Toward a Practice of User-Centred Design for Shape-Changing Interfaces

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Abstract

Shape-changing User Interfaces (UIs) are maturing in application and complexity, and therefore are becoming a tangible reality with regards to commercialization and design in a wider context. Current prototypes support a variety of bespoke interactions and are extensively tested, but applications for these constructs are often limited to the research scenario, and within the limitations of academic institutions. Engaging with a wider audience to develop novel UIs and applications is a valuable addition to the early design process, and can elicit new directions for research. Additionally, focusing on the user fulfils a requirement for developing a User-Centred Design methodology for shape-change, as it presents novel challenges for interaction design. This position paper calls for early adoption of such processes to support the emerging technology of shape-change, and for the formation of a collaborative UCD working group in this field.

Author Keywords

Shape-change; Interaction Design; User-Centred Design; User-Experience Design, Application Design.

ACM Classification Keywords

H.5.2. Information Interfaces and Presentation (e.g. HCI); User Interfaces;

**Shape-Change:
What is it good for?**

Public ideation study:
Sturdee et al. [6] conducted a brain-storming study in a busy city-centre location. 74 participants generated 330 ideas for shape-changing technology.

Idea categorisation: 11 top-level categories were generated (in % order): Entertainment, Augmented Living, Medical; Utensils & Tools; Research; Architecture; Infrastructure; Industry; Wearables; Education & Training & Null (Not Applicable to the study).

Novelty & existing research: Participants generated both novel ideas and duplicated ideas from existing research projects. One major finding suggests a direction for shape-changing interfaces that supercedes devices such as tablets or computers in favour of a seamless integration with the world we live in.

Introduction

Shape-changing User Interfaces (UIs) are actuated devices that support a range of tangible interactions, in addition to those you would normally expect to find on the planar surface of tablets and mobile phones. The potential for this technology is almost limitless, and has been shown to be desirable in both the research setting (as is evidenced by the wide range of prototypes currently in testing and development) and for a wider, more generalised audience [1, 2, 12].

This position paper focuses on the ideation process for designing shape-changing UIs –and, additionally– on the challenges of designing meaningful applications for interfaces that span not only multiple disciplines, but can be "any way, shape or form" [6]. Exploring the options for output in this context requires a complex set of skills which are borrowed not only from computing as a whole, but also psychology, neuroscience, interaction design, physiology, and engineering to name but a few. User-Centred Design (UCD) is already a highly detailed practice, but with shape-change as interaction there are added layers which require a new approach.

Here, we do not expect to achieve a fully formed practice within a short space of time, incorporating the multiple phases of UCD (e.g. User Experience) – but more simply to set the practice in motion through discussion, collaboration and relationship-building – not only between institutions, but outside of the walls of academia. Therefore, we propose three initial discussion points around the concept of User-Centred Design for shape-change for inclusion in the upcoming workshop: 1) As shape-change challenges the notion of "device" orientated interfaces, how can we identify how

and where to embed this technology within our environment? 2) How do we identify "need" and "desire" in the wider context when developing shape-changing research projects? and, 3) Can involving end-users to inform these processes improve or facilitate research and commercial outputs?

Related Work

The first steps toward a practice of UCD might be to present research to its intended audience during early stages of planning. Thus *ReForm* [14] would be pitched to product designers, *Physical Telepresence* [9] might be discussed with military families, and *Cloth Displays* [10] with fashion designers and consumers. Current research spans a huge range of outputs, each with an identifiable audience or end user, and some interfaces are already within the public sphere, e.g. *Aegis Hyposurface* [3], *Protrude, Flow* [7] or Rasmussen's *Ariel Tunes* [11] or Gronvall et al's *Shape-Changing Bench* [4]. MIT Tangible Media Lab also makes use of open-house sessions in which small groups are invited to view current research [2].

In addition to public user-testing and exhibition, there have also been several studies involving interaction design and HCI professionals in a workshop setting, where themes around shape-change such as emotionality and affect [8], or rapid-prototyping [5] are explored. This does not include a number of exploratory workshops in the field, held at conferences such as CHI, or those held between research groups which do not result in a directly published output.

Recently, we approached the notion of user-inclusion during early-stage research by taking a shape-changing prototype [5] into a public setting in order to engage

with future end-users (summarised in the sidebar on the previous page) [12]. Further research used the same base unit to produce a *ShapeCanvas* [1] with which members of the public were invited to program visual and actuated output on.

The current state-of-play for user engagement is that multiple research groups appear to be working steadily toward inclusivity in the research and design process, but this action is happening in silos, often on different continents. In order to facilitate the proposed development of UCD for shape-change, there must be a collaborative environment and communication between research groups. This is no easy task, due to confidentiality for those in the commercial setting, or working on novel hardware. In this respect the communication must happen at a later stage when the hardware is formed, but the application of the technology itself at the planning stage.

We would therefore propose the formation of a novel UCD working group composed of researchers from institutions and projects representing a range of shape-changing UIs. By creating such a group, we could complement and enhance existing and future research in this field.

Discussion

An international working group on UCD for shape-changing interfaces is an ambitious proposal, but to discuss such a notion with leading researchers in the field is the first step toward actualizing the idea. By learning about the design process in different institutions we can gain insight into the feasibility of user inclusion during the early stages of research, and develop the idea as an on-going dialogue if it proves to

Figure 1: Taking your research to town – running experiments and fostering engagement with a publicly-sourced participant base can give novel insights into how shape-changing technologies might be used in everyday life.

be of interest. The essential argument within this paper is that a practice of User-Centred Design would be beneficial for the field of shape-change, but that insights from peers within the field are necessary to facilitate its birth.

Our on-going work in this area has involved a framework of classification for shape-changing prototypes, and an investigation into the action of temporality upon these UIs and how this affects the formation of a process of interaction design in the field. Findings thus far present a glimpse into the challenges faced by researchers and designers when coping with additional dimensions of interactivity and user engagement, and further work is planned to focus on the psychology of such tangible, actuated devices to augment the background theory in this area. We hope that by sharing our initial findings around UCD in shape-change, we will gain insight into our own work, and inspire new collaborations and directions of research in the work of others. In addition, we continue to be engaged in creating a resource for those interested in shape-changing interfaces at www.shape-change.org which aims to contain comprehensive list of all current prototypes and products which fulfil the given criteria.

During the workshop on sharing perspectives, we would also like to hear about the design and implementation processes used by researchers when building and testing their prototypes, and gauge whether the proposed approach building on existing UCD principles would benefit the field. Additionally, we would like to share our own experiences working with atypical participants within the public setting, and how this can be applied to the further development of *ShapeClip* [5]

and *Emerge* [13] which are part of *GHOST* group (*Generic, Highly-Organic Shape-Changing Interfaces*). We also hope to bring a cross-disciplinary perspective to the workshop, with the proposed attendee having extensive experience in design and illustration, sketch-noting, user-testing and studies in a clinical environment, and perception theory. As well as creating a dialogue around user-centred design, we would like to provide an illustrated record of the workshop over

both days, visualising interactions and workshop outputs in a format that can be saved and given to participants, and/or published online on www.shapechangingui.org.

Finally we look forward to engaging with the participants and participating at the workshop at CHI 2016 in May.

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