Tilting\Plate and *Bending\Arches*: Shape-Changing Interfaces as Expressive Forms

Morten Winther
IT University of Copenhagen
Copenhagen, Denmark
mwla@itu.dk

ABSTRACT
How can designers gain a better sensibility for designing more sensory engaging and aesthetically pleasing objects as well as for the expressive richness and potentials of shape-change? The two exploratory prototypes, *Tilting\Plate* and *Bending\Arches,* investigate the visceral, aesthetic dimensions of shape-changing interfaces. While shape-change is currently receiving a lot of attention in Human–Computer Interaction (HCI) and interaction design, less attention has been given to the expressive qualities of such interfaces. The prototypes presented here focus on the immediate, aesthetic potentials of shape-change and illustrate the expressional diversity and richness of actuation. Aesthetic explorations can also help to identify radically new applicational uses of shape-change as a design modality.

Author Keywords
Shape-changing interfaces; Interaction design; Aesthetic interactions; Expressive forms

ACM Classification Keywords
B.4.2 Input/Output Devices; F.m MISCELLANEOUS

INTRODUCTION
Objects with the ability to change their physical shape are receiving increased attention due to their new potentials for design. However, current research in shape-changing interfaces is primarily dominated by functionality and technological advancements [cf. 3]. But instead of exploring shape-change as yet another technology for efficiency and utility, this work seeks to propose an alternative path, which entails a sensibility for the aesthetic potentials of actuation. Thus, the two prototypes presented here approaches shape-changes as *expressive forms* to draw attention to the *immediate and sensory qualities* of shape-changing interfaces, which is still a rather under-explored domain [3,4]. In this sense, the prototypes are the beginning of an aesthetic inquiry into better understanding the visceral, expressional dimensions of actuation as a design modality:

5th Decennial Aarhus Conference on Critical Alternatives
August 17 – 21, 2015, Aarhus Denmark

DOI: http://dx.doi.org/10.7146/aahcc.v1i1.21322

"*Forms, either abstract or concrete always carry meanings. It is the responsibility of the designer to make good use of these meanings, for example to make products beautiful, exploiting all the sensorial aesthetic languages, to stress the importance of certain values, or to improve a product's ease of use to create and facilitate richer experiences*" [1].

The purpose of the prototypes is to bring attention to a need for design literacy about the expressive means that designers have available to attend to the visceral meanings within shape-changing objects and to argue for attention to the radically new possibilities they hold.

DESCRIPTIONS OF THE PROTOTYPES
What is the expressional diversity that can be created with steel as the main material and two motors as actuators? This is the specific question that the prototypes seek to answer. The scope of the two prototypes is to explore the diversity of contrasting expressions that can be made based on the basic design principles of steel as the main material and two motors as each of the prototypes' actuating technology.

Figure 1. Tilting\Plate has a rigid surface plate that can move around two axes of symmetry

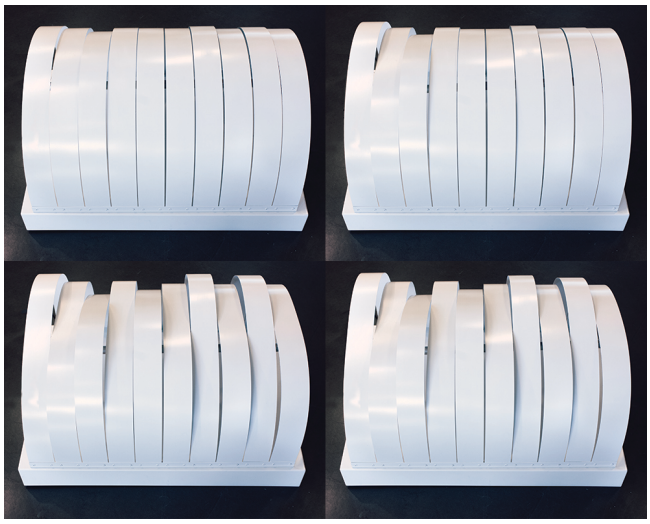

Figure 2. Bending\Arches consists of ten flexible steel arches

Prototype 1: Tilting\Plate

Tilting\Plate is a 60x60x30 cm steel box. Its top plate is connected to a frame with two bolts. This frame is, in turn, connected to the steel box, also with two bolts (figure 1). This makes it possible for the top plate to rotate around one axis of symmetry, and for the frame to rotate independently around a second axis perpendicular to the first axis. Two servomotors are used to tilt the angular positions of the inner plate and the frame respectively. The motors are controlled with an Arduino board. As input, a Kinect is used to monitor the space immediately above *Tilting\Plate*. Within this space, users can interact with the prototype through abstract gestures.

Prototype 2: Bending\Arches

Bending\Arches consists of ten pieces of flexible steel, which are fastened onto a 67x50x7 cm steel base (figure 2). *Bending\Arches* reacts to sound; the louder the sounds, the more the arches bend. A quieter soundscape results in relaxation of the arches.

Each of the arches is connected to an inside crossbar. The two ends of the crossbar are then attached to two linear actuators inside the steel base. These two actuators are driven by stepper motors and are used to pull down each end of the crossbar. This way it is possible to control the slope of the crossbar, which results in the shape-changes in the prototype. As such, the individual arches cannot be independently controlled, but follows the slope of the crossbar.

SHAPE-CHANGING INTERFACES AS EXPRESSIVE FORMS

While both prototypes have been made from steel and two motors, their expressions are quite diverse. The planar shapes in *Tilting\Plate* give it a more uniform and rigid expression, whereas *Bending\Arches* has a flexible and softer aesthetic. The qualities of the dynamics in *Tilting\Plate* are its fluid movements, where the plate almost seems to be floating, because the inner plate and the frame are able to move independently. *Bending\Arches,* on the other hand, is characteristic in the way it goes from a uniform surface in its relaxed state to a complex, uneven surface when the arches are bent. As such, the dynamic qualities of *Tilting\Plate* stem from its continuous movements, whereas in *Bending/Arches* they stem from the transformations between its expressional diverse states.

With their leitmotif "*function resides in the expression of things"*, Hallnäs and Redström [2] have advocated for not only defining an object's form based on its functionality, but to use form explorations to help discover new applications. In this sense, an aesthetic approach to shape-changing interfaces will not merely improve design literacy about their visceral expressions, but can also pave the way for radically new uses of actuation. Perhaps *Tilting\Plate* could be appropriate for visualizing balance or indicating states of equilibrium. The dynamic permeability of the surface in *Bending\Arches* could, for instance, be used for controlling the inflow of light. As such, different expressive forms allow for different potential uses, which can allow for new and more aesthetically pleasing types of objects.

As illustrated here, the two prototypes exemplify the expressional richness of shape-changing interfaces through rather contrasting expressions made from the same basic principles. The purpose of the prototypes is to draw attention to this richness and the aesthetic potentials of actuation as a design modality. However, it is not a matter of *if* shape-changing interfaces should encompass aesthetic dimensions, but rather *how qualified* we deal with the expressions of such objects. As designers, we must be aware of the expressive means we can use when designing with actuation to create sensory stimulating and engaging experiences. Furthermore, we must use appropriate shape-changing modalities to support desired functionalities and uses. Aesthetic explorations of shape-change seek to improve design literacy to help designers make better design decisions for shape-changing interfaces.

REFERENCES

[1] Feijs, L. and Kyffin, S. A taxonomy of semantic design knowledge. *Proceedings of DeSForM 2006*, Koninklijke Philips Electronics N.V (2006), 70–83.

[2] Hallnäs, L. and Redström, J. Abstract information appliances. *DIS '02 Proceedings of the 4th conference on Designing interactive systems: processes, practices, methods, and techniques*, ACM Press (2002), 105–116.

[3] Rasmussen, M.K., Pedersen, E.W., Petersen, M.G., and Hornbæk, K. Shape-changing interfaces: a review of the design space and open research questions. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, ACM Press (2012), 735–744.

[4] Zigelbaum, J. and Labrune, J.-B. Some Challenges of Designing Shape Changing Interfaces. *Proceedings of CHI 2009*, (2009).