AwareKit: Exploring a Tangible Interaction Paradigm for Digital Calendars

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Abstract
Digital calendars are a conventional tool for planning meetings and providing information about the availability of others. In this paper, we explore an alternative tangible way of interaction with existing electronic calendaring systems. Our prototype, called *AwareKit*, is a tangible toolkit aimed at supplementing existing electronic calendar systems and exploits quick, fun and playful interaction. It integrates an attractive design and utilizes touch and rotation as interaction techniques to access different types of information. In this paper, we outline the design concept of *AwareKit*, its hardware implementation and the first usability feedback. The results of the pilot usability study showed that *AwareKit* is easy to use and facilitates intuitive and playful interaction.

Author Keywords
Interactive calendar; Tangible interaction; Physical visualization; Awareness display; Internet of things (IoT).

ACM Classification Keywords
H.5.m [Information interfaces and presentation (e.g., HCI)]: Miscellaneous

Introduction
Digital calendars play an important role in planning meetings, handling invitations and setting reminders in the professional environment [19]. Moreover, they provide the in-

formation regarding colleagues' availability not only about the current moment, but also with regard to the future. Another advantage of digital calendars is their flexible accessibility from both desktop computers and mobile phones [23, 21].

Given these advantages and the ubiquitous usage of digital calendars, in our work we aim to supplement them to facilitate quick access to calendar information in a fun and interactive manner. Our goal was to explore an alternative tangible way to interact with digital calendars via a tangible toolkit, called *AwareKit* (Figure 1). It is not meant to replace digital calendars, but rather supplement them in an intuitive, fun and interactive manner.

This networked toolkit provides availability information (day and week) for a single or a group of colleague(s) via different feedback modalities, such as light and sound, without need for a smart phone or desktop application. The modules in *AwareKit*, can be rotated, touched and connected to provide working colleagues with different calendar information in unique and personalized ways.

Before diving into system design and implementation, we provide an example of a possible usage scenario. Work colleagues Mike and Tom enjoy discussing research ideas over a cup of coffee when they have a free minute. However, they often lack information regarding each other's availability. Using a tangible figure that represents Mike, Tom touches a dedicated module in a quick and playful manner, which shows Mike's availability for today. Seeing that Mike is available now, Tom decides to come to his office for a small talk.

Related Work

Our work has been influenced by prior research in computational toolkits and tangible awareness systems. Therefore, we cover a small subset of related systems that our work builds on.

Figure 1: *AwareKit* consists of six types of tangible modules. Four modules for retrieving availability information (in the center), tangible figures and magnetic connectors. Tangible acrylic figures used to represent individual colleagues and magnetic connectors for communication between modules.

Tangible systems and interfaces habe been introduced in different domains since the early works by Ishii and Ulmer [12]. They have shown to increase awareness via various objects and modalities, and further engage interaction through their affordances and physical properties [12, 9, 13]. For example, Klemmer et al. [14] presented Papier-Mâché, a toolkit for building tangible user interfaces using computer vision, bar codes and electronic tags. They showed how users could easily build new interfaces and adapt applications to other technologies. Ananthanarayan et al. [1] presented a computational toolkit that combines craft and health, allowing children to craft their own tangible

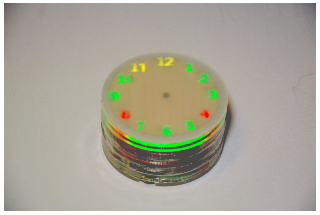

Figure 2: A *Day* module.

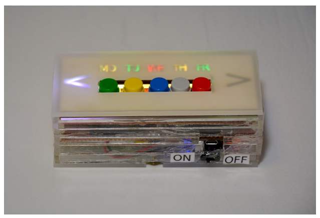

Figure 3: A *Week* module.

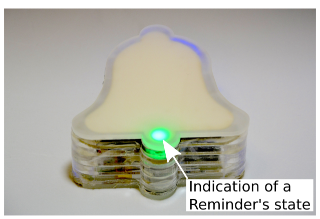

Figure 4: A *Reminder* module.

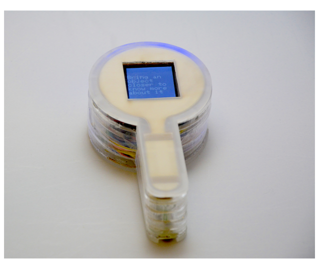

Figure 5: A *ToolTip* module.

health visualizations based on data from an accompanying wearable device. Results of the study with PhysiKit by Housen et al. [10] showed that people get engaged into exploring the physical and ambient representation of environmental information by interacting with a physical toolkit.

As for tangible awareness systems, Peek et al.[20] proposed a system with a physical representation of instant messaging contacts via hanging tangible avatars. Hausen et al. [5] presented different ways of facilitating the state management for instant messaging systems in an interactive way. They investigated a peripheral interaction for changing own state and provided an overview of the states of others at a glance. Holleis et al. [8] presented a set of small independent displays that communicate with each other. By changing the position of these objects one can change a user's state and see it immediately on the object. Other ambient awareness systems, such as SpiralClock [3] and AmbientTimer [18], showed the feasibility of light as a medium to represent information about upcoming events in an unobtrusive manner. Other systems, such as Forget-Me-Not [26] and Cubble [15], allowed users to interactively change their states and stay connected with distant peers. More recent work also showed the feasibility of using a tangible event awareness device based on electronic calendar information in the form of a cube [16]. With CubeLendar one can access information from an electronic calendar by rotating an object and retrieving one chunk of information per each cube's face.

Much like other tangible toolkits [10, 1, 17], *AwareKit* is designed as a set of separate modules to provide users with more interaction freedom. Each module encapsulates particular functionality and interaction, and aims to increase awareness. In order to engage users, the toolkit is designed with playful icons, shapes and colors. It also leverages ambient feedback mechanisms for usage in an office environment. In the following sections, we describe the design, implementation and the initial usability feedback of our toolkit.

Design Concept

AwareKit consists of six types of tangible modules. Four of the modules enable users to retrieve availability information for single or multiple colleagues, and two of the modules facilitate communication and interaction between the modules.

The unique shapes of the four modules are suggestive of the action or information they present. The *Day* module, which shows availability over a day, looks like an analog clock since it provides an overview of typical working hours (7 a.m to 7 p.m.) (Figure 2). The *Week* module is based on an analog calendar representation; it is rectangular shaped and provides an overview of the typical working days (Monday-Friday) at a glance (Figure 3). The *Reminder* module, which notifies users about a person's availability, has the shape of a bell, which is well-known and commonly used representation for a reminder in the existing software applications, such as Google Notifications[1], Just Reminder[2], Nag[3], etc (Figure 4). Finally, the *ToolTip* module helps in finding out about the states of other modules; it looks like a magnifying glass since it provides more information about other objects in a way similar its real life counterpart (Figure 4).

The two components that facilitate interaction between the four aforementioned modules include tangible figures that

[1] https://plus.google.com/notifications

[2] https://play.google.com/store/apps/details?id=in.smsoft.justremind&hl=en

[3] https://itunes.apple.com/us/app/nag-multiple-timers-alarms/id391957434?mt=8

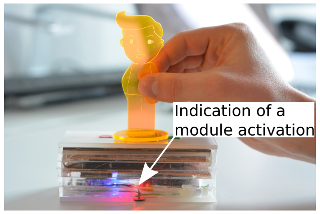

Figure 6: An example of a module activation.

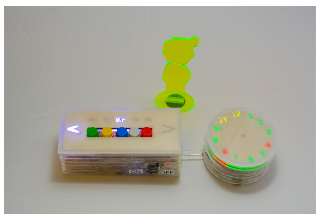

Figure 7: Communication between *Day* and *Week* (top view): Availability for Wednesday next week.

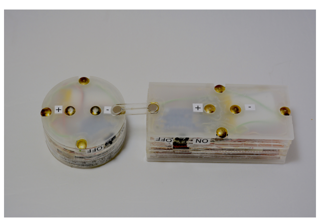

Figure 8: Communication between *Day* and *Week* (bottom view).

can be assigned to particular colleagues and magnetic connectors that enable communication between the different modules. The tangible figure component represents an individual and allows activating all four modules. Tangible figures also differ in colors and genders to give users an opportunity to create unique and personalized mappings to their real colleagues. A user can manually assign a given figure to a particular colleague. This figure can also be reassigned to another person in the future.The second magnetic component facilitates connection between the modules (Figure 1).

A user can activate a module by touching the tangible figure to the top of the module (Figure 6), similar to Nintendo[4] and Lego Dimensions[5] games. In the case of the *Day* and *Week* modules, an activation (signified by a red LED blink) shows the associated colleague's availability via LED indicators. There are 12 LED indicators corresponding to the 12 working hours for the Day module, and 5 LED indicators for the working days (e.g. Monday - Friday) in the *Week* module. A green light signifies that the person is free (no appointments); a yellow light represents that the colleague is somewhat free (at least half an hour/day), and a red light indicates not free (less than half an hour/day).

Additionally, the *Week* module can be tilted to the left or right to alternate between the current and subsequent week. The LED arrows indicate possible directions for rotation. Thus, if the right LED arrow is illuminated, the user is in the current week and can look at next week's availability data by tilting the module to the right. Similarly, the user can tilt left from the future week to the current week.

[4] http://www.nintendo.com/amiibo/
[5] https://www.lego.com/en-us/dimensions

The *Day* and *Week* modules can also be interfaced together using the magnetic connectors at one of four equidistant locations located at the bottom of the modules (Figures 7 and 8). After connecting the *Day* and *Week* modules, the user can press the button associated with a particular day on the Week module and see detailed hourly availability data on the *Day* module for the selected day.

One can additionally touch the *Day* or *Week* modules with multiple tangible figures to see overlapping availability for a selected group of colleagues (perhaps to find a free timeslot within the group).

The *Reminder* module enables users to setup a quick alarm for the next available slot in a colleague's calendar for the current day. It indicates a successful and unsuccessful alarm setting through a green and red LED, respectively (Figure 4). When a colleague becomes free, the module rings softly like a bell.

Finally, the *ToolTip* module can be used to display the current state information of the other modules on a small LCD screen. This is accomplished by placing the *ToolTip* module on top of another module. For example, when the ToolTip module is placed on top of the *Day* module, the screen displays the name of colleague whose availability is currently shown. When one touches the *Reminder* module with the *ToolTip* module, the LCD display shows what the notification is about (Figure 9). In a similar interaction with a tangible figure, the display shows the name of the colleague mapped to a particular figure.

System Implementation

The *Day* (7,5 x 7,5 cm), *Week* (12,5 x 5,5 cm), *Reminder* (10,5 x 11 cm) and *ToolTip* (7,5 x 13,5 cm) modules of *AwareKit* are housed in lasercut clear Plexiglass with a semi-opaque Plexiglass top to diffuse LED light. For the

Figure 9: Checking a Reminder with a *ToolTip* module.

Figure 10: Participant is interacting with *AwareKit* during a pilot usability study.

purposes of consistency and to facilitate connections with the magnetic connectors, all four ambient modules have the same height of four cm. The 10 cm tangible Plexiglass figures each contain a unique RFID tag on the bottom that maps to a particular individual. The magnetic connectors (1,2 x 4,5 cm) contain two circular neodymium magnets that are connected by thin wire channel.

Each of the ambient modules contains a NodeMCU 8266 board[6] with an integrated Wi-Fi module and powered by a LiPo battery that can be charged via two pins at the bottom (Figure 8). In addition, each module has an integrated RFID reader for touch-based interaction with tangible figures, and RFID tags for a touch-based interaction with the *ToolTip* module.

For the *Day*, *Week* and *Reminder* modules, we used Neopixels[7] to represent information, while the *ToolTip* has a 1.8" TFT LCD display for showing textual information. To enable interaction with a *Week* module via rotation, we decided to use an accelerometer module to infer tilt.

Ambient modules are completely autonomous and communicate over Wi-Fi through JavaScript to the Google calendars of all colleagues. For the implementation of *AwareKit* we decided to use the Google scripts service since it provides easy retrieval of information from a Google calendar and communication with NodeMCU boards.

Pilot Usability Study

To evaluate our prototype, we recruited twelve participants (six female) aged between 22 and 57 (M = 33.83, SD = 10.26) from a local research institute. The participants had different indoor professional occupations, such as researcher, student assistant, library assistant, secretary and service worker. Participants were given three tasks which involved all modules, components and interactions of *AwareKit*. For this study, participants received a preconfigured system, but in a future study they will be able to configure it themselves using a custom Android application.

For the first task participants had to find out the availability of a particular colleague for the current day, current week and subsequent week. For the second task participants had to find out the availability for a group of colleagues for a particular hour on a particular day. For the third task participants had to set a reminder for a particular colleague. If he was not available at the moment, they were asked to check the state of the *Reminder* module when it rang after a couple of minutes. After all tasks were completed, participants were asked to fill in a 10-item questionnaire based on the System Usability Scale (SUS) [2]. Additionally, they were asked about the usability and implementation problems they experienced while interacting with the toolkit in a subsequent interview.

Results

Overall, participants found AwareKit fun and easy to use. The prototype received SUS score of 87.29, where any SUS score greater than 70 is considered as usable. They were also able to finish all the tasks without additional help. The shapes of the modules were functionally intuitive. For example: *"Tipping was easy and intuitive to do. I find it also good that a magnifying glass [ToolTip] gives me more information about the objects. Metaphors were easy to understand."* [P4].

For all three tasks, however, participants had problems finding a spot for positioning a tangible figure on top of the modules to activate them. During the first and second tasks

[6] https://en.wikipedia.org/wiki/NodeMCU
[7] https://www.adafruit.com/category/168

three participants had problems understanding the encoding of hours on a *Day* module. For example, P4 said: *"It's hard to understand whether she has time at 9 am or time between 9 and 10. The mapping was not clear for me."* As for the last task, six participants perceived a red light on a *Reminder* module as an indication of a person's unavailability and a green light as a person's availability, which created some confusion. For example, P5 mentioned: *"It was weird and confusing whether light was about availability or not."*

All participants could see themselves using *AwareKit* regularly in a working environment. The *Day* module, however, might be more useful than the *Week* and *Reminder* modules. For example, P1 said: *"I would use a Day and a Reminder for short meetings. For meetings in the future I would use my electronic calendar."*

Discussion & Future Work

We aim to use *AwareKit* to increase situational awareness in both professional and private environments, since electronic calendaring systems are also widely used among family members [4]. Based on these use cases and supporting literature [6, 24], we consider a long-term study with repeated interviews and automatic logging of users' activities. We suspect that *AwareKit* might be better suited for day to day or current week data, since users already mentioned during the interviews that if they wanted to look ahead next week, they would use electronic calendars.

From an implementation perspective, we identified three main problems from the pilot usability study. Before conducting future experiments, we will add a marker on top of the modules indicating the spot for placing tangible figures. We also plan on increasing the granularity of hours on the *Day* module and changing the state colors for the *Reminder* module.

Tangible interactive systems are known to facilitate smooth transition of attention between background and foreground [12, 11]. Moreover, tangible objects provide a sense of intimacy, which is sometimes hard to achieve with screen-based interfaces. Thus, *AwareKit* has the potential of increasing spontaneous and informal communication among colleagues, which influences their productivity and social connectedness [7].

In a working environment, *AwareKit* can also play the role of a "bridge" between spatially distributed teams. This would allow us to investigate the seamless transitions between implicit and explicit communication among colleagues. This part of social communication is an emerging field and has not been comprehensively studied yet [22, 25]. It would also be interesting to explore *AwareKit* in the context of large groups. For example, with 15 colleagues, users might have trouble remembering all the tangible figures they touched to a particular module or make interaction mistakes.

Since the modules of *AwareKit* are completely autonomous and ambient, users can also take them to meetings. The modules of *AwareKit* can help colleagues find the next suitable meeting's date after the meeting is over. It would be interesting to explore *AwareKit* in these different use cases to discover boundary conditions of this tangible interaction paradigm for calendaring.

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References

[1] Swamy Ananthanarayan, Katie Siek, and Michael Eisenberg. 2016. A Craft Approach to Health Awareness in Children. In *Proceedings of the 2016 ACM Conference on Designing Interactive Systems*. ACM, 724–735.

[2] John Brooke and others. 1996. SUS-A quick and dirty usability scale. *Usability evaluation in industry* 189, 194 (1996), 4–7.

[3] Pierre Dragicevic and Stéphane Huot. 2002. SpirаClock: a continuous and non-intrusive display for upcoming events. In *CHI'02 extended abstracts on Human factors in computing systems*. ACM, 604–605.

[4] Kathryn Elliot and Sheelagh Carpendale. 2005. Awareness and coordination: A calendar for families. (2005).

[5] Doris Hausen, Sebastian Boring, Clara Lueling, Simone Rodestock, and Andreas Butz. 2012. StaTube: facilitating state management in instant messaging systems. In *Proceedings of the Sixth International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 283–290.

[6] William R Hazlewood, Erik Stolterman, and Kay Connelly. 2011. Issues in evaluating ambient displays in the wild: two case studies. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 877–886.

[7] Pamela J Hinds and Mark Mortensen. 2005. Understanding conflict in geographically distributed teams: The moderating effects of shared identity, shared context, and spontaneous communication. *Organization science* 16, 3 (2005), 290–307.

[8] Paul Holleis, Matthias Kranz, and Albrecht Schmidt. 2005. Displayed connectivity. In *Adjunct Proceedings Ubicomp*, Vol. 5. Citeseer.

[9] Eva Hornecker and Jacob Buur. 2006. Getting a grip on tangible interaction: a framework on physical space and social interaction. In *Proceedings of the SIGCHI conference on Human Factors in computing systems*. ACM, 437–446.

[10] Steven Houben, Connie Golsteijn, Sarah Gallacher, Rose Johnson, Saskia Bakker, Nicolai Marquardt, Licia Capra, and Yvonne Rogers. 2016. Physikit: Data Engagement Through Physical Ambient Visualizations in the Home. In *Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems*. ACM, 1608–1619.

[11] Hiroshi Ishii. 2007. *Tangible user interfaces*. CRC Press.

[12] Hiroshi Ishii and Brygg Ullmer. 1997. Tangible bits: towards seamless interfaces between people, bits and atoms. In *Proceedings of the ACM SIGCHI Conference on Human factors in computing systems*. ACM, 234–241.

[13] Yvonne Jansen, Pierre Dragicevic, Petra Isenberg, Jason Alexander, Abhijit Karnik, Johan Kildal, Sriram Subramanian, and Kasper Hornbæk. 2015. Opportunities and challenges for data physicalization. In *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. ACM, 3227–3236.

[14] Scott R Klemmer, Jack Li, James Lin, and James A Landay. 2004. Papier-Mache: toolkit support for tangible input. In *Proceedings of the SIGCHI conference on Human factors in computing systems*. ACM, 399–406.

[15] Robert Kowalski, Sebastian Loehmann, and Doris Hausen. 2013. cubble: a multi-device hybrid approach supporting communication in long-distance relationships. In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 201–204.

[16] Andrii Matviienko, Sebastian Horwege, Lennart Frick, Christoph Ressel, and Susanne Boll. 2016. CubeLendar: Design of a Tangible Interactive Event Awareness Cube. In *Proceedings of the 2016 CHI Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 2601–2608.

[17] David A Mellis, Sam Jacoby, Leah Buechley, Hannah Perner-Wilson, and Jie Qi. 2013. Microcontrollers as material: crafting circuits with paper, conductive ink, electronic components, and an untoolkit. In *Proceedings of the 7th International Conference on Tangible, Embedded and Embodied Interaction*. ACM, 83–90.

[18] Heiko Müller, Anastasia Kazakova, Martin Pielot, Wilko Heuten, and Susanne Boll. 2013. Ambient timer–unobtrusively reminding users of upcoming tasks with ambient light. In *IFIP Conference on Human-Computer Interaction*. Springer, 211–228.

[19] Leysia Palen and Jonathan Grudin. 2003. Discretionary adoption of group support software: Lessons from calendar applications. In *Implementing collaboration technologies in industry*. Springer, 159–180.

[20] Nadya Peek, David Pitman, and others. 2009. Hangsters: tangible peripheral interactive avatars for instant messaging. In *Proceedings of the 3rd International Conference on Tangible and Embedded Interaction*. ACM, 25–26.

[21] Anna Sell and Pirkko Walden. 2006. Mobile digital calendars: an interview study. In *Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06)*, Vol. 1. IEEE, 23b–23b.

[22] Norbert A Streitz, Carsten Röcker, Thorsten Prante, Richard Stenzel, and Daniel van Alphen. 2003. Situated interaction with ambient information: Facilitating awareness and communication in ubiquitous work environments. In *Tenth International Conference on Human-Computer Interaction (HCI International 2003)*. Citeseer.

[23] Bart van den Hooff. 2004. Electronic coordination and collective action: use and effects of electronic calendaring and scheduling. *Information & Management* 42, 1 (2004), 103–114.

[24] Thomas Visser, Martijn Vastenburg, and David Keyson. 2010. SnowGlobe: the development of a prototype awareness system for longitudinal field studies. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems*. ACM, 426–429.

[25] Daniel Vogel and Ravin Balakrishnan. 2004. Interactive public ambient displays: transitioning from implicit to explicit, public to personal, interaction with multiple users. In *Proceedings of the 17th annual ACM symposium on User interface software and technology*. ACM, 137–146.

[26] Torben Wallbaum, Janko Timmermann, Wilko Heuten, and Susanne Boll. 2015. Forget Me Not: Connecting Palliative Patients and Their Loved Ones. In *Proceedings of the 33rd Annual ACM Conference Extended Abstracts on Human Factors in Computing Systems*. ACM, 1403–1408.