
Provoking Performing Objects – Expanding the Design Space for Soft Robotics

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Abstract

Soft robots are typically developed with specific functions in mind. What we propose here is to shift focus to their aesthetic and performative qualities as means to open up a larger space of potential expressions and tacit abilities of these animated artefacts. Basically, to focus on the aesthetic potential of the objects through form, material, and movement exploration. As a strategy, we use provocations to broaden the design space with new interactive experiences in the physical realm. We argue that by using provoking performative objects as inspiration we can ultimately design a more connected and bodily engagement with computational devices.

Author Keywords

Soft Robotics; Design Research; Material Interaction; Temporal Form; Performing Objects; Provocation

ACM Classification Keywords

H.5.m. Information interfaces and presentation:
Miscellaneous

Introduction

Soft robots are traditionally described as using their ability to achieve a measurable goal, for example,

picking a range of awkwardly shaped objects up using the same soft grabber [4], squeezing themselves through tiny holes [3], and withstanding high impacts [1]. We believe the design space for these objects is much bigger and are curious of what else these objects could be doing.

At Cornell University researchers have come up with a 3D printed tentacle with 'incredible agility' [2]. This little tentacle is astonishingly phallic in some instances and incredibly cute in others demonstrating some of the challenges in designing within this realm. The point is, that these complex movements and forms are responsible for exciting expressive qualities perceived as humorous, appalling, or merely intriguing but those qualities are usually only accidental by-products of a research and development process. We propose a strategy that deliberately focuses on these expressive 'by-products'. Instead of leaving the provocative aspects to chance we find that embracing them and exploring their possibilities opens a much richer design space.

Soft Robotics with Temporal Dexterity

In developing a strategy to deliberately design for provoking expressions in soft robotics we rely on Vallgård's notion of form-giving [5]. This approach includes aesthetic explorations of material as well as temporal form [6] Where the material form draws on tactile as well as cultural references to engage an audience, the temporal form can be used for poetic as well as rhythmic expressions.

The strategy for exploring provoking expressions entails exploiting the extreme temporal dexterity afforded by soft robotic objects. We rely on a playful exploration of this relationship, working with pneumatic and hydraulic fluid actuation, shape memory alloys and other means of soft actuation. Focusing specifically on how material and temporal form can be combined to distort and deform soft objects. The resulting movement allows us to frame the prototypes as performing objects with unique physical attributes and body language – thus providing a provoking combination of other worldly appearance and emotive physicality. In this space lies the interactive potential. Not unlike a computer controllable version of the characterized goo in the film *Flubber* [7]. In combination, this encompasses what we believe to be the key approach to creating provoking expressions with soft robotics.

Material Prototypes Exploring Provocative Soft Robotics

In this section, we will show five examples of this strategy of provocation used to expand the design space for soft robotics.

In all of these examples we work with air actuation. Air actuation makes it easy to prototype the movement of soft robotic object. Once an airtight chamber has been created and sealed, we can test its material and temporal abilities using a hand pump, syringe or by just breathing into the object through a tube.

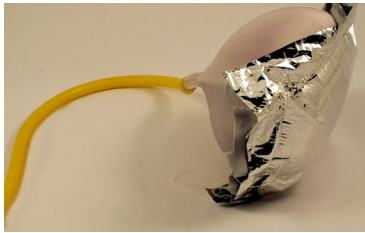


Figure 1: Playing with the Material and its Response to Movement

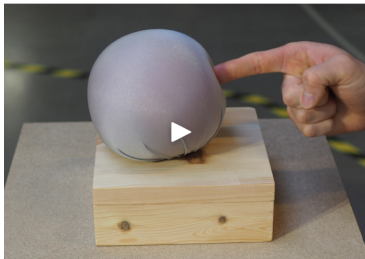


Figure 2: Excited Elastic (<https://vimeo.com/174354769>)

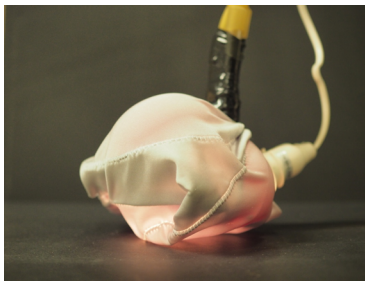


Figure 3: Multiple Lycra Chambers

Material Movement (See Figure 1) shows how a latex balloon (airtight chamber), Lycra and a foil sheet can be stitched together ready for animation. The Lycra bears references to clothing – underwear in particular – and as such it invokes an intimate reference. The foil sheet, on the other hand, is a material with references to space technology. Combining the two already creates a slightly provoking expression in that we are not sure exactly how to decode it first-hand. Furthermore, the red colour of the latex balloon appears through the Lycra as the blob is inflated. Simply inflating and deflating the blob gives the appearance of a ‘throbbing squid’, whilst the red and the Lycra enables associations to the intimate and life like where the sound of the foil gives the associations to something rather anxious.

Excited Elastic (See Figure 2) is an example of playing with the temporal form to gain a provoking expression and experience using manual methods to replicate the possibilities of soft robotic actuation. The Lycra and Latex Orb can pulse rapidly or slowly. The change of tempo can be changed and rhythm can be introduced alongside a sudden halt in movement or physical volume. In this case provoking the participant into a playful interaction with poking, squeezing, grabbing and holding.

Multiple Lycra Chambers (See Figure 3) In this example we explore the potential of multiple chambers where similar construction techniques with stitched Lycra form independent compartments. The result is an object that can physically move in different directions, and pulse and change in volume with different tempos simultaneously.

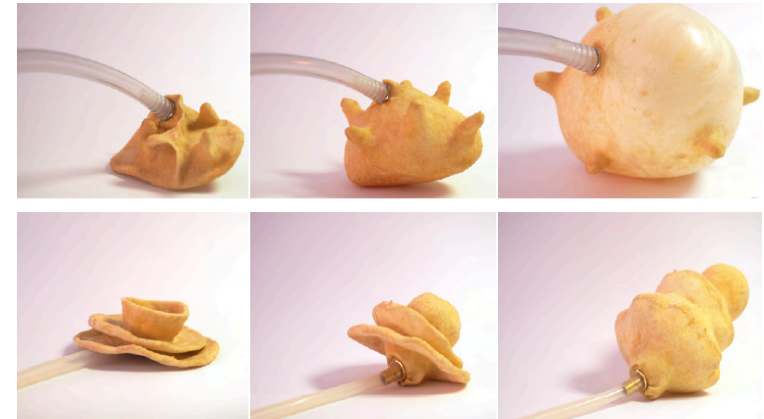


Figure 4: Vacuum and Inflation of Organic Latex Shapes

Organic Latex shapes (See Figure 4) is an example of where we use raw uncoloured latex formed on clay to make more intricate forms and details. The bodily colour and texture of raw latex combined with the ‘nipples’ features draw obvious provocative comparisons to body parts. The folds on the bottom series of pictures allows for an outward/ inward ‘breathing’ motion and intense and stiff wrinkles when subjected to vacuum. The inconsistencies in layered latex mean when inflated the form distorts in ways otherwise unexpected in a more uniform material, thus giving the sense of something more organic in nature.

Wrinkles with Double Chambers (See Figure 5 & 6) combines one airtight latex chamber within another and allows for the outer skin (under vacuum) to be sucked around an independently controlled and inflatable inner

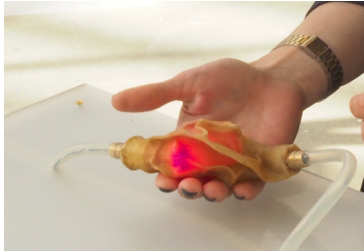


Figure 5: Stiff Wrinkles
(<https://vimeo.com/174354442>)



Figure 6: Soft Wrinkles

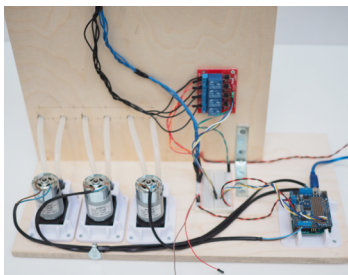


Figure 7: Arduino programmed Actuators

chamber. This enables us, for instance to turn on and off stiff wrinkles that surround a beating inner chamber. These wrinkles become more visible through the backlit effect and the warmth from the light made the surface even more skin like. The heartbeat and the warmth provoked an apparently instinctive interaction. The audience had a predilection for picking up and holding the object in two hands and asking if it was something they were doing that was making the object 'die' or 'panic' (See Figure 8). Technically, the heartbeat animation of the organic latex shape was driven entirely by a setup of simple solenoid valves and vacuum pumps programmed using an Arduino board (See Figure 1).

Discussion

Essentially, what we propose here is using material combinations, shapes, temporal forms, and other means of expression (heat and light) to create more or less provocative performing objects. We believe the use of provocations – in line with speculative and critical design practice – enables us to reflect on what soft robotics could look and feel like. Together these prototypes encompass the beginning of a research program seeking to expand the design space of soft robotics through simple performative objects.

Next steps entail further explorations along the path of the examples above with other materials, actuators, and object performances. However, we also want to explore the potential of making these objects responsive and intelligent as means for an audience/user to begin forming even stronger bonds. Creating responsive expressions also involves introducing sensors such as air-pressure sensors, light



Figure 8: Dying Object

sensors and movement sensors placed inside the objects. Using the combined expressional strength of temporal forms, material compositions and shapes as done above, we have shown how easy it is to design for the creepy and eerie as well as the familiar and calming all in one performing object. This complex relationship we can have with these objects, we believe, is worth using as a driver for future design research into soft robotics and performative objects.

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