From Prototype to Product: Scaling the Adoption of Data Physicalizations with LOOP

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Abstract*—This proposal centers around LOOP, a pre-existing electronic prototype designed to motivate physical activity through a physical sculpture representing personal data in an abstract manner, diverging from traditional numeric and graphical displays. LOOP has been deployed in five homes for up to a week, revealing its potential to serve as a versatile platform for visualizing various types of time-based data. This project aims to explore LOOP as a case study to overcome the barriers of entry when designing physicalizations. The primary goal of participating in this workshop is to gain insights into transitioning from research prototypes to scalable research products, addressing the challenge of broader adoption and long-term deployment of interactive systems such as physicalizations.

I. Introduction & Background

As data becomes increasingly available and engrained in our daily lives, modern technologies such as wearables, IoT devices, sensor systems, and crowd-sourced tools are revolutionizing the way data can be accessed and used by larger audiences than ever before.

Physicalizations [4] – physical depictions of data – emerge as a promising method to embed data meaningfully into everyday experiences, making it accessible beyond traditional digital interfaces. These physical forms facilitate deeper engagement and understanding of information across various domains (e.g. personal informatics, environmental sciences, public health) and spaces (e.g. domestic settings, cultural venues, educational and urban environments).

Existing work illustrates the positive attributions of physicalizations, such as their impact on information retrieval [3], memorability [11], learning [5], and collaborative sensemaking [4]. Our prior in-the-wild studies [7][10] further highlight the pivotal role of physicalizations in making data more experiential, transforming abstract information into tangible and engaging experiences.

Despite these benefits, data physicalization is underutilized in research, commercial, and domestic settings, largely due to significant barriers to entry. Increasing accessibility to data physicalization devices (e.g., [1]) will enable larger-scale research to explore the long-term impact of physicalizations beyond academic settings. Unlike visualizations, physicalizations inherently require physical prototypes, which need design, engineering, fabrication, and software development skills to build.

Our proposed approach to addressing this limitation involves making existing research physicalizations commercially available, investigating and overcoming significant challenges in durability, scalability, and sustainability. Specifically, we propose using LOOP [10] as an exemplar device to conduct this project (Figure 1).

Fig. 1. Impression of the LOOP data sculpture.

II. Case Study: LOOP

LOOP [9][10] is an existing prototype designed to motivate physical activity through an abstract visual representation. LOOP (Figure 1) is a data sculpture that encodes physical activity in motion of rings of increasing size. When the owner is active, the ring representing the current weekday moves upwards and positions itself relative to the step goal ring. Over time, LOOP provides an overview of physical activity at a glance.

LOOP represents data in an informative yet aesthetically pleasing form, allowing it to blend into the home context. Its versatility as an abstract visualization platform makes it suitable for various time-based data visualizations. Additionally, it could support personalization through different attachments and user modifications. If successfully manufactured and scaled, LOOP can bridge the gap between research prototypes and practical applications. Our goals include:

1. Manufacturing process: Developing guidelines for creating durable and sustainable physicalizations beyond academic settings.

2. Scalability: Enabling larger-scale investigations through research products to explore the practical impact of physicalizations.
3. Sustainability: Ensuring sustainability in development, production, and use of interactive systems, focusing on longevity and adaptability.

A. Prototype details

The LOOP prototype[1] has a maximum size of approximately 30x30x30cm due to the spatial movement of the rings (Figure 2). The entire model is laser-cut, with the rings made from plywood, the electronics casing and stand from frosted white acrylic, and the precision parts such as gears from polyoxymethylene (POM) for stiffness and stability (Figure 3). To move each of the rings independently, the prototype contains a Wi-Fi-enabled microcontroller powering eight servo motors.

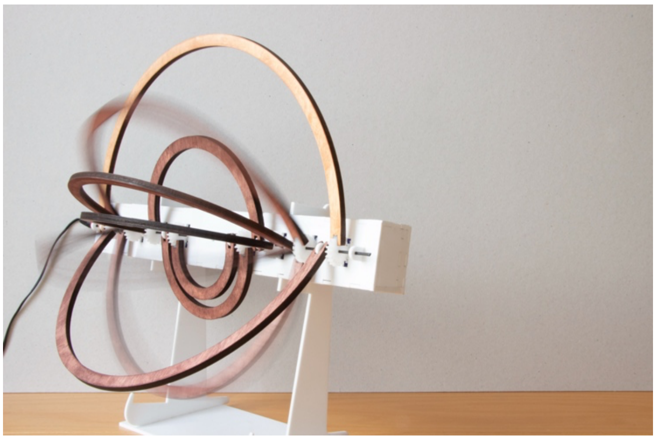

Fig. 2. Impression of the spatial movement of the rings.

Assembly and finishing are done manually (Figure 5). The plywood rings are stained with different colors for a finished look and to provide a subtle distinction between the weekday rings (dark brown) and the step goal ring (light brown). The final prototype consists of a mix of materials, with the white acrylic and wood exterior serving both aesthetic and practical purposes. Using solid acrylic allowed us to keep the electronic components, such as the motors, in place and protected (Figure 4). The rings are made of wood as it is a lighter material, making it easier for the motors to lift and rotate.

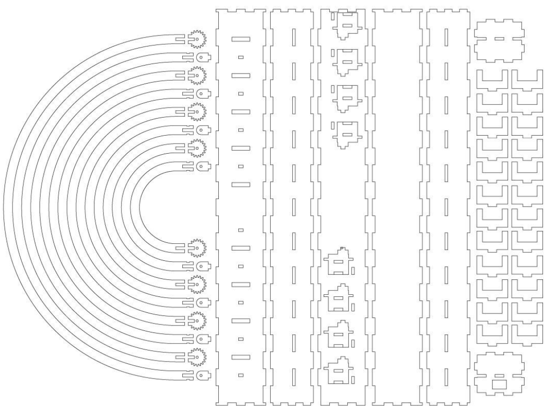

Fig. 3. Digital drawing of the 2D components.

1. https://vimeo.com/user17187099

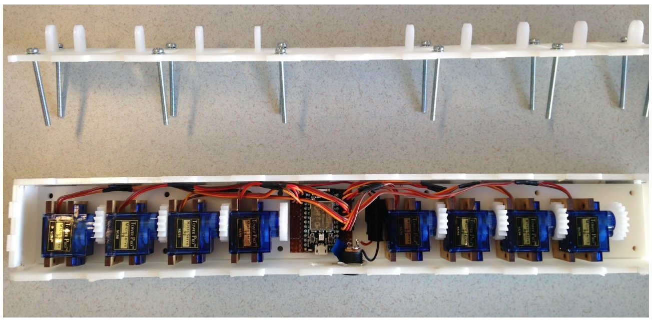

Fig. 4. Interior of the final prototype, showing the organization of electronics.

For the field study we conducted with the existing prototype [10], the personal activity data of the participants was connected to LOOP via the Fitbit developer website.

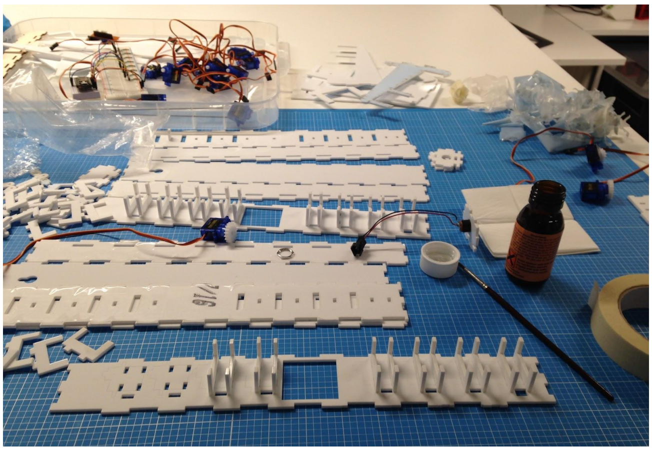

Fig. 5. Assembly of the final prototype.

B. Opportunities for expansion

Beyond refining the existing version of the LOOP prototype, we foresee other avenues to explore as part of the manufacturing process, including the following:

- Integration with existing software packages to send data to the artifact.
- Inclusion of direct interaction possibilities with the physical sculpture to manipulate data.
- Expansion of the prototype as a toolkit or tutorial for different levels of replication.
- Enabling multiple attachments/adaptations to support personalization of the visualization.

III. Responsible Innovation

Our approach to responsible innovation focusses on the following aspects:

1. Longevity and versatility: LOOP's design supports long-term use and adaptability for various data visualizations.
2. Social impact: LOOP adds value to society by providing a first step towards commercializing physicalizations, thus opening up further avenues for larger audiences to engage with data, specifically personal informatics.
3. Environmental sustainability: We are committed to sustainability in LOOP's design, materials, and production process.

We aim to design physicalizations that consider the sustainability of materials, longevity, and versatility of use.

LOOP's abstract physicalization can serve as a platform for many time-based visualizations, potentially allowing individuals to build these systems themselves, forming an initial footprint for larger adoption of commercial physicalizations.

IV. Author bio(s) / experiences

Kim Sauvé is a Research Associate in HCI at the University of Bath with over 7 years of experience in designing and developing physicalizations. She deploys design practice and creates interactive prototypes to understand people's interactions with data. Her research revolves around physicalizing data in interactive systems to offer accessible ways for individuals to interact with data for reflection, decision-making, or behavior change. Her work includes LOOP [10], Econundrum [7], and wider reflections on designing and building these systems (Chp 4.2 in [2]) [8]. Relevant projects can be found at www.kimsauve.nl.

James Nash is a PhD candidate in HCI at the University of Bath. His research focus on exploring the design, impacts, and implications of force-augmented devices. He utilizes a range of engineering techniques to create artifacts, combining this with mixed-methods research to understand how they impact interactions. His prior work includes DeformIO [6], a novel force-augmented display which leverages pneumatics and embedded sensing to create a soft variables stiffness display. He also has over 5 years of experience working as a design engineer on the design and manufacturing of hydraulic excavators.

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