# Context Specific Visualizations on Smartwatches

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**Abstract**

*We present an analysis of the results of a full-day context-specific ideation exercise for smartwatch visualizations. Participants of the exercise created 34 sketches during a sightseeing activity. Our analysis of these sketches showed where visualizations could be applied and shown, what information needs they could target, and how data could be represented in the sightseeing context. Supplementary material is available at–https://osf.io/vhn43/.*

**CCS Concepts**
• ***Human-centered computing*** → ***Empirical studies in visualization; Mobile devices;***

## 1. Introduction

Wearers of smartwatches commonly use features for monitoring and tracking activities or responding to notifications, in addition to timekeeping [PBML16]. With smartwatches' advanced sensor and internet capabilities, their use can be versatile and wearers may want to see practical information in different usage scenarios. Previous work on smartwatch visualizations has shown that visualizations can be effective forms of data representations in the context of wearable devices. Smartwatches can show complex data such as weekly sleep overviews [IAB*22] in the form of small micro visualizations [Ise21]; and people can perform simple comparison tasks with visualizations within several hundred milliseconds [BBB*19].

The most frequently explored applications for smartwatches have been related to health [AHBI17,BSE15,NSI19], enterprise applications [AU14, BDS*14, BJMG15], driving [LPPC16], or sports [LDB21, GB21]. However, we are still far from having explored the full potential of smartwatches for supporting in-situ information needs of wearers. Ideation exercises can help to derive new forms of smartwatch applications and have been used successfully in the past. Gouveia et al. [GPK*16], for example focused on glanceable physical activity feedback for smartwatches derived through an iterative ideation process. Through participatory design workshops with children with ADHD, Cibrian et al. [CLT*20] identified tensions when receiving notifications on a smartwatch and challenges in designing wearable applications supporting children's self-regulation. Similar to these two examples we were interested in ideation activities for smartwatches with a focus on deriving new ideas for smartwatch visualizations. We focused on a specific usage context, sightseeing, rather than attempting to derive broad but unspecific visualization ideas. In contrast to the prior work our designs were derived during the activity, in-situ, and attempted to capture the information needs of participants in specific locations and during the activity itself.

## 2. Ideation Activity

We made use of an in-situ ideation method [CKSC18] during a half-day group sightseeing activity in Stuttgart, Germany. We customized the design methodology toward smartwatch applications as described as part of a book chapter [CIP*21]. Our goal was to see whether the methodology would be able to generate a rich set of smartwatch visualizations dedicated to the activity. We gave every participant a physical paper prop in the shape of a smartwatch. The group, consisting of six people, two foreigners (one who had never been to the city), three locals, and one person who grew up in the area but had been living abroad for over 16 years, started to explore the city of Stuttgart by visiting sights and stopped every 30 minutes. Each individual evaluated their information needs in the current situation and sketched a visualization on the prop that would address these needs in the current situation. After the sketching time, pairs of two discussed their ideas and added comments, adjustments, or interpretations to their notes and sketches. The ideation exercise took place at different locations, including a market hall, the town hall with a famous paternoster elevator, twice in a museum with a historic clock collection, and during lunch. We collected 34 sketches from the group. Here, we go beyond prior work [CIP*21] by analyzing the sketches in-depth to find underlying patterns in the designs and draw inspiration for future smartwatch visualizations.

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## 3. Findings

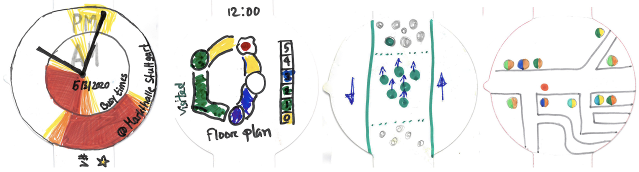
To analyze the 34 sketches we conducted an open card sorting exercise [WW08] with printed copies of the sketches. The dimension of each image was 12.5 cm × 18 cm. The session lasted for one hour. Here, we report on the most interesting categories observed from the card sorting.

**Applications vs. Watch Faces.** We found two different types of interfaces people sketched (see Figure 1): Watch faces (18 ×) that showed the time in addition to other information and applications (16 ×) that did not show time. 44% (8/18) of the watch face designs and 50% (8/16) of the applications included visualizations in the form of charts and maps. Perhaps, applications showed visualizations more frequently because no space needed to be dedicated to displaying the current time. On the watch face designs, time was shown in two ways: analog time imitating classic dials or digital time using text. 83% of the designs used a digital time representations (15×) and only 17% used an analog time (3×) display. This echoes previous findings that showed digital watch displays to be more common on smartwatch faces [IBL*20].

**Information Needs.** We grouped the sketches into eight categories based on the information need categories the designs mainly targeted: entertainment (7×), shopping (6×), activity tracking (5×), tasks (5×), restaurant (4×), navigation (4×), elevator riding (2×), and weather (1×). It is interesting that not all designs targeted sightseeing-related information needs. Specific locations, such as the town hall, also elicited ideas related to administrative tasks. However, entertainment-related information needs were the most common. These included mainly ideas related to memory keeping or showing additional data about interesting sights or exhibit pieces seen. A contrast in targeted information needs was visible when comparing the watch face with the application interface designs. For example, information about an activity (4×) (e.g., calories burned, step counts) or task keeping (5×) (e.g., appointment scheduler, day tasks plan) were more common on watch faces than in application-type (1× activity overview, 0× task keeping-related info) sketches. However, entertainment-related designs (e.g., memory keeping, exhibition recommendation) were more apparent in application-type (5×) interfaces and less in watch face (2×) designs.

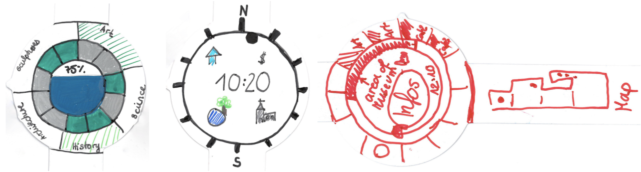
**Data Representation.** We found that most of the data was represented using charts (10×) (see an example in Figure 2a) followed by icons (9×) (see an example in Figure 2b), text (6×), icon+text (4×), icon+chart (1×), and last pictograph (1×). Few sketches also showed a map/navigation (4×) or icon+map (2×) (see Figure 2c) representation. Charts were mainly radial bars (6×), bars (2×), heatmap (1×), and a line chart (1×). Proportion type data such as budget spent at the market, goal-based data such as calories burned based on total goal, or distance traveled in meters are represented were radial bars. Maps abstracted particular locations such as the street view showing restaurants in Figure 1d or the building floor plans on the watch strap in Figure 2c.

**Going Beyond the Display.** Eight sketches included visualizations on watch straps to complement the main display. The watch straps mostly showed static contextual information such as maps (see Figure 2c), additional information about a visited place (e.g., ratings, established year, the total area). One example included dynamic data showing the current floor on a map while riding an elevator.




(a) (b) (c) (d)

**Figure 1:** *Smartwatch face (a & b) and application (c & d) ideas. The sketch (a) is an analog watch face representing the market crowd in the morning and the evening using a heatmap; (b) is digital watch face with a museum floor plan tracking which rooms one had already visited; (c) represents the townhall elevator: how many people are riding up or down in a real-time; and (d) shows the restaurants in a specific area: colors represent price, types of food, or rating; the single red dot shows the wearer's current position.*




(a) (b) (c)

**Figure 2:** *Three representation ideas. (a) shows an overview, recommendation, and ranking of exhibition pieces in the museum as a guide on what to see next; (b) shows an abstract map with icons representing visited places in the vicinity; (c) shows a floor plan on to the watch strap about the wearers' position in the museum and visited exhibition pieces on the watch face.*

## 4. Conclusion

We studied smartwatch visualization design ideas in a specific usage context—sightseeing. We found several data needs concerning smartwatch usage contexts that clearly differed from common usage (e.g., health-fitness data). These data needs were met with a wealth of dedicated visualization designs that go beyond those commonly seen on watch faces [IBL*20] with a focus on visual design rather than interaction. Watch straps were predominantly used to show details related to the main display rather than completely different information. Future research needs to establish the feasibility and usability of watch straps as data displays. Concerning data representations we saw in particular icons used in creative ways. Icons are rare on standard desktop-based representations but may be useful for micro visualizations because they can label as well as represent data.

### Acknowledgements

We thank our ideation activity participants. Pantelis Antoniadis, Cristina Morariu, and Anne Reuter in the workshop. The work was funded in part by an ANR grant ANR-18-CE92-0059-01 and a DFG grant DFG ER 272-14.

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