Chapter 7.

Introduction to the Design Portfolio

The following sculpted computational objects chronicle the design and artistic work of this thesis. These projects include the *Triangles, Electronic Fashions, and Embroidered Musical Instruments*. They are presented as support for the main design and artistic premise of this thesis: that a meaningful expressive language for physical computing cannot be fully developed without new, sculptural and active computing materials. Because I believe that the story of my work has developed over time, I have chosen to present the portfolio works generally, in the order in which they occurred, rather than in an order related to the most significant contributions. I have also chosen to group some projects, which are related both in time and content, together in chapters. I have done this to best communicate my story, not as a reflection of the importance of any single project.

While the portfolio of projects focuses on design and artistic issues, these cannot be truly separated from the technical constraints and advances related to the creation of these objects. Without my technical development of smart textiles, I simply could not have made the design and artistic advances and experiments that this portfolio presents. Moreover, the many of the technical contributions of this thesis were driven by the needs of creating these objects. Consequently, technical developments that are essential to and directly influence the design and artistic story are included in this section. More detailed technical information can be seen in Chapters 13-16.

Motivating Design Work in Tod Machover's Brian Opera, 1996*

My interest in computing technology as a three-dimensional artistic medium began while designing and building many of the physical interfaces of the interactive musical instruments in Tod Machover's *Brain Opera* (1996).[1] I firmly believe that the artistic and technical questions I am asking today, are motivated by the artistic experiences I had while working on this project. Before this project, computers seemed abstract and isolated to me. Designing new physical interfaces and environments for the *Brain Opera* intrigued me because I began to see how and why computers could emerge from their boring beige,

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* I designed the *sensor objects and hand-held interfaces* in the Brian Opera, and collaborated closely with project architect, Ray Kinoshita, on the larger objects that hold them. This was all done with the input of visual design director, Sharon Daniel.

1 Orth, M., *Interface to Architecture: Integrating Technology into the Environment of the Brain Opera,* The Proceedings of Design of Interactive Systems, (DIS 1997), Amsterdam, ACM Press, (1997).

plastic boxes. Moreover, the direct and hands-on material struggle I faced during this early design work, led directly to the work created for this thesis.

My motivation to use new materials and physical forms in the *Brain Opera* was multiple. Practically, the sensing needs of these musical instruments demanded new materials and manufacturing processes. The fact that these instruments would become part of a traveling public show meant that they had to be robust. Artistically, I wanted to create computers that were both tactilely and visually, unique and unexpected. My design goals included using unique textures to encourage audience members to touch and interact with the instruments, and creating a physical space that encouraged a different type of exploration than computer keyboards and mice. I wanted people to see and experience the expressive and creative potential of computers, not just their practical abilities. To do this, I felt I had to create a new tactile, material, and visual identity for computers. The resulting objects are physically and visually antithetical to what was then the standard look and feel of technology at the time. They are transparent, organic, soft and rubbery.

Most of my design work in the *Brain Opera* involved simply re-housing commercial sensors and display devices into novel physical forms made from unusual plastic and rubbery materials. Commercial screens, earphones and microphones were wrapped in silicon. Commercial sensors were cast into rubber casings. The bulk of the computer and audio equipment, (PC's, synthesizers, etc.), were placed on a grid up top, away from the equipment with which people had to directly interact or touch, like speakers and headphones. This allowed the physical interfaces to be light and transparent. While the re-housing of commercial devices and sensors (like headphones and LCD screens), inside rubbery, transparent and light materials was successful on many artistic levels, it was not enough to truly achieve my goals, either practically or artistically. Soon deeper artistic questions emerged, questions that ultimately led me to this thesis. These included how to create better physical computing design materials and how to realize the expressive potential of physical form, networking and computation.

*Talking Trees**

Perhaps the best examples of the re-housing of commercial electronic devices in the *Brian Opera* are the *Singing*[2] and *Talking Trees.*[3] These interactive stations integrate an LCD screen, a microphone, headphones and a re-housed commercial mouse, in a sculptural, silicone rubber and polypropylene pod. The bending of the rubbery and transparent silicon sheet material into an organic shape gives these interactive stations an entirely unexpected feeling. Soft and rubbery materials helped encourage people to touch these interactive stations, and become physically

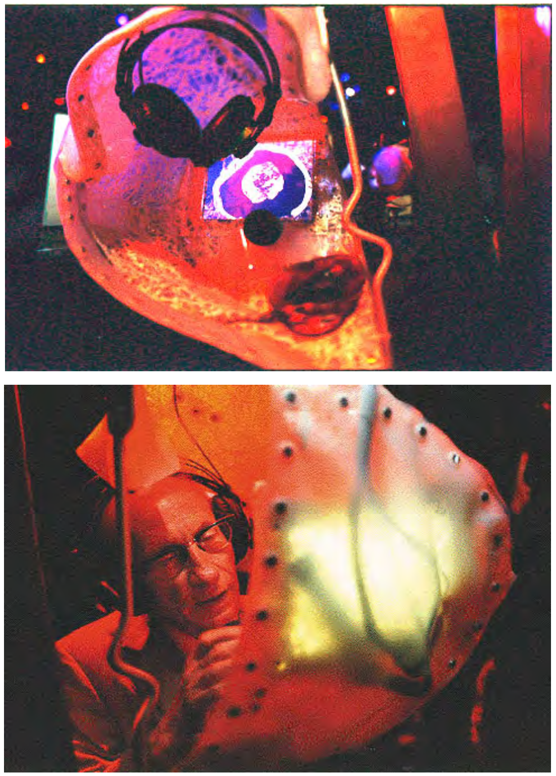

Figure 7.1 Maggie Orth, Ray Kinoshita, *Talking Trees,* from Tod Machover's *Brain Opera,* 1996.

* Physical design in collaboration with Ray Kinoshita.

[2] Oliver, W., Yu, J., Metois, E., *The Singing Tree, Design of an Interactive Musical Interface*, The Proceedings of Design of Interactive Systems, (DIS 1997), Amsterdam, ACM Press, (1997) pp. 261.

[3] Orth, M., *Interface to Architecture: Integrating Technology into the Environment of the Brain Opera,* The Proceedings of Design of Interactive Systems, (DIS 1997), Amsterdam, ACM Press, (1997).

intimate with them, placing their heads inside. But despite the success of this transformation, I was ultimately disappointed in its superficiality for two reasons: 1) The *Talking Tree's* software was functionally no different than that written for a computer with a standard monitor and mouse. 2) I had to accept the square and rigid mechanical properties of all the electronic devices built into the organic pods, especially the LCD screen. Ultimately, I felt that the silicon hoods were only putting a new face on existing forms, not fully exploring or changing their fundamental meaning and function.

Rhythm Tree **Pads**

While many of the objects in the *Brain Opera* remained in the category of re-housed, commercial electronic devices, the *Rhythm Tree*[4] and its organic, rubbery drum pads began to suggest the artistic potential of computational objects to me. The *Rhythm Tree* was a digital musical drum machine consisting of three hundred networked drum pads. Each drum pad had a unique ID, a piezoelectric sensor, an LED and a connection to a central computer. Artistically, I wanted to incorporate each of these elements into a rubbery, organic, and extremely tactile housing. Practically, this housing needed to trigger the piezoelectric sensor, hold and protect the electronics, and be made from a transparent material, to display the lighting of an LED when the pad was hit. To achieve this, the electronics were cast directly into a rubbery urethane form molded

Figure 7.2 *Rhythm Tree* Circuit (Joe Paradiso), *Rhythm Tree* Pad Housings, (Maggie Orth), *Rhythm Tree* in Brain Opera, (Ray Kinoshita and Maggie Orth), 1996.

[4] Paradiso, J., *The Brain Opera Technology: New Instruments and Gestural Sensors for Musical Interaction and Performance*, Journal of New Music, Research, Vol. 28, No. 2, (1999) pp. 130-149.

from a hand-made original. Originally, I varied the shapes of the drum pads and made them highly textured to create visual variety and encourage people to touch them. Unexpectedly, the different shapes of the drum pads also allowed players to play them differently. Pads with different sizes and shapes caused different vibrations in the sensors and ultimately created different music in the computer. In addition, players could use different textures to play the pads differently. For instance, the pointy pads can be plucked, creating numerous quick sounds, as opposed to the smoother pads which create one sound per hit.

The interaction between the physical form of the pads and the behavior inside the computer excited me and suggested new possible interactions between physical form and computation. The *Rhythm Tree* also made me raised the question, "What does it mean *expressively* to have three hundred networked objects that can communicate, know each other's identity and state?" These two issues, how can the form of an object be meaningful in computation, and how can an artist use networked objects expressively, became the fuel for my later research.

Digital Baton[*]

Designing and manufacturing the physical housing for Teresa Marrin's *Digital Baton* [5],[6],[7] truly crystallized the

[*] In collaboration with Teresa Marrin and Joe Paradiso.

[5] Marrin, Teresa, *Possibilities for the Digital Baton as a General-Purpose Gestural Interface*, Extended Abstracts of the Conference on Human Factors in Computing Systems, (CHI 97), Atlanta, ACM Press, (1997) pp. 311-312.

material challenges involved in creating computational objects. My design goal was to integrate five commercial pressure sensors, an accelerometer, an infrared LED (for pointing in a 2-D space), and central electronics, into a small, squishy form that fit in th plam of your hand and was easy to play. My basic design involved creating a hard plastic central core to hold the electronics, covering it with pressure sensors, and then imbedding it all in a rubbery goo. The central core had to be fairly large, to hold all the electronics. This meant that the rubbery material covering it had to be thin. Consequently, the squishy feeling of the baton was literally only skin deep. The commercial pressure sensors were glued to the surface of the core. These sensors were big, square and extremely fragile. To preserve their electrical abilities, they had to lie flat on a rigid substrate. Integrating these bulky sensors under a rubbery skin, and over a sculptural three-dimensional form was nearly impossible. The electronics in the core also had to be awkwardly connected to the sensors with bulky, rigid and fragile wires, two per sensor. All of these factors limited the shape and size of the baton, and eventually the sensors failed electrically.

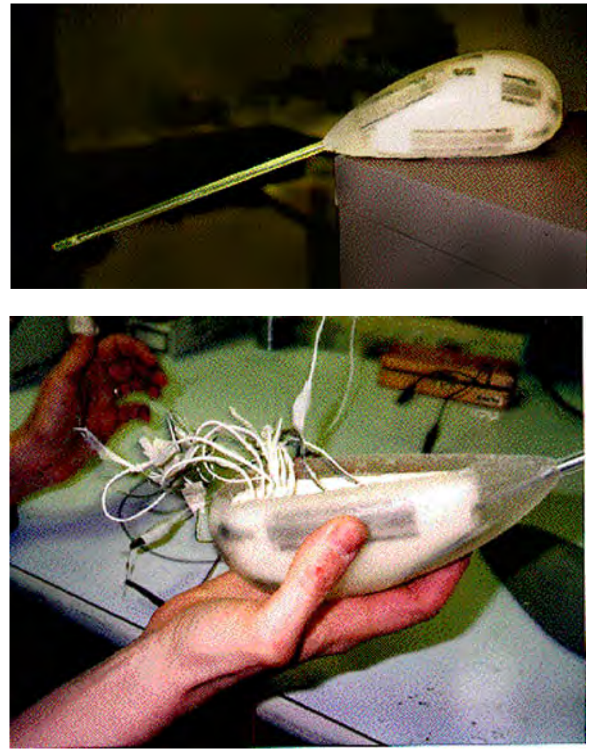

Figure 7.3 Teresa Marrin's *Digital Baton,* 1996, with commercial pressure sensors under clear squishy skin.

After trying to imbed the commercial sensors into a sculptural rubbery object, I longed for sensor materials

[6] Marrin, Teresa, Paradiso, J., *The Digital Baton: a Versatile Performance Instrument*, Proceedings of the International Computer Music Conference, Thessaloniki Greece, (1997) pp. 313-316.

[7] Teresa Marrin, Joseph Paradiso, Tod Machover, Christopher Verplaetse, and Margaret Orth, Apparatus for Controlling Continuous Behavior Through Hand and Arm Gestures, United States Patent # US5875257, (1999).

that would allow me to create small and intricate instruments, with both ease and an economy of steps. I wanted materials that could be both the sensors and housing, that I could bend, cut and mold into any shape I wanted. I wanted a sculptural sensor skin to create multi-channel musical instruments.