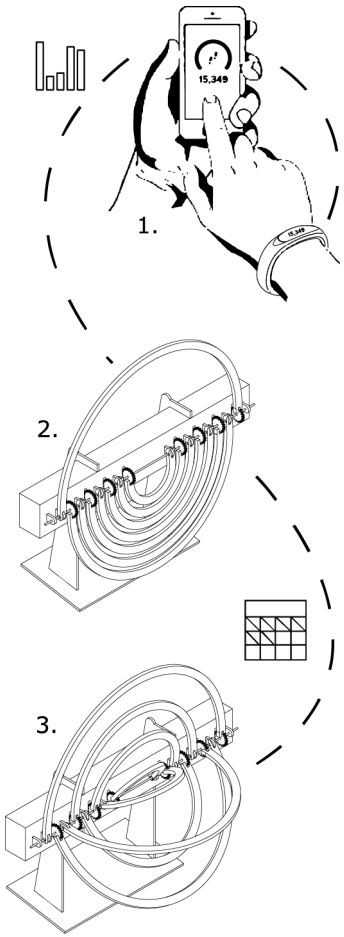

Figure 1: The traditional activity tracking system (1) providing step data to *LOOP* (2) and over time showing the steps made on each day of the week (3).

LOOP: A Physical Artifact to Facilitate Seamless Interaction with Personal Data in Everyday Life

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Abstract
We investigated how a physical artifact could support seamless interaction with personal activity data in everyday life. We introduce *LOOP* (Figure 1), a physical artifact that changes its shape according to the activity data of the owner, providing an abstract visualization. This paper reports on the design process of *LOOP* that was informed by interviews and co-creation sessions with end users. We conclude with future work on the evaluation of the concept. This paper makes two main contributions. Firstly, *LOOP* is proposed as an example of an alternative approach to physically represent activity data. Secondly, the design process and rationale behind *LOOP* are presented as design knowledge.

Author Keywords
Physical Visualization; Ambient Information Systems; Shape-Changing Interfaces; Self-Tracking

ACM Classification Keywords
H.5.2. Information Interfaces. User Interfaces – Interaction Styles, Prototyping, User-Centered Design

Introduction and related work
Activity tracking, which uses interactive wearables in conjunction with mobile or web applications to track

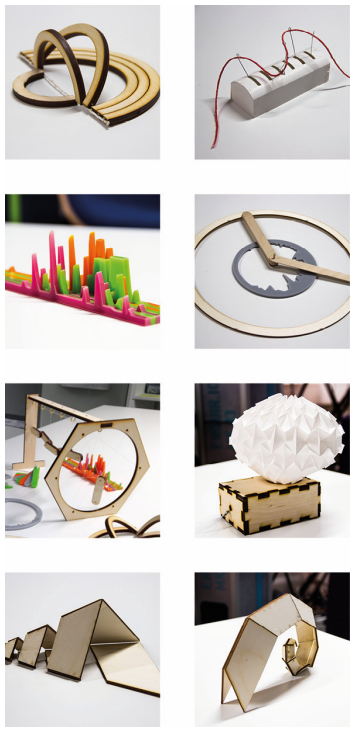

Figure 2: The collection of prototypes for the co-creation sessions.

heart rate, steps taken, etc., has become increasingly popular. The data gathered by most activity trackers is typically visualized using default data representations, namely, numbers and graphs. This data is useful as it can help people become more conscious of their activity and potentially help them change their behavior. However, counting steps and showing targets reached is only one way of revealing what activities people have done. Might there be other ways of representing data that can help people understand the data more? Previous work has suggested that people may become more aware of their data, and thus more likely to change their behavior, when it is incorporated in their physical environment and everyday routines [1].

To provide new ways of visualizing personal activity data to people, several data *physicalizations*, physical artifacts whose geometry or material properties encode data [4], have been proposed. Although data physicalizations cannot provide the same level of detail and precision as existing visualization techniques do, they can be placed in the everyday environment and thereby make the data readily available in a more seamless way. Such artifacts can provide a basic understanding of the data, potentially in the periphery of attention, but can also entice the user to further explore the data using the traditional visualizations in the mobile application.

SweatAtoms [5] and Activity Sculptures [9] are examples of physicalizations of activity data. However, both focus on static representations, which may not necessarily exploit the potential of physicalizations [4]. To compare, dynamic objects such as shape changing interfaces [7], can display real-time data, which static objects cannot. Alternatively, ambient information systems [6], such as Breakaway [3], can present information, which is often important, but not essential for the user's personal life, in the periphery of attention.

Inspired by these concepts, we propose a new approach to visualizing personal data. In particular, we introduce *LOOP* (Figure 1), a shape-changing physical artifact designed to make personal activity data available as ambient information in the home environment. This paper describes our design process, the final design and implementation of *LOOP*, and future work on the evaluation of the system.

Design process

We conducted 11 interviews with end-users of activity tracking devices to obtain a better understanding of the current use of activity data and how it could be improved in the future. Additionally, two co-creation sessions were organized to introduce 6 end-users to the concept of physical datavisualizations (Figure 3). During these sessions we used a collection of 8 prototypes (Figure 2) as generative tools [8] to trigger the participants to answer the questions: *What information would it show you? Where would it be in your house? When would you use it?* Every 5 minutes the participants were asked to discuss their ideas, repeating this process twice. The prototypes were inspired by the design possibilities in shape-changing interfaces [7], varying in type of shape change, transformation and interaction. The findings from the interviews and co-creation sessions are presented below in terms of the following topics:

Figure 3: An impression of the co-creation session.

Comparison
The participants indicated how comparison and correlation are important values when looking at their data. As current data solely is not very useful, historical data was used to create a meaningful comparison. Additionally, the ability to compare with values remembered by heart, such as the step goal, assist the user to make not only relative, but also absolute estimates.

Personal
Most participants stated that the act of activity tracking was mainly for themselves. They indicated that comparing data with others would not be constructive or fair as everyone has a different lifestyle.

Abstraction
It was suggested that the metaphor used to represent the data should be abstract and serve two purposes. Firstly, it should enable the owner to shift from the focus of attention to the periphery, allowing them to monitor themselves without digging into their data. Secondly, while the data should be informative for the owner, it should provide privacy when observed by others. Suggested associations for the visualization were natural forms and behaviors that make the data less quantifiable. With the use of movement, different layers of information could be provided.

We concluded that *LOOP* should be an abstract physical representation of data, providing information for the owner, while being pleasant to observe for others. The shape changing visualization should both serve informative and aesthetic properties to blend in with the home environment. Due to a layered visualization, providing both absolute and relative values, the owner can perceive detailed information in the center of attention, but also an overall idea of their activity in their periphery.

LOOP

LOOP (Figure 4) is a physical artifact that visualizes the step data collected from an activity tracker. The visualization of *LOOP* consists of 8 wooden rings. The inner 7 rings (dark brown) represent the weekdays from Monday (smallest) to Sunday (largest). The outer ring (light brown) represents the step goal set by the user. *LOOP* starts with all rings positioned downwards (representing a value of 0) except for the goal ring, pointing upwards (representing 100 percent). When users are active, the ring of that day will turn upward and position itself relative to the step goal ring. In case the step goal is reached *LOOP* will rescale according to the highest number of steps taken that week. The rings are updated every hour, so only once per hour the rings will move. After one week *LOOP* will reset itself and return to its initial position.

LOOP is strongly inspired by one of the prototypes used in the co-creation sessions. It consisted of several rings (top left of Figure 2), which the participants perceived as abstract, but also provided association as the repositioning of the rings reminded of growth. We chose a relative mapping to the range of actual steps taken by its user. Example data showed that an absolute mapping would result in too small or too large changes, which either would not create aesthetically appealing visuals, or would not be possible to visualize. As the visualization becomes scalable it was important to introduce the step goal ring, as this allows the user to obtain an indication of absolute values from the visualization.

Figure 4: The final design of *LOOP*.

Implementation

To demonstrate the functioning of *LOOP* and to enable a user evaluation, we developed a working prototype. It can reach a maximum size of approximately 30x30x30cm due to the movement of the rings in space. The entire model is laser cut and contains a Wi-Fi-enabled microcontroller that powers 8 servo motors. The connection to personal activity data is established via the Fitbit developer website [2]. Therefore, *LOOP* is currently only compatible with Fitbit activity trackers. With minor changes *LOOP* could visualize any time-based data.

Conclusion and future work

In this paper we have shown how activity tracking data can be represented in an alternative way using a physical artifact. We introduced *LOOP*, as one such instantiation; that changes its shape according to the activity data of the owner, providing an abstract visualization. We believe that a physical artifact will facilitate reflection on personal performance and will be more accessible than data on a screen. We plan on conducting a field study in which *LOOP* will be placed in the participants' homes. The aim is to evaluate the use of *LOOP* in context and to investigate (1) how it could help the individuals interpret their data, (2) facilitate seamless interaction and (3) fit in their lifestyle.

Video link: https://vimeo.com/207790307

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