COGNITIEF

Peripheral interaction

Why interaction designers should be inspired by everyday human attention management

Everyday life is full of simultaneous activities. For example, we walk around, fiddle with a pen, think about our schedule for the day, while also being aware of the things going on around us. Nowadays interactive devices such as smart phone play an important, but often needlessly obtrusive role in our everyday routines. This can be prevented when interaction with these devices would require less of people's attention. Activities that do not require focused attention are a common part of our everyday interactions with the world around us, but are very rare in our usage of computing devices. This paper discusses why that is the case, and explores how 'peripheral interactions', which require minimum attention, could be facilitated by rethinking the interaction design of interactive devices.

Saskia Bakker

Everyday attention management

It is Monday morning, Carol just woke up. It is still dark outside and rain is softly ticking against the window, hopefully it will be dry when she needs to leave for work. She flicks on the lights while looking at herself in the mirror thinking whether or not she should wash her hair. While taking soap from the bottle, she hears subtle sounds from downstairs that must be the dishwasher she pre-programmed last night. 'It sounds like the program just started, it is still early', she thinks. As she dries her hair she over thinks her schedule for today; she should not be late for that meeting with the new client. Suddenly, her smart phone starts buzzing on the bathroom cupboard. 'Could it be that client?', she thinks. She looks at the screen but it went black already. She dries her hands, unlocks the screen and sees it was the weekly newsletter of her supermarket. She switches to her calendar application to check the meeting agenda. She opens the meeting event and sees the agenda is attached in a format she cannot open on her phone. 'I should not forget to look at it once I arrive at work', she thinks, while walking back to her bedroom to get dressed.

Carol's Monday morning presents a common scenario of today's everyday life. Various activities are taking place at the same time: Carol almost continuously interacts with her environment. From this environment, she perceives relevant information, such as information about the weather or the time of day. Interestingly, this information does not require focused attention to be perceived; Carol is aware of it without actively thinking about it, because it is available as part of her surroundings. However, she may also consciously focus her attention on this information, for example when interpreting the time of day from the sounds of the dishwasher. These kinds of everyday information are perceived in the background or periphery of people's attention, and are only focused on in the center of attention when relevant. Similarly, several everyday physical actions can be performed in the periphery of attention. For example, Carol switches on the lights while looking in the mirror, takes soap from a bottle while listening to the sound of the dishwasher, and dries her hair while thinking about her schedule for the day. While some of these activities require a certain precision, they can easily be performed without conscious attention. Such actions can take place on a routine basis in the periphery of attention, but may also shift to the center of attention when they become relevant. For example, when the bottle of soap would be almost empty, Carol may briefly focus on getting the last bit out of it.

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Figure 1. FireFlies interactive system for classroom communication (Bakker e.a., 2013)

Clearly, multiple everyday activities can, under certain circumstances, be performed simultaneously (i.e. concurrent multitasking; Salvucci & Taatgen, 2010). This results from a function of the human attention system called divided attention (Wickens & McCarley, 2008). Divided attention theory describes attention as the division of mental resources over activities. Since a limited amount of mental resources is available, only a limited number of activities can be executed at the same time, depending on their resource demand. Most of our everyday activities, e.g. taking soap from a bottle, or interpreting the weather from the sounds around us, are performed on a routine basis, and therefore require a low number of resources. Moreover, these activities rely on various (sensory) modalities, such as vision, hearing, or perceptual-motor skills. Activities that use different modalities can, under the right circumstances, easily be performed at the same time (e.g. listening to the news while driving a car). Such human attention abilities allow us to perform everyday activities both in the center and the periphery of attention. As a result of these abilities, most everyday activities do not overwhelm us, but instead form a fluent part of our everyday routines.

Everyday usage of computing devices

In the above story, Carol also interacts with the digital world through her smart phone. Different from most other activities, Carol requires conscious attention to access and interact with information on her phone. For example, she needs to consciously search for the meeting agenda and the phone needlessly attracts her attention when receiving a (seemingly irrelevant) newsletter.

As evident from the scenario, such computational devices are becoming omnipresent in our everyday environment. Different from our everyday routine-based activities, interactions with these digital devices are usually performed in the center rather than in the periphery of our attention. Instead of fluently blending into the course of everyday life, these interactions therefore often seem to hinder or disturb our everyday routines. This difference poses an interesting challenge. Particularly, since the number of computing devices we use in everyday life is rapidly increasing, it seems undesirable that all our interactions with all these devices demand our focused attention. It is therefore deemed important for interaction designers to take into account the possibility of interaction with computing devices in the periphery of attention. In order to achieve this, interaction design research is needed to understand how such 'peripheral interactions' can be facilitated. What types of interaction design can be used in the periphery? In other words, how can insights in the human attention system be translated in design guidelines?

'Peripheral interaction': a very brief history

The increasing number of computers in our environment is not a new development; it has been ongoing for years and was foreseen decades ago. In 1991, Marc Weiser already envisioned the computer to become ubiquitously present in the everyday environment in the 21st century (Weiser, 1991). Along with this prediction, Weiser recognized that traditional methods of human-computer interaction (HCI), such as screen, mouse and keyboard, demanded focused attention, which would potentially prevent them from becoming a seamless part of our everyday life. He therefore argued that future computing technology would need to disappear into the background. Not only should computational components be integrated in everyday objects and environments, but rather should human interaction with such objects and environments take place outside the attentional focus. When interacting with computers in that way, humans would be 'freed to use them without thinking and so to focus beyond them on new goals' (Weiser, 1991, p. 94). Weiser and Brown (1997) later coined the term calm technology, to describe computing technology that would reside in the periphery of attention while shifting to the center of attention only when relevant.

Today, computers and digital information can indeed be found all around us. Different from the envisioned 'calm' interaction with these devices, however, our current interactions still mainly seem to engage the center of attention. Therefore, seamless integration of such interactions in our everyday routines remains a challenge. One way to address this challenge is by building on human attention and perception abilities, which are gained through interaction with the everyday physical environment. With the increasing number of computing devices in our everyday environment, these so-called peripheral interactions (Bakker e.a., 2014), are of increasing relevance to enable people to be in control of technology without being overburdened by it.

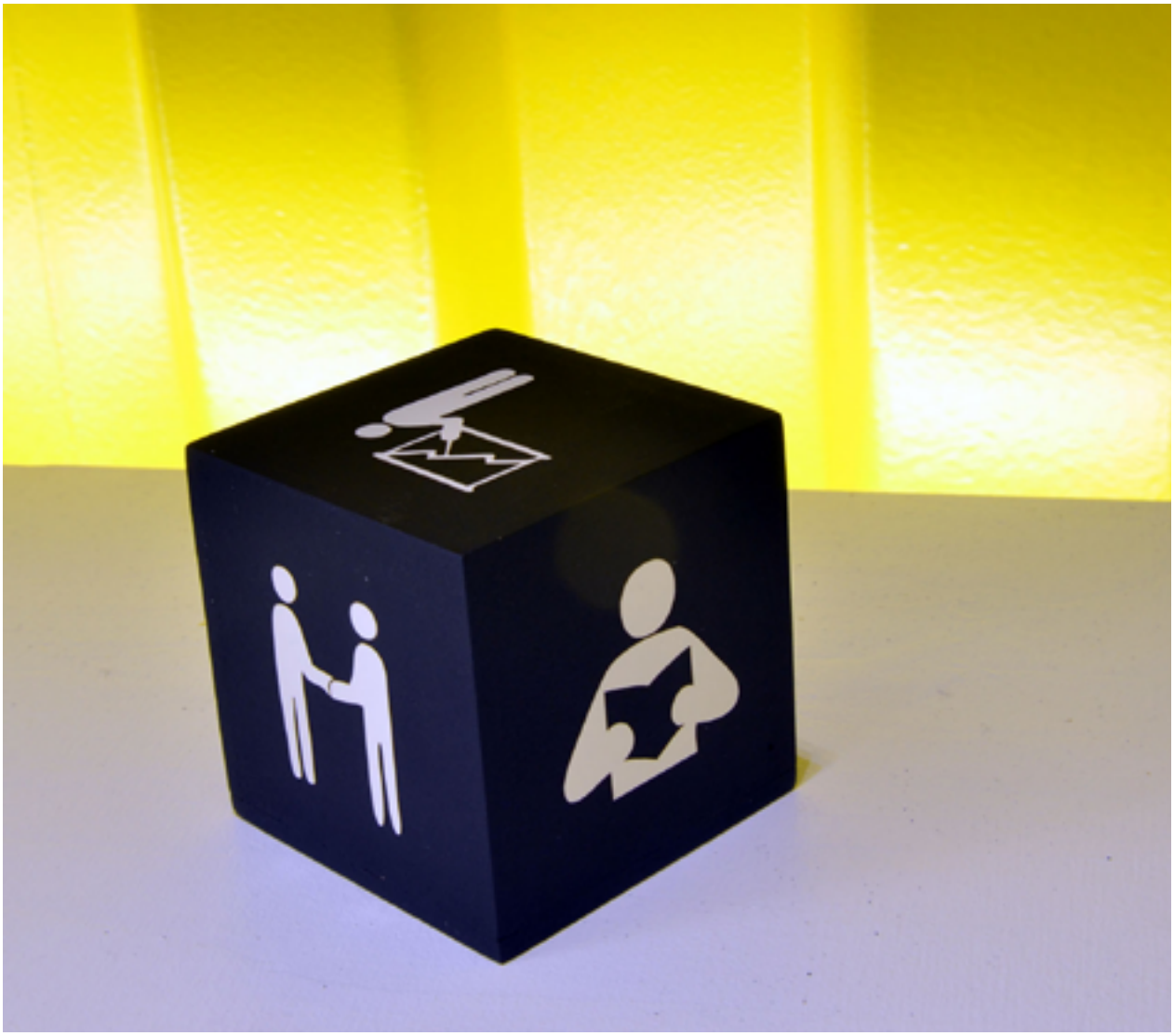

Figure 2. LightCube interface for interactive lighting systems at home (Offermans e.a., 2014)

Realizing peripheral interaction: beyond the screen

While numerous everyday activities seamlessly shift between center and periphery of attention, such shifts are not prevalent in human computer interaction. To this date, only very few examples are known of 'peripheral interaction designs'. But why is a style of interaction that is so common in our everyday routines so rare in our usage of computing technology? A possible reason for this is the dominance of the screen in computer interfaces. Screens, which also tend to become increasingly smaller, usually require focused attention in order to appreciate all visual and textual information that is being displayed. Moreover, mainly using the visual modality does not do justice to our human capabilities of handling multiple modalities at once. A first step towards translating knowledge of the human attention system into insights relevant for interaction design, therefore is to encourage exploiting physical interaction styles and using multiple modalities.

Physical interaction styles

Physical styles of human computer interaction differ from traditional interfaces such as screen, keyboard and mouse, in the sense that they are inspired by our interactions with the physical world. Tangible artifacts (Hornecker & Buur, 2006), such as physical cubes, coins and handheld objects, or bodily movements (Dourish, 2001), such as arm gestures and whole body movements, are used to directly control and manipulate digital data. This is useful for peripheral interaction because it avoids additional steps, such as going through menus to interact with digital information.

PinchWatch (Loclair e.a., 2010), for example, is a wrist-worn device which recognizes gestures made with hand and fingers. Such gestures (for example sliding with one finger along another finger) can easily be performed while being engaged in other activities such as walking or rock-climbing. These gestures can

be interpreted as input by PinchWatch, e.g. to adjust the volume of a music player. Another example is a design presented by Edge and Blackwell (2009). Their design consists of coin-shaped physical tokens, which are linked to digital tasks or calendar items. Office workers can manipulate these tokens on the side of their workspace, outside the visual focus, to track or update task progress in the periphery of attention. A further example is the LightCube (Offermans e a., 2014; see figure 1), an interactive device that can be used to control modern lighting systems. Such systems offer various possibilities such as adjusting color, saturation and brightness of light sources in the home environment, usually controlled through smart phone applications. The LightCube is a physical cube, which allows users to switch between six light settings through a single movement.

Multimodal interaction styles

In our everyday routines, we are continuously aware of all kinds of information from our environment. This information, such as the current weather or the status of the dishwasher, is often perceived through auditory, rather than visual perception. Peripheral interfaces often combine different modalities to support interaction as part of our everyday routines.

An example of such a peripheral interface is FireFlies (Bakker e a., 2013; see figure 2), a design for primary school classrooms. FireFlies consists of a small lamp on the desk of each child and an interactive device with which the teacher can set the colors of these lamps. Teachers can use it to send short messages to the children. For example 'you can quietly discuss' or 'you can work on the computer'. A background sounds cape of nature sounds also reveals the colors that are currently being used. This way, overall awareness of what is going on in the classroom is obtained through listening. A glance around the classroom gives more details on the activities of each individual child. Another example is ShoeSoleSense (Matthies e.a., 2013), an interactive shoe sole that can sense movements of the user's toes. These 'toe gestures' can be used to interact with a smart phone, e.g. to control the music player. Additionally, the sole uses vibration and heat feedback to subtly present information to the user. Though implemented as an experimental interaction design, it turned out that interactions with such a shoe sole could easily be performed during other activities as part of an everyday routine.

Conclusion

In our everyday life routines, interactions with the physical environment frequently shift between our center and periphery of attention. In contrast, most of our interactions with computing devices usually require focused attention. Since the number of computers in our everyday environment is rapidly increasing, it seems undesirable and unfeasible to focus on each of these devices at once. The upcoming field of peripheral interaction studies how people can perceive information from and physically interact with computing technology in their periphery of attention. We have for example seen that such peripheral interface often avoid screens, but use physical artifacts or audio embedded in the surroundings. With computers becoming omnipresent in everyday life, attention is becoming an increasingly scarce resource. However, drawing inspiration from the way we manage our attention in everyday life, can support computing technologies in becoming a seamless and meaningful part of people's everyday routines.

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