

## THE BREATHING WALL (BRALL)— TRIGGERING LIFE (IN)ANIMATE SURFACES

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### Abstract

This paper investigates the tactile possibilities of human interaction with synthetic biomorphic surfaces through an interdisciplinary collaboration between arts, materials science, mechanical, and electronics engineering. We created a breathing wall (BRALL) composed of nine silicone-based tiles that feel like flesh, breathe, emit sound, and respond to touch by pneumatic activation that is enabled by soft robotics technology. We believe combining a flesh-like material with soft motion and tactile responsiveness brings us a step closer to replicating/imitating organic life. We also question the potential of interacting with synthetic structures and what the social and cognitive implications of such exchanges could be.

### Hybrid Relationships—Biomorphism, Art, Materials Science, and Mechanics

The initial stage of BRALL stems from a collaborative work to fabricate synthetic human organ and tissue models as a tactile platform for surgical training. We created breast, skin, and vascular models which aimed to respond realistically to incision, dissection, and suturing [1]. During this project, we realized that beyond the medical applications of such models, there was also room to explore the effects and implications of providing tactile experiences with synthetic structures. We combined nine pneumatically-actuated silicone tiles to form a “breathing” wall (BRALL) that has flesh-like tactile properties (e.g., softness, sagging, porosity, resilience, and elasticity) (Fig. 1). BRALL expands, collapses, and responds to touch by modulating its breathing. BRALL’s thin, elastomeric, membranous surface can be altered through tuning its density, porosity, and curing process such that the sensation and composition of no two tiles are entirely alike. These tiles can resemble different organic matter, e.g., sponge, anemone, organ, human, and animal skin. The use of silicone as a material for BRALL has many benefits due its likeness to skin—it can be stretched and will collapse back to its initial size, tear and be healed with more of itself, and the surface sensation is a mixture of soft, sticky, saggy, and malleable characteristics.

Locke and Joye suggest that the presence of biomorphic forms and natural elements within a visual environment can serve to enrich human emotional experience [2]. They also draw a line between familiar natural environments and positive ancestral associations with plentitude of resources, the lack of predators, and healing. Flannery outlines the advent of technologies such as cell illustrations in the early 20th century



Fig. 1. BRALL, Silicone on Polycarbonate panel, 145cm × 145cm, 2015, (© Ece Budak and Ozge Akbulut. Photo © Baris Dervent.)

influencing painters, especially Surrealists and abstract painters, in terms of their vitality, sexual, and sensual potential [3]. In its current architectural manifestations, biomorphic structures exemplified by Felipe Mesa and Alexander Bernal’s *Orquideorama Botanic Garden* (2006) utilize complex biological forms such as flowers, trees, and honeycombs; Herzog and De Meuron’s *Olympic Stadium* in Beijing (2008) resembles a maze of interlacing strands that form a colossal nest.

The shift towards interactive biomorphic forms, which focus not only on external structural qualities but also on tactile characteristics, has had its strongest echo in the design of wearable items. Neri Oxman’s biologically inspired designs *Bacteria Infested Space-Suits* (2014) and *Carpal Skin* (2010) are both acrylic composite prototypes with surfaces similar to that of organic matter. She states, “The future of wearables lies in designing augmented extensions to our own bodies that will blur the boundary between the environment and ourselves” [4].

### Pneumatics and Soft Movement

The actuation of breathing has been led through our collaboration with Dr. Adam Stokes, the principal investigator of Soft Systems Group at the University of Edinburgh, and through the work of Onur Zirhli, an electronics engineering student at Sabanci University. This collaboration has allowed us to utilize the principles behind soft robotics, where pneumatic activation is used to achieve soft movement. The design of soft robotic structures is frequently inspired by animals which do not have internal skeletons. These soft robots can: manipulate fragile objects; provide a range of motions that cannot be generated by hard robots; and simplify construction of complex systems by eliminating the requirement for multiple mechanical parts [5]. Usually, elastomeric materials are used in these systems since elastomers i) can offer continuous deformation, ii) are soft and thus easily moldable, and iii) tough and resilient. An example of soft motion is the project FURL, an installation at the Interactive Architecture Lab at the Bartlett School of Architecture, which consists of a series of pneumatically activated tentacles that curl and uncurl by responding to EEG brain waves [6]. The pneumatic networks that are embedded in our elastomeric design enable the movement of the material; and through a

valving system, we can control both the rate and frequency of air intake. This flexibility has allowed us to emulate a variety of emotional states that correspond with different breathing motions. Some of the tiles are more porous and inhale/exhale easily, reminiscent of joyous and relaxed experiences, while some tiles are denser and expand/collapse laboriously, such as one would in stressful or fearful situations. For the responsive element, we have used capacitive sensing via aluminum panels inserted underneath each tile. When a tile is touched, the sensor is activated and this activation causes an excitation response which leads the tile to both expand with a sudden rush of air and play a recorded breathing sound. The exhalation of the tiles is passive and facilitated by the porosity of the foamed silicone. This autonomous release is an essential part of the design because it not only gives the structure a more organic motion than pneumatically deactivated structures, but also engages the viewer in a similar fashion to that of a living organism. We believe that combining breathing and feedback to physical stimuli will foster greater responses on the part of the user—whether these responses are of identification or disassociation—the interaction will be closer to that of organic life.

## Implications

Hersteinstein states that the study of touch has been vastly neglected in contrast to the other sensory modalities used in nonverbal communication [7]. He explains that while one person may feel positive about being touched in a certain way, another may feel negative. Beginning in infancy, the communicative aspect of touch, is essential to a child before verbal communication, and is the foundation upon which a child learns of his/her environment, how they communicate, form attachments, and bond with others. He also details how touch in adults plays a fundamental role in human exchanges, such as providing support, fostering intimacy and sexual interest, and negotiating power relations. The Hapticat project—a breathing, warming, purring cat-robot with moving ears created at the University of British Columbia—has received positive affective feedback in small group trials [8]. Hapticat has four distinct emotional states that are combined and expressed psychically while being held by the user. These findings encourage further research into the potential for “connectedness” between man and robot animal companion. However, we are still very much at the beginning of understanding the real effects of tactile engagement with synthetic organisms. What happens when we move touch from the private to the public realm? Is it intimate or is it distant? Does it satisfy a need for natural forms or does it further alienate us by reminding us all our interactions are becoming more and more synthetic?

In Masahiro Mori’s seminal 1970 article, he introduced the concept of the uncanny valley as the unsettling experience of interacting with a robot that has been built with or emulates human characteristics [9]. A preliminary example he uses to explain this phenomenon is a prosthetic hand. This synthetic appendage has been designed to look entirely real, however upon touching the hand, its limp and cold characteristics lead to a dissonance, which results in a pervasive feeling of eeriness. Another example he gives is of a robot constructed for the 1970 World Exposition in Osaka with 29 pairs of artificial muscles. The robot was programmed to smile with the same accuracy of its human counterpart, but if the timing for the smile was too gradual or enacted in half of its normal

speed, it aroused feelings of discomfort and disassociation. He argues the closer the robots or their designs come to life, the more this sensation of discomfort increases. He concludes that designs for robots should follow distinctly non-human characteristics to avoid the feelings of interacting with a corpse or alien species.

## Conclusion

As we are faced with the increasing loss of natural environments and their replacement with synthetic structures, new challenges emerge for our perception of space, place, and the body—what it is to be human and how we feel or recognize our surroundings. While architecture and wearable items have been using biological forms due to their aesthetic and ergonomic properties, they have neglected the issue of touch, in itself, as the actuator of an intimate experience. BRALL confronts these issues by utilizing biomorphic forms to create a synthetic wall architecture that pushes the boundary between structure and creature, material and flesh, breathing and life. Also, since touch has been shown to aid cognitive and social development, our project aims to provide an environment where these alternative biologies will serve as inspiration and a learning opportunity about biology, materials science, and mechanics for younger students, and as medium of communication for designers, engineers, and creative people. In the future of our collaborative research, we hope to focus on creating various unexpected biological structures using composite materials and various types of actuators. We will also continue to encourage touch and to promote/question its role within increasingly synthetic environments.

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