The Digital Hourglass

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ABSTRACT
This paper presents the Digital Hourglass, an alarm clock that focuses on the amount of sleep, rather than wake-up times. It follows a simple approach, lighting one LED for each hour of sleep, and physically resembles the interaction with a conventional hourglass: Tilting the hourglass moves 'time' between its chambers, placing it in an upright position activates it, turning it by 180° snoozes it and placing it horizontally on a surface turns it off..

Keywords
Alarm clock, digitalization, hourglass, LED, physical interaction design, sleep, time

INTRODUCTION
According to existing research, an amount of eight hours of sleep can be considered as healthy [10]: While this may differ individually, less sleep may generally result in decreased attention and concentration [4]. Due to recent changes in the lifestyle of (mostly young) people engaged in freelance design or consulting jobs, wake-up times are no longer determined by a fixed schedule, but rather by the time people go to sleep. For example, freelancers may prefer to work late at night, until they have reached a certain point of satisfaction with their work, and sleep later afterwards.

Conventional alarm clocks do, however, base upon a 'wake-up time', and not on the number of hours passed after going to bed. This project is concerned with the creation of an alarm clock that focuses on exactly this: Sleep duration, rather than wake-up-time.

Background
The market of alarm clocks is broad, and recent developments include, besides classical radios or beeping clocks, systems that measure the depth of sleep (in order to wake up the user in a less deep period of sleep, within a timeframe of waking up) [6, 7] and gradual light- or scent-based systems [9, 5]. Other systems require their users to perform physical actions to either snooze [2], turn off awake [3] or simply find [8] them in the morning.

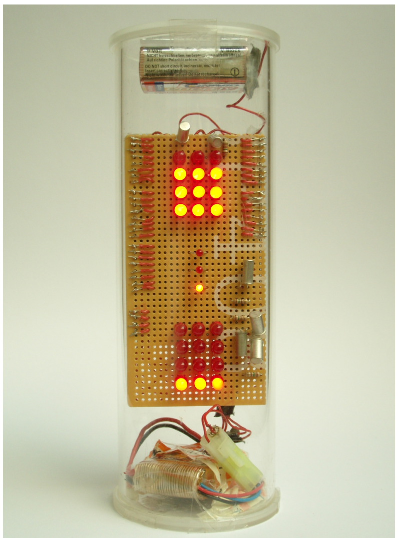

Figure 1: Digital Hourglass prototype.

Patients with sleep disorders or partial insomnia are often advised not to look at the time at night, in order to prevent them from getting stressed. Even though we propose a display-based system, it does not require users to calculate their remaining sleep time because it is glance-able at night.

An hourglass appeared to be suitable as the blueprint for the desired clock, both for the visualization and the style of interaction, as it features no control elements and indicates duration rather than current time.

PROTOTYPE
We implemented a first prototype, consisting of a WIRING [1] microcontroller board, 24+3 LEDs (Figure 1), six tilt sensors, and two battery packs. In our prototype, one LED in the clock's 'chambers' represents one hour of time. The three LEDs in between visualize the *flow* of time. The prototype presented does not allow acoustic waking in its current state. For easier demonstration, it employs a dedicated mode, in which time is accelerated. It allows for the following interactions:

Setting the desired duration of sleep

The desired sleep time is set by holding the hourglass in both hands and tilting it from one side to the other. We recognize holding the device in hands and tilting it as a signalization of manipulation, and so the time can be shifted for easy adjustment (1hr = 2s of tilting). This manipulation is sensed through six tilt sensors, mounted on the circuit board in different angles.

Initiating the time flowing

Once placed vertically on a surface, time starts flowing. Now, the three small LEDs between the chambers blink in one third of a second interval, imitating the grains of sand used in old hourglasses.

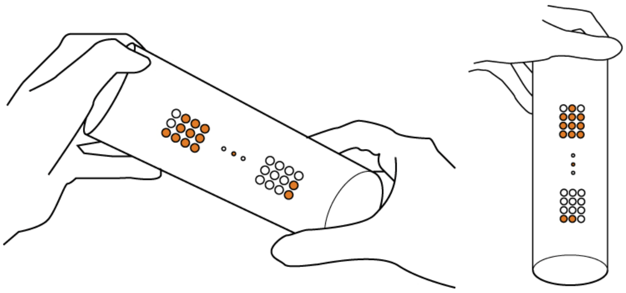

Figure 2: Setting the amount of sleep by tilting the hourglass (left), initiating time flow (right).

Wake-up Alarm

After all time has flown from the upper to the lower chamber, the alarm is activated. All 24 LED's will blink at the same time.

Snooze

The alarm, once activated, can be postponed by 5 minutes ('snooze') by turning the Digital Hourglass upside down. This may be repeated as often as desired.

Turning Off

The Digital Hourglass can be turned off by laying it flatly on a surface: The off-center location of the battery packs and the cylindrical shape of the case cause it to roll on its display side, this will deactivate the Digital Hourglass.

USER RESPONSES

While we did not conduct a formal user study, we were able to collect insights and responses from users in various presentations of the Digital Hourglass. It seems that the metaphor of the classic timepiece is intuitively understandable for users of all ages and demographic backgrounds. What was not intuitive to many of them, however, was the fact that time traveled faster through the chambers when the device was held in hands – some users suggested using buttons or twisting the clock, or a base station with controls. When asked 'How would you expect it to be turned off?' most users had the correct answer at hand: Stopping the time flowing through horizontal positioning was understood and appreciated by almost all users. After using it for a while, users enjoyed playing with 'gravity' in our system: Shifting time from one chamber to the other, setting it upright on the table, and turning it around. The interaction was considered bodily rich and satisfying.

Many users appreciated the ambient display, which would allow them to read the remaining sleep time at a glance during the night in a partially awake state.

CONCLUSION

We believe that two valuable findings lie in the Digital Hourglass: Firstly, basing the usage principles of modern technology on the interaction principles of old technology is fruitful ground for the simplification of complex devices. Secondly, we believe that the inclusion of gravity as the most central element proved to be helpful for users to understand the underlying logic instantly.

OUTLOOK

Investigating whether and how the quality of a user's sleep could be enhanced through different displays (or total occlusion) of the time remaining to sleep, or other forms of sleep/wake management, is probably worthwhile. We can not yet conclude how the hourglass would affect a user's sleep behavior in a real-life situation. Here, a long-term study is needed, which puts the presented work in comparison with others of its kind. As for the device itself, including a way of tactile or weight-based feedback into the device might provide benefits in terms of clarity: It could, for instance, give the user a feeling of how much time is in each chamber while setting it, or how fast time is flowing, depending on the device's tilt level. Basing the style of interaction with modern technology on that of the past is a topic we encourage further research in.

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