an inquiry to compare these technologies and limit the design space. The gadgile probes are "off-the-shelf" technologies selected from a technology review. In contrast, technology probing involves installing one particular technology into a real use context and observing how this technology is used over a period of time [11]. The designer must have an underlying understanding of the context to select which technology to use as a probe and adaption to the context might be necessary. We understand technology probes as a successive step to gadgile probing, a second iteration in the design process to investigate one promising technology in more detail.

6 Conclusion

Designing for mobile interactions is challenging. Designers must understand the multidimensional nature of the mobile context and require an overview of interaction techniques feasible for that context. Established methods in interaction design such as contextual inquiry or technology probing have limitations for mobile context. In this paper we demonstrated gadgile probing as a possible alternative supporting design of active mobile interactions. Introducing "off-the-shelf" technology in the inquiry phase enabled us to explore not only *what is* but also *what could be* early in the design process. We showed an example from running and biking. Our findings demonstrate that gadgile probing can add benefits of probing to traditional contextual inquiry. We generated a good understanding of the context, listed needs and desires of participants, evaluated alternative interaction styles, and inspired designers and participants to ideate about future technologies. Gadgile probing supports a holistic understanding of active mobile interactions. We invite the interaction design community to critically evaluate gadgile probing in future mobile interaction projects.

References

1. Bach, K.M., et al.: You can touch, but you can't look: interacting with in-vehicle systems. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1139–1148. ACM, New York (2008)

2. Bergstrom-Lehtovirta, J., et al.: The effects of walking speed on target acquisition on a touchscreen interface. In: Proceedings of the 13th International Conference on Human Computer Interaction with Mobile Devices and Services, pp. 143–146. ACM, New York (2011)
3. Beyer, H., Holtzblatt, K.: Contextual Design: Defining Customer-Centered Systems. Elsevier, Amsterdam (1997)
4. Boehner, K., et al.: How HCI interprets the probes. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 1077–1086. ACM, New York (2007)
5. Edwards, H.M., et al.: Exploring teenagers' motivation to exercise through technology probes. In: Proceedings of the 25th BCS Conference on Human-Computer Interaction, pp. 104–113. British Computer Society, Swinton (2011)
6. Fitton, D., et al.: Probing technology with technology probes. In: Equator Workshop on Record and Replay Technologies (2004)
7. Gaver, B., et al.: Design: cultural probes. Interactions **6**(1), 21–29 (1999)
8. Gaver, W.W., et al.: Cultural probes and the value of uncertainty. Interactions **11**(5), 53–56 (2004)
9. Gemperle, F., et al.: Design for wearability. In: Proceedings of the 2nd IEEE International Symposium on Wearable Computers, p. 116. IEEE Computer Society, Washington (1998)
10. Graham, C., Rouncefield, M.: Probes and participation. In: Proceedings of the Tenth Anniversary Conference on Participatory Design 2008, pp. 194–197. Indiana University, Indianapolis (2008)
11. Hutchinson, H., et al.: Technology probes: inspiring design for and with families. In: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 17–24. ACM, New York (2003)
12. Ishii, H., Ullmer, B.: Tangible bits: towards seamless interfaces between people, bits and atoms. In: Proceedings of the ACM SIGCHI Conference on Human Factors in Computing Systems, pp. 234–241. ACM, New York (1997)
13. Kim, K., et al.: Wearable-object-based interaction for a mobile audio device. In: CHI 2010 Extended Abstracts on Human Factors in Computing Systems, pp. 3865–3870. ACM, New York (2010)
14. Kurdyukova, E.: Inspire, guide, and entertain: designing a mobile assistant for runners. In: Proceedings of the 11th International Conference on Human-Computer Interaction with Mobile Devices and Services, pp. 75:1–75:2. ACM, New York (2009)
15. Lumsden, J., Brewster, S.: A paradigm shift: alternative interaction techniques for use with mobile & wearable devices. In: Proceedings of the 2003 Conference of the Centre for Advanced Studies on Collaborative Research, pp. 197–210. IBM Press, Toronto (2003)
16. Marshall, J., Tennent, P.: Mobile interaction does not exist. In: CHI 2013 Extended Abstracts on Human Factors in Computing Systems, pp. 2069–2078. ACM, New York (2013)
17. Negulescu, M., et al.: Tap, swipe, or move: attentional demands for distracted smartphone input. In: Proceedings of the International Working Conference on Advanced Visual Interfaces, pp. 173–180. ACM, New York (2012)
18. Noy, Y.I., et al.: Task interruptability and duration as measures of visual distraction. Appl. Ergon. **35**(3), 207–213 (2004)
19. O'Brien, S., Mueller, F.: "Floyd": holding hands over a distance: technology probes in an intimate, mobile context. In: Proceedings of the 18th Australia Conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments, pp. 293–296. ACM, New York (2006)

20. De Oliveira, R., Oliver, N.: TripleBeat: enhancing exercise performance with persuasion. In: Proceedings of the 10th International Conference on Human Computer Interaction with Mobile Devices and Services, pp. 255–264. ACM, New York (2008)
21. Preuschl, E., et al.: Mobile motion advisor — a feedback system for physical exercise in schools. Procedia Eng. **2**(2), 2741–2747 (2010)
22. Raven, M.E., Flanders, A.: Using contextual inquiry to learn about your audiences. SIGDOC Asterisk J. Comput. Doc. **20**(1), 1–13 (1996)
23. Saponas, T.S., et al.: Devices that tell on you: The nike+ipod sport kit (2006)