Challenges in Designing Content for Non-Rectangular Displays

Marcos Serrano

University of Toulouse - IRIT

Toulouse, France

Marcos.Serrano@irit.fr

Anne Roudaut

Bristol University

Bristol, UK

Anne.Roudaut@bristol.uk

Pourang Irani

University of Manitoba
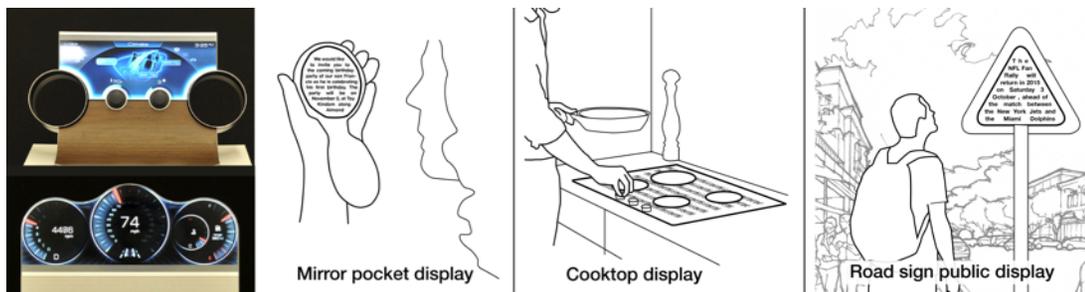
Winnipeg, Canada

Pourang.Irani@cs.umanitoba.ca

Figure 1. Left: Examples of freeform displays developed by Sharp. Right: Freeform display usage scenarios: circular mirrors for private notifications, shapes with holes such as a cooktop displays for recipes or the back of triangular road signs as public displays

Abstract

Emerging technologies allow for the creation of non-rectangular displays with unlimited constraints in shape. However, the introduction of such displays radically deviates from the prevailing tradition of placing content on rectangular screens and raises fundamental design questions. In this position paper we present a cursory overview of results obtained from four legibility experiments on non-rectangular displays and introduce some of the big challenges to address.

Author Keywords

Freeform display; non-rectangular display; visual design guidelines; text legibility.

ACM Classification Keywords

H5.2 [Information interfaces and presentation]: User Interfaces - Screen design.

Introduction

Recent breakthroughs in display technologies enable the design of displays with varying shapes (Figure 1). However, such novel form factors challenge many of the fundamental principles and guidelines that have been accumulated over the past decades for presenting and interacting with content. To support the practical adoption of such form factors, we need to rethink our understanding of how we display and interact with associated content.

Figure 2. Symmetric display shapes favor text legibility.

Figure 3. If the shape contains a hole, text should be displayed using a broken layout.

Figure 4. Tangential text on sharp displays is perceived as harder to read than continuous text.

In this position paper we report on first results in our exploration of text legibility on freeform displays [2]. Our work is built on information obtained from participants in focus groups to collect usage scenarios of free-form displays (Figure 1). From these, we computed several *display shape properties* using an algorithm inspired from [1] and used them to build a framework that identifies different *mappings* of text onto a non-rectangular shape. We finally conducted a series of quantitative text legibility studies to investigate hypotheses concerning legibility for different *display shape properties.*

In this position paper we extend this previous work by proposing challenges that need to be addressed to usher the adoption of such technologies

Text legibility on freeform displays

We investigated different mappings of text content onto free-form shapes [2] based on a new framework. Our framework describes three axes with increasing levels of abstraction (examples in Figure 5):

• Layout: this axis describes the general text layout, which can be continuous or by block. For example, the CHI Proceedings layout is in blocks (formatted on two columns). We could have also considered the case where the layout is not continuous (e.g. random), but this would clearly disturb text readability.

• Token size: this axis describes the size of the tokens, which can be constant or variable. E.g. the fisheye menu illustrates the case variable. It is important to note that many deformations are possible.

• Line alignment: this axis describes the line alignments in which the text fits. It could be linear, i.e. horizontal, or oriented parallel lines, or what we call tangential, i.e. following the shape. More precisely, text could follow a

vector field around the shape boundary. This is typically the case in calligrams.
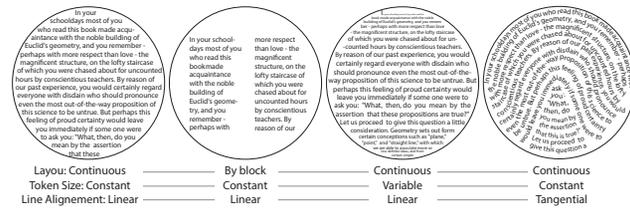

Figure 5. Example of text *mappings*.

From our studies we provide a set of design guidelines for optimizing text legibility on non-rectangular displays:

• Both left and right irregular alignments should be avoided, as text in these are perceived to be difficult to read. Instead, symmetric shapes are preferred (Figure 2).

• Shapes with circular or sharp alignments are acceptable for presenting text: they are perceived to be easy to read (Figure 2).

• If the shape contains a hole, text should be displayed using a broken layout with two columns around the hole to prevent any impact on reading performance (Figure 3).

• Text on very sharp shapes should be avoided, as text on these is harder to read than on linear shapes. If used, such shapes should be filled with continuous text rather than tangential that impacts reading performance (Figure 4).

Scrolling text on freeform displays

We also investigated two different techniques for scrolling text on freeform displays: dynamic scrolling or page scrolling (Figure 6).

Figure 6. Dynamic scrolling with text of constant size (left) or variable size (right).

Our main finding is that to use dynamic scrolling on non-rectangular shapes, text should be resized so that each line contains the same amount of text. Otherwise, we should use page scroll with constant text size. Resizing text for dynamically scrolling is perceived as beautiful and clean, but resizing text with page scrolling raises mixed results. Some users disliked it because of display space loss and of varying interline spacing. Resizing text should thus be limited to dynamic scrolling.

Challenges in designing content for non-rectangular displays

Our work represents a first step in identifying text legibility concerns on non-rectangular displays. However there are many challenges yet to explore to help the design of content on non-rectangular displays. We discuss briefly these here.

Content type

A general challenge is to explore the possible mapping of UI content into a shape. We can reduce this problem into a simple question: *what are the possible dispositions of a set of n tokens {t0,…tn} into a shape S?* To answer this question we need two types of information: the *token semantic*, i.e. the relationship between tokens and *the mapping of tokens* onto shape.

We started identifying preliminary token *semantic* as:

• Free: there is no intrinsic relation between the tokens and they can be placed randomly. E.g. tokens = icons of apps to place on a screen, their position does not matter.

• Sequential: the tokens have a sequential order but they can be broken into lines and columns. E.g. tokens = characters.

• Fixed in one dimension: the tokens have a sequential order but they cannot be broken into lines and columns, they are constrained to 1 dimension. E.g. a color strip in which it is important that each token is located next to its two neighbours.

• Fixed in several dimensions (2D or 3D): the tokens have a logical order in a 2D or 3D reference system. This is the typical case where tokens are pixels in an image. This could also correspond to tokens being graphical elements in a UI such as a map or a tree. Another typical case is a keyboard (tokens = keys).

As for the *mapping of tokens*, we already explored some mappings in our framework [2] for the case of text content but other mappings can be considered when sequentiality of tokens, and orientation (reading an upside down text is difficult) are not a requirement anymore. For example it would be possible to consider a radial mapping when the token are icons.

Aside from tokens another more complex form of content are images. These raise numerous questions. For example, should images be cropped based on the underlying display shape or should images use variable shapes to fit the contained display? Furthermore, aside from the shape of images, should their position vary based on the display shape, so that they always appear as taking the most available space for any given image.

These questions could be verified using empirical support.

Interacting with non rectangular objects

Although we mainly focused on output, the emergence of non-rectangular display also raised many challenge in term of interaction. It is yet unclear how we should interact (point, flick, perform gesture, type) with something that is not rectangular anymore. In fact some shapes might have some benefit for interaction. For instance, long and narrow objects could perhaps enable other flicking mechanisms, such as using the edges of the shape to displace content. Similarly, interacting with the display workspace via operations such as zooming or reaching for off-screen content needs consideration.

Such questions merit further investigation and could impact the manner in which traditional graphical artefacts get re-engineered for non-rectangular displays.

Conclusion

This position paper presents an overview of several guidelines for presenting text on non-rectilinear displays. It also presents key challenges that require further empirical support. These include how to design tokens and images, how to interact with content and with non-rectilinear displays workspaces. Addressing such questions will present opportunities for advancing novel designs for non-rectilinear displays.

References

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