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RE/CONNECT:
An Interdisciplinary Exploration of Wearable Technology in Devised Theatre

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RE/CONNECT:
An Interdisciplinary Exploration of Wearable Technology in Devised Theatre

by

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Dedication

This thesis is dedicated to my colleague and friend Emily Robertson, without whom, I would have been a very different person at the end of all this.

Acknowledgements

In my short life, I have had unbelievable opportunities that I would have never even considered without the help of some amazing people who deserve far more than just my gratitude. First I must thank my wonderful, enormous, and brilliant devising team for always being ready to work and, more importantly, willing to play. Every one of you—designers, engineers, choreographers, stitchers, musicians, cast—made this project a joy and I am so very proud of us. For my co-producer and colleague, Ryan Belock: thank you for raising this "art baby" with me—I'm so excited to watch it grow! A sincere thank you to my graduate advisor, James Glavan, for his trust and enthusiastic support of this project, and for honoring my request of "kicking my butt"—I'm so much better for it. Thank you to my thesis committee for all of your insight and advice on this journey. To each of my parents, thank you for believing in me when I struggled, and for bringing me back down to earth when I needed it. Thank you to the Theatre & Dance faculty at Gustavus Adolphus College for introducing me to my two academic true loves: devised work and research. Without the encouragement of my UT costume shop family, I probably would have lit these costumes on fire a long time ago. I love you, my weird family! Finally, I would like to thank Barry Costanzi for his emotional and technological support, and one particularly important question in a late-night conversation: "Have you ever heard of micro-controllers?"

Abstract

RE/CONNECT:
An Interdisciplinary Exploration of Wearable Technology in Devised Theatre

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The University of Texas at Austin, 2015

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How can theatrical costumes help develop a narrative about intimacy in a world that is increasingly detaching from physical contact? My thesis explores this question through interactive costumes and the use of Wearable technology. I created two micro-controlled costumes that employed a variety of proximity sensors and LEDs that light in reaction to the touch and closeness of another person. The costumes are a response to the statement made by MIT psychologist Sherry Turkle: "We're lonely, but afraid of intimacy." The garments were featured in both an interdisciplinary devised theatrical production I helped create, entitled *RE/CONNECT*, and an interactive educational exhibit, illustrating the importance of physical touch in an increasingly digital age.

Only by integrating new and old technologies will theatre remain relevant and funded in a world that is losing interest in physical interaction. Beyond the benefits of

study for the production team, the final thesis performance attracted audience members from a wide demographic range, including those outside of the theatrical community with positive results. By incorporating nontraditional technologies in performance, and allowing audience members to experience these technologies firsthand outside of a museum, I have challenged my colleagues in the theatre and sciences to further investigate applications of developing technologies, and put to art and technology in deeper conversation.

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Chapter 1: Introduction

Why This, Why Now?

I am employed in a field that requires both touch and time. A garment cannot be created without putting hand to cloth, and a person cannot become a master artisan without spending countless hours manipulating the tools and materials of the trade. It cannot be learned merely from text, sight, or speech; you have to "get it into your hands," and the process cannot be expedited. It is almost unfortunate, then, that I am also a child of the digital age—the last generation to know life before the Internet.

I can (just barely) recall what it was like to consult a gas station attendant and a paper map for directions, or look up contact information in the phone book. I remember painstakingly learning the Dewey Decimal system to search for books in an actual library. All of these things are now entirely antiquated—at best they summon a quaint nostalgia, but more often seem a cumbersome, time-consuming hassle. Instant gratification has become the norm; the idea of a slow-loading web page is enough to set teeth on edge for some (Chillot). Today, everything is at our fingertips. Paintings, books, news, virtual tours, education, conversation—all can be delivered to your aural and visual receptors via a few taps on a screen.

However, it is vital that we remain attached to the physical world. While digital contact such as texting, Skype, Facebook, or any number of other forms are convenient, they deny us the psychological benefits of inhabiting the same space as another human (Gentilviso). Sherry Turkle, a psychologist from MIT whose work chronicles the

development and culture surrounding the personal computer, has written about this in her recent book, *Alone Together: Why We Expect More From Technology and Less From Each Other*. Turkle discuses how we are "Lonely, but afraid of intimacy," and our culture's growing narcissism—the need to update statuses and post our feelings about every meal we eat, all the while we interact less with others IRL (Internet slang for "in real life").

For my costume technology MFA thesis project, I wanted not only to challenge myself to learn a new technology, but also to make a statement about the importance of physical connection, and reflect on society's current state. I believe art is meant both as and for reflection; it forces us to acknowledge the changes around us and how we feel about them, so we do not travel blindly forward. Turkle refers to a similar reflection in her book. She calls it *realtechnik*:

> What I call realtechnik is just that we step back and reassess when we hear triumphalist or apocalyptic narratives about how to live with technology. Realtechnik is skeptical about linear progress. It encourages humility, a state of mind in which we are most open to facing problems and reconsidering decisions. It helps us acknowledge costs and recognize things we hold inviolate (294).

Based on this need for reflection, one concerning change in our world is the rapid acceptance of electronic communication over physical communication: talking through a screen rather than speaking face-to-face. This trend is additionally worrying for a theatre

artist. While the feature film scrim was the first partition to divide audiences and actors, the screens have only decreased in size and increased in ubiquity.

With so many entertainment options (and devices) beckoning for attention, the theatre is one of the last places you can reach out and touch a performance. No matter how well-rehearsed a show is, it will be slightly different each night, and an audience can feel a sensory connection with a live human being that they cannot feel with an on-screen avatar. You can smell the air, touch the space, and sense the emotion in the room as the event is happening; you are sharing the venue with the performers, and there is something visceral and human about sharing space.

In her book, Turkle also confronts the question of why people are texting, rather than talking. As one of her interviewees states, "It doesn't seem weird that you pause for two minutes to think about what you're going to say before you say it, like it would be if you were actually talking to someone." With texting, you have control over when and how you respond, control that you do not have when talking in physical proximity. However, when texting, you lose a certain degree of emotional authenticity—visual and aural cues—similar to when a person chooses to see a film over a live performance.

The increasing pace of the tech-obsessed world may seem at odds with the meticulously laborious profession that produces one-of-a-kind garments. However, this is not true; the relationship is merely in its infancy. In fact, Phillip Burgess, a contributing editor to Adafruit Industries Learning blog writes, "We're seeing more [LED-integrated

costumes] but it's still relatively scarce. Is it too heady? 'It's engineer stuff and must be hard!' Nonsense. Patterning trousers is hard. LEDs are a piece of cake!" (Burgess)

Few engineers know how to sew, but many engineering "Maker Spaces" feature sewing classes alongside 3D printing, laser cutting, and other tech-related courses. It is rare to find a costume technology program that teaches computer coding, and many think the fields are disparate. I hope to change the fearful enthusiasm shared between art and engineering and to encourage professionals in the field of costume technology to reach out. I wish for them to begin investigating the myriad of uses for electronic technology in costumes, specifically micro-controllers. Micro-controllers or micro-computers are small computers with a central processing unit (CPU) on a single printed circuit board (PCB) with inputs and outputs (See Figure 1). Garments integrated with micro-controllers are called "Wearable Technology," and I believe the theatre is the next home for Wearables.

Figure 1: An Arduino Uno brand micro-controller is about the size of a credit card (arduino.cc).

Project Overview

This thesis is my exploration of interactive theatrical costumes through the use of Wearables. Backed by the traditional skills I have developed as a costume technician, and inspired by all of the possible applications for Wearable technology, I set out to make costumes that reminded me of the importance of physical touch, and placed these garments in the context of the theatre, where, just like in conversation, we have little control of what happens next. I created two micro-controlled costumes that employed a variety of proximity sensors and LEDs that light in reaction to the touch and closeness of another person. The costumes are a response to the statement made by Turkle: "We're lonely, but afraid of intimacy." The garments I designed and built were featured in a larger devised theatrical performance based on the work of Turkle, entitled *RE/CONNECT.*

The technological component of this thesis was very important to me. Like many people in the arts, I had limited familiarity with computer programming, and little experience with any of the hard sciences. Though there is still much to be explored, I have changed that for myself, and I now have the opportunity to share my discoveries with my peers. In this paper, I outline my experience in the research and development of the devising practice for the performance, including the many roles I performed outside of costume technician and designer. However, my focus will remain on the costumes. I will explain the research and the projects I did to prepare, design and construction of the costumes used in the final performance, and finally, reflect upon my experience.

Chapter 2: Research

The Themes of *RE/CONNECT*

A generative thesis that is technological, collaborative, and performative poses a unique challenge for a costume technician, who is usually bound by their place (and physical space in the theatre) in the machine that is a production. I am a costume technician because I love solving problems and honing my craft. I am a theater artist because I crave knowledge of all kinds and I find value in collaborative performance. I wanted the opportunity and challenge of creating something outside of the norm for costume technicians, along with more avenues to collaborate with others on the production team that I would not normally interact with. With this Wearables project, I aimed to shift the traditional production hierarchy, and in its place offer a tool that can be approached equally by director/choreographer, performer, designer, and technician.

RE/CONNECT began in the fall of 2013 as my initial thesis proposal in my second year of graduate school at The University of Texas at Austin, in which I submitted that I would create two proximity-sensing LED costumes for a dance or physical theatre performance. When I saw then-second-year MFA candidate Ryan Belock's thesis presentation, in which he proposed a physical theatre performance that utilized live performers acting in-sync with projected media, I discovered we had a shared love of physical theatre and dance, exploring new technologies, and collaborative, devised theatre. After a lengthy discussion over coffee, we decided to merge our theses into one production. By combining the two ideas, neither one of us sacrificed our initial goals as

experimental artists, or the challenges our thesis proposals posed for us as students. We were able to create a project we felt would only enhance each other's work, and which offered us a chance to collaborate with artists we are often separated from by the theatrical production hierarchy. Belock and I each explored how our technologies could influence narrative and crafted a production together.

Belock and I found that each of our projects lent themselves to the themes of connection and our relationship with technology. We were also drawn to the ways in which communication technology has changed throughout history, from story-telling by starlight, to the telegraph, to Skype. Our content research included many scholarly and anecdotal articles, videos, plays, books, and other media, but we were mutually inspired by the film *Her* and Sherry Turkle's work. We curated a large part of our research on a Facebook page, and eventually our website (Belock, Wordpress), so as to make it available to any interested parties, in keeping with the nature of open-source sharing.

Her, by Spike Jonze, is a critically acclaimed major motion picture about an emotionally detached man named Theodore who falls in love with his sentient computer operating system. He spends long periods of time physically alone in his apartment, rarely interacts with his coworkers, and avoids contact with strangers on the street. The few friends he does have, he only sees on rare occasion. It is easy to see how a man lacking social interaction could be susceptible to finding a romantic connection with a non-human entity. The degree to which Belock and I accepted this behavior frightened us.

Anecdotally, we could name several friends who could have easily filled the main character's role.

Only a few days later, we found Dr. Sherry Turkle's book, *Alone Together: Why We Are Expecting More From Technology and Less From Each Other*. The answer to both Turkle's title statement, and the thematic questions of *Her*, is that technology is more convenient for our egos. With textual communication, we have control over when and how we respond to messages. When dealing with a real person, in real life, we have to respond instantly, lest we appear odd, and perhaps face ridicule. It is uncomfortable to not be in control, and it is difficult work to always appear interesting. Conventional conversation is an art form that few have studied, and many seem to be avoiding all together, according to Turkle.

As Turkle observes, it is, on the surface, more comfortable to have protected relationships and conversations at a distance. However, when we avoid the potential for embarrassment, we miss something deeply human and important—emotional connection. Turkle claims we are at risk viewing ourselves and others as objects. When we create a profile that reduces us to a list of "favorites," or speak in acronyms, we sacrifice quality for brevity. And it is not only the quality of the conversation, but the emotional benefits that we lose. Without real people surrounding us, continual online connection can feel even more lonely (227).

While it is not technology, but we as human beings, who cause these emotional troubles for ourselves, technology does make it easier to ignore the warning signs when

everyone is participating in it:

> Kevin Kelly (Author of *What Technology Wants*) asks, what if one of the things [the creators of] technology wants is to exploit our disappointments and emotional vulnerabilities? When this is what technology wants, it wants to be a symptom… a robot companion services both symptom and dream. Like all psychological symptoms, it obscures a problem by "solving it" without addressing it. The robot can provide companionship and mask our fears of too-risky intimacies. As a dream, robots reveal our wish for relationships we can control …it is "easier" to be enraged by long supermarket line than to deal with the feeling that your spouse is not giving you the attention you crave. When technology is a symptom, it disconnects us from our real struggles. (282)

And the symptom appears to be forming into a virus: Turkle cites a 30 year study of college students that shows that since 2000, coeds report a drastic decrease in interest for interaction with others. They no longer find value in empathizing with others. The authors link this issue with the pervasiveness of online connection. Perhaps a person can relate strongly to another online, but they only need to interact with the part of the person they choose. Many students are losing the desire for deeper relationships (273).

Online "communities" can only offer us a temporary high. As Turkle discusses, "communities are constituted by physical proximity, shared concerns, real consequences, and common responsibilities" (239). Humans are social creatures. We need the shared

human experience—the emotional and physical experience, and all it entails—to relate to others, and to fulfill certain psychological needs.

The irony of my using more technology to remind us of the importance of physical connection is not lost on me. Turkle herself may criticize me for this, as she has said, "overwhelmed by the pace that technology makes possible, we think about how new, more efficient technologies might help dig us out" (280). But neither Turkle nor I want communication technologies to go away, rather, we hope to remember that technology is meant to be a tool, not a symptom. I hope that through my costumes, I can remind people to use technology to our advantage, and not let it diminish us and our relationships.

What Are Micro-controllers and Wearables?

I first learned about micro-controllers in August 2013 at a costume party. My friend, and Exhibit Prototyper at the Science Museum of Minnesota, Aaron Heidgerken-Greene, was comically dressed as a wizard, and had placed a small red-green-blue light-emitting-diode (RGB LED) and a micro-controller into the hollow of a walking stick. He activated the light with a magnet hidden in a ring he wore, which triggered a reed switch on the micro-controller in the staff. When he held the magnet in the ring up to the switch, the micro-controller got the signal to light the LED. Only his ring controlled the staff, embellishing his costume and character backstory of magical powers; in anyone else's hands, the staff refused to light. Later that night, after discussing it with Barry Costanzi, a University of Minnesota Physics PhD candidate, and going through many obsessive Google searches about micro-controllers, I quickly became fascinated by the technology.

Wearable technology, or "Wearables" for short, are a category of micro-controlled electronic devices that can be worn on the body. Micro-controllers are programmable for input and output, and can be connected to sensors, GPS, motors, and lights, among other things. Popular commercial Wearables include items such as Google Glass, the Apple Watch, the FitBit, and Phillips Lumalive fabrics. Wearables have been making an exciting impact in flashy large-venue theatrical spectaculars and in the experimental fashion world, but have yet to truly crossover into the world of smaller, more intimate theaters.

Many micro-controllers are open-source. This means any computer code, software or hardware is developed to be freely shared and modified by any user, much like

costumers share their tools and techniques for construction, knowing that the next generation will alter them to their needs. The most popular micro-controller is produced by the Italian open-source hardware and software company Arduino (See Figure 2). In conjunction with electronics company Smart Projects, Arduino developed a micro-controller and accompanying software in 2005 meant to specifically make prototyping easier for disciplines outside of computer engineering. The software runs on the common computer languages C and C++, and the input and output slots on the board, known as "pins" (think of them as intelligent power outlets and inputs), are built so wires can be easily plugged in or removed without the traditional method of soldering. For an engineer, the Arduino board serves as the costumer's mock-up of the circuitry—it can be easily and cheaply altered or rearranged, but it is not something a person would consider a "finished" product. For that, you might make or buy a PCB and solder your connections, to make them permanent and beautiful. For Wearables, however, soldering is not ideal, as it is brittle.

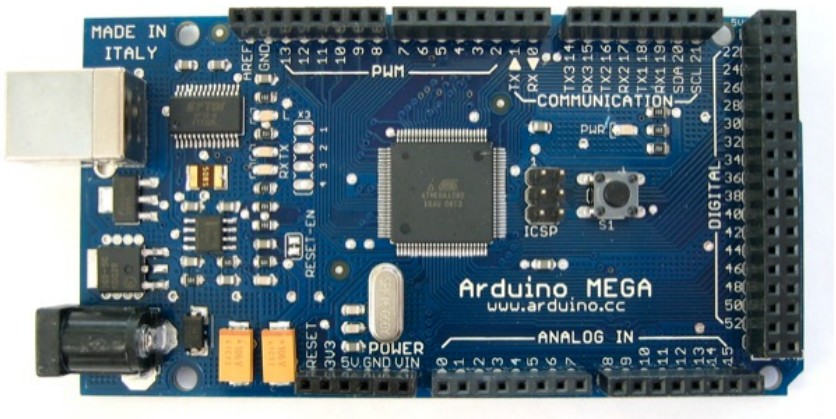


Figure 2: An Arduino Mega micro-controller (arduino.cc.) The black grid-like slots are called "pins" and serve as input/output plugs.

The Wearable answer, a combination of the PCB and Arduino board came two years later, in 2007, when Leah Buechley of MIT opened up the world of computer engineering to a new field. She created the Lilypad Arduino, produced by SparkFun Electronics (See Figure 3). The Lilypad is a sewable Arduino micro-controller with a beautiful appearance that makes creating textile-based electronics a possibility for the amateur. Items such as conductive thread and conductive fabric proved perfect companions to the Lilypad. For this thesis, I focused largely on using the Wearable electronic components available in order to explore their applications in theatrical costuming. Ultimately, I developed an embedded system—a computer system dedicated to a larger mechanical function, often based on micro-controllers—in costume form using Wearable products.

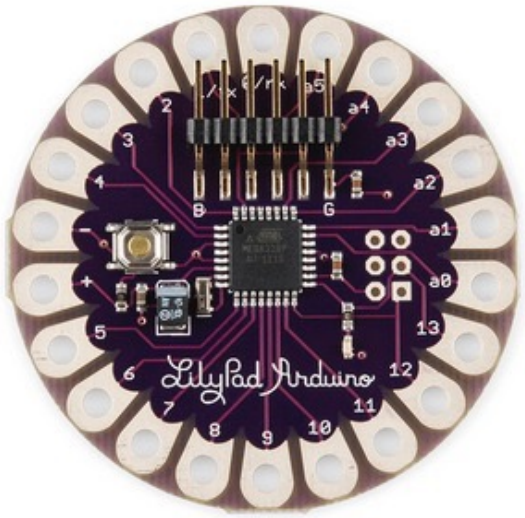


Figure 3: A Lilypad Wearable micro-controller is just under 2” in diameter (sparkfun.com).

Shortly after the release of the Arduino learning system, many other iterations of open-source hardware and software programs came along, including Raspberry Pi, Seeeduino, Freeduino, Japanino, and the Adafruit Industries system. However, none are as popular as the Arduino platform to the hobbyist. Many hobbyists—who refer to themselves as "Makers," "Tinkerers," or "Hackers"—have formed online communities, such as github.com, where they can share code, ideas, and troubleshoot their projects with other Makers. However, it is not an entirely digital enterprise, as many Makers have formed meeting groups within their local communities, often participating in conventions known as "Maker Faires," hosted annually in major cities all over the world.

Hobbyists are not the only group diving into Wearables. As our culture becomes increasingly attached to our devices—so much so, we want to become one with them (Llorens, "Vibrating Tattoo Patented by Nokia Alerts users When Phone Rings")—large companies are getting involved. MIT's MediaLab has already developed many Smart Textiles that can sense heart rate and body temperature changes, inspiring companies like Phillips, Sony Ericsson, and Makerbot to include textile experts for their Wearables lines. The Apple Watch and Google Glass are Wearable accessories marketed on a global scale.

Fashion has embraced the trend as well. Several fashion programs in Canadian and European universities are offering courses on Wearables, while pop stars such as Will.I.Am, Katy Perry, and Nicole Scherzinger are wearing costumes by companies like "CuteCircuit" ("Twitter Dress"). The popular reality TV show, Project Runway, even

incorporated Barbizon Lighting products into one of their weekly challenges (Stern, "Project Runway Takes on Wearable Electronics").

Large-venue theatre acts like iLuminate, *Sesame Street Live!* and the Radio City Rockettes are utilizing micro-controllers—yet, with the exception of these Spectaculars, theatre has been behind in utilizing this technology. Some may consider Wearables garish —my own thesis advisor warned me against making a "Christmas tree costume"— however there are a growing number of examples where fashion and technology have been seamlessly combined (Steph, "High Tech, High Fashion"). Micro-controllers and their software share similarities with the field of costume technology; our techniques are "open-source," never copyrighted, and passed down from teacher to students. We make instructional videos, share patterns, and allow them to be altered or built upon because we hope that others will learn from our work and improve our methods. The "hardware" is, of course, very open—dress forms, tools, fabrics, all necessary products that we share for "Making." Even the name, "maker," is shared between the fields.

In my research, I have found that, of the many Makers out there, only a few had tried to apply Wearables to theatre. Among these few, they either only used static standard LEDs (Huang, Steph), costumes controlled by an external input like a light board operator or piano (iLuminate, Yeh), or incorporated sensors with sound, rather than light (Faveri, Lindsay). Unlike these previous applications, my costumes controlled themselves, and in a way, the performance. My costumes directly interacted *with* the performers, giving them the agency to alter the appearance of the costume as well as the

appearance of the production, rather than the choreography or text determining the costume.

The costumes could be considered as a third "performer," in that they are somewhat unpredictable, and offer another thing for the human characters to interact with, but I disagree. They are a tool. If these costumes were simply on stage without human bodies operating them, they would not evoke the same emotional response. They are a tool to sometimes use in the conversational nature of live performance, like our smart-devices should sometimes serve us in our daily communication.

Proof of Concept: *Warning!* A Wearable Electronic Dress Prototype

In Spring 2014, to test my theory of synthesizing art and technology and accomplish a project as large and unfamiliar to me as what I wanted *RE/CONNECT*'s computer coding and hardware development to become, I began researching and testing. In winter 2013, I assembled a small electronics kit, and sought out an Arduino tutor via several university departments. Those departments included the electrical engineering department in the Cockrell School of Engineering and the electronic music program in the Butler School of Music. Dr. Bruce Pennycook from the Butler School connected me with Rodrigo Carvahlo, a visiting Digital Media PhD student from the University of Porto, Portugal. Carvahlo had done several projects with Arduino already, and was interested in creating a project that incorporated "movement-as-output."

Carvahlo and I decided that, over Spring 2014, we would create a prototype that supported our individual goals. In exchange for my help with a Wearable prototype that incorporated multiple technologies we were each interested in, he would teach me what he knew about Arduino programming. Through this experience, my goal was to prepare for the coding necessary in my thesis work. During our initial research phase, Carvahlo found The Creepy Couture Spider Dress by Dutch designer Anouk Wipprecht, a stunning example of proximity sensors at work in a fashion garment (See Figure 4). Carvahlo wanted experience working with robotics motors, known as servos, and I wanted to test a variety of proximity sensors, including conductive paint. I also wanted to test fiberoptic fabric as an option for lighting large sections of a body.

Figure 4: The Creepy Couture Spider Dress designed by Anouk Wipprecht (CNET.com)

In terms of the aesthetic, I performed the role of costume designer, and Carvahlo, the role of director. He was attracted to "something animal," "futuristic but still familiar" and the idea of "urban camouflage." The final design I proposed for our joint research venture had elements of an Australian frill-necked lizard, a lion fish, an Elizabethan whisk, an android, and the appearance of bioluminescence. The costume featured four SG90 mini servos, one Arduino Duemilanove micro-controller, one HC-SR04 Ultrasonic Sensor, ten ultrabright white LEDs, a breadboard, Bare conductive paint, the Abelton music program, and one Lilypad Arduino AT328 Mainboard. The costume was supposed to be attractive and lure you in, but startle you as you approached, much like our reactions to strange animals. We named the costume "*Warning!* A Wearable Electronic Dress Prototype" (See figure 5).

Figure 5: Visual Research Collage for *Warning!* (left), Design sketch for *Warning!* (center), and production photo, modeled by Emily Robertson (right)

The third member of our *Warning!* team was Ammon Taylor, an undergraduate composer from the Electronic Music program. Taylor composed a piece of music using the Abelton computer program that Carvahlo requested sound like an "ambient drone" with random individual arpeggiated tones. We built the costume so the music was triggered when a person touched the conductive paint stripes on the bodice, similar to piano keys.

The process of developing a Wearable—or a electronic circuit of any kind—is similar to the development of a costume. For both, the appearance and materials (hardware) for a costume or product are selected by a designer. A costume technician or a hardware engineer, backed by the knowledge, tools, and techniques of their trade, brings the design idea into the physical world. They research similar predecessors, draft out a their plan, make samples, and make several "mock-ups" or prototypes using cheap and

easily alterable materials. Once the construction is approved by the designer, the product is manufactured out of the real medium. With electronic prototypes, a design is made with the desired function in mind first, aesthetic, second. However, with costumes, it is often the opposite. For Wearables, it's both, at the same time.

For *Warning!* the research portion of the prototype lasted about two months. Carvahlo and I made several miniature samples using a variety of products. We began by testing the effectiveness and ease of programming using the four different micro-controllers we had: the Lilypad AT328 Mainboard, the FLORA from Adafruit, the Arduino Uno board, and the Arduino Duemilanove board. The Lilypad and the Arduino boards shared the same language and labeled their hardware the same, but the Uno was restrictive in its limited number of pins ("smart outlets"). The FLORA spoke the same coding language and offered more power output pins but required a bit of translation when working with the hardware. We decided to use the Duemilanove and the Lilypad for our micro-controllers.

When selecting our lights, we tested a variety of standard-shaped LEDs and a few brands of fiberoptic cloth. We settled on the white ultra bright LEDs and the fiberoptic fabric from Sparkfun electronics. The LEDs were chosen for their intensity and longevity, and the fiberoptic cloth because it seemed more susceptible to necessary abrasions. In fiber-optics, the light travels down the shaft of a "fiber," which can be thought of as a wire that carries light instead of electricity. The light remains trapped inside the fiber unless cut or scuffed. A fiberoptic cloth's weft is made from many of these fibers, so to

get the “sparkle” out of fiberoptic cloth, you must scratch the warp, without damaging the stabilizing weft, which is made of polyester. At one end, all of the warp is gathered into a bundle and attached to an ultra bright LED (See Figure 6). It is possible to bundle many sections of warp onto many LEDs to increase brightness, but increasing LED count will also increase the number of batteries that needed to connect to the bundles, and we found that this quickly generated a lot of unwanted bulk. An additional frustration with fiberoptic is that the cloth can only be sliced “on grain.” If you cut the fabric with the grain, the light continues, but if you cut cross grain, the light stops. Think of the light like a river—if you fork the river (cut on grain), the water will continue to flow around the object, but you if you put a dam in the river (cut horizontally), it stops flowing entirely. This is an issue when you consider that at one end, you have a “tail” of bundled warp connected to a battery. Originally, we had hoped to use the fiber optic fabric in the collar, but the collar needed to be cut on the diagonal, or bias, in some places, and it was very difficult to hide the warp “bundles” around such a small area as the neck. I chose instead to use the fiberoptic fabric as a skirt panel and hide the battery at her lower back.

Figure 6: Fiberoptic fabric and the warp “bundles” that extend from one end of the fabric (sparkfun.com)

The most important items for me were the capacitive touch and proximity sensors, as I wanted to use these in my thesis costumes. Capacitive touch sensors detect anything with a different dielectric (how susceptible it is to having its charged particles reorient themselves when near other charges) than air. For example, the dielectric constant of water is 80 times higher than that of air, and because humans are made mostly of water, it is easy for these sensors to detect human bodies. Products that use capacitive sensing include tablet screens, motion sensors, and theremins. Out of the Wearable capacitive sensors we tested, we found that the most successful ones for our purposes were the stretch conductive fabric sold by Sparkfun and Bare conductive paint. Of the proximity sensors, Sharp brand infrared short-range sensors, and the HC-SR04 Ultrasonic Sensor. I was more attracted to using the paint for aesthetic reasons, and we needed more distance and width than the Sharp sensors could offer, so the choice was made to continue with the HC-SR04 and the Bare paint.

I constructed the costume so that each component was modular and could be attached and removed independently. The costume could be disassembled for programming, laundering, and storage purposes (See Figure 7). The crystal-sheer collar, which held the ultra-bright LEDs connected by conductive thread, was a slip-cover that slid over the corset bones. Those corset bones served as extension arms or "spines" for the micro servos. The front of the collar snapped onto the center front of the bodice, much like a traditional whisk attaches to the front of an Elizabethan stay. At the back, the micro servos were hidden in a pleated cloth cover, and Velcro brand fasteners were used

to attach onto the center back of the StiffStuff-and-buckram bodice. The bodice was covered in stripes of Bare conductive paint.

As mentioned before, when the black conductive paint stripes on the bodice were touched, the Abelton music from the computer and the ultra bright LEDs in the collar were simultaneously triggered. The micro-controllers were attached to a removable Velcro mount, and set at center back of the bodice. Mounted in the center front of the bodice was an ultrasonic proximity sensor. This sensor could detect objects in a six foot wide region in front of the costume, up to 30 feet away, though we only programmed it at a 10-foot distance. When approached, the sensor activated the micro servers. As a body got increasingly nearer, the micro servos began to undulate more and with increased rapidity. The final design element was stationary fiberoptic fabric stitched to the skirt of the garment.

Figure 7: Several of the garment pieces in process and, disassembled. Clockwise from far left: Bodice (unpainted) and skirt, collar slip-cover, micro servos with corset bone arms (in housing platform), and Arduino board velcro mount.

Carvahlo altered code that he found on the Arduino Learning website and came up with the schematic (a schematic is like an engineer's road-map for electrical connections) while I built the costume. We completed the costume in May 2014 and the project culminated in a filming and photoshoot. After Carvahlo published the video to Vimeo, it was noticed by Adafruit Industries' Wearable Wednesday blog. They asked if they could publish a story about *Warning!*, and the video now can now be found under the title, "Dress Reacts Like Lizard" (Birch).

There were several items which we found difficult to work with; these included the fiber optic fabric, as it was never as bright or as malleable as we wanted, and the servos, as they took up a lot of power, and mis-fired often. We also had to reboot the program each time we turned on the costume, which is acceptable for a prototype, when you have the code and the computer available, but not when you desire the costume to function untethered.

Additionally, the Abelton music program had to be connected to the computer via USB cable, denying us full wireless capability. If this project is ever picked up again, we will connect the two via Bluetooth or another wireless transmitter. Unfortunately, due to our full graduate course-loads, the language barrier, and the time it took to test and build *Warning!*, little time was left for me to learn coding in any formal capacity. I instead spent the following summer of 2014 teaching myself using books and websites suggested by Carvahlo and Heidgerkin-Greene.

The most useful part of the learning experience of *Warning!* was discovering how much research and development time a Wearable project requires, mostly due to hardware testing, and especially for creative costume solutions for hiding the components in the garment—particularly with all of the moving parts. The greatest success of the project was the reaction it received. Carvahlo and I have both had positive reviews for the project, and being picked up by one of the most well-known Wearables websites was an exciting privilege.

Chapter 3: Devising *RE/CONNECT*

The Production Team

With the completion of *Warning!* in May 2014, Belock and I began our devising processes in earnest, starting from the point of view of technicians. For the first time for either of us, we had the opportunity to decide what components we wanted to include in a performance. In addition to my costumes and Belock's media designs, the performance experience we desired required movement, dialogue, and live music. We wanted the opportunity to interact with artists we would not normally interface with in a traditional production, and we knew we needed talented people we could trust to fill roles we were unfamiliar with (See appendix F). With these goals in mind, we recruited a skilled team of collaborators beginning in late Spring 2014, and ending in Fall 2014. We made a conscious effort to gather minds from outside of our department, and people of different demographics, in hopes to represent a wider range of experience in our performance. After assembling our group, we put my personal management philosophy (and a recurring theme in the production) to work: every person yearns for significance and belonging.

We wanted our team members to each feel ownership over the production, with an opportunity to flex their creative skills, and to feel like they all had a voice in editing the performance. By setting up this rule, we felt that we would utilize every individual's strengths, and the performance would develop organically and fairly, into something beautiful and interesting. In my experience, this view of significance and belonging in the

devising process is the same welcoming mentality shared by the online and local Maker community. They recognize that as individual engineers, artists, or designers, they do not have all of the answers, but they are experts in their own fields with advice to offer. We knew if we could combine all of our skills and ideas, we could make something exciting happen. In prototyping as in devised theatre, time is a precious commodity, and it is required for trial and error. For a proper vetting process, Belock and I decided to host several different kinds of workshops over the next year, focusing on each area to be included in the performance, to help create material for the production.

The Workshops

Starting in Summer 2014, Belock and I conducted one-hour bi-weekly meetings in which the we mapped out possibilities of what the show would look like. These early workshops always included our playwrights, Eva Suter and Lydia Blaisdell, and occasionally other individuals from the UT community interested in the project. Additional production team members that joined in May 2014 included choreographer and professor of dance at The University of Texas at Austin, Andrea Beckham and Ammon Taylor, the composer from *Warning!*. During this time, we discussed the ideas we wanted to develop, and the ultimate structure of the piece. Belock and I, having come from musical backgrounds, enjoyed the idea of a "concert" setting. We organized the performance around the idea of a piece of music with "variations on a theme." The theme was of course, connection, communication, and human relationships with technology. The variations would be short vignettes expanding upon the leitmotif.

It was Suter and Blaisdell who developed the "verses" of the performance. Out of their natural partnership bloomed our phrasing structure and part of our script. The show would follow a romantic couple and their interaction with each other through technology. We would see them three times in the performance, punctuated with vignettes on a similar theme. The couple, who we named "A" and "B" had three interactions:

1. Emotional closeness, but physical distance: a long-distance relationship, in which they communicated via electronic methods

2. Nirvana: physical and emotional closeness (this became the wordless pas de deux in my costumes)
3. Physical proximity but emotional distance, in which they were in the same location, but were distracted by their devices.

The vignettes, supported by the AB scenes (or perhaps the AB scenes, supported by the vignettes), allowed us to expand on ideas and show different experiences with technology without the story seeming disjointed. As a group, we decided to frame the performance with a large iPad proscenium. With that design solution, we were able to provide masking for the projection screens, give ourselves another visual tool to interact with, and made the show reflect the experience of getting lost in a "click-hole" on a tablet. Next, we needed to move from the theoretical ideas of the production meetings to the real-time testing of workshops.

Beckham, our movement specialist, led our two-hour movement workshops efficiently and creatively. She recruited several of her dance students for the workshops, in addition to the actors Belock and I knew. During production meetings, we organized an agenda, but it was Beckham's natural skill at putting strangers at ease that truly shined and help shape the workshops.

During one of our early meetings, Belock and I stumbled upon a graphic about the "10 Levels of Intimacy in Today's Communication" by artist Ji Lee that got us thinking about how people relate to one another (See figure 8). We chose to use this graphic as a prompt in our workshops and we asked what would be an eleven, or a zero on this scsale.

In our Fall workshop, one student, Jordan Moranto, poignantly responded with, "I think [an eleven is] just listening" (Moranto, Workshop, 09/14/2015). She perfectly summed up the issue of our narcissistic social networking culture—we're so focused on being heard and understood, that we forget to listen, for it is through listening, that we learn to empathize. The feeling of being connected deepens and strengthens with that bond. Moranto's comment links directly back to Turkle's statement: "We're lonely, but we're afraid of intimacy."

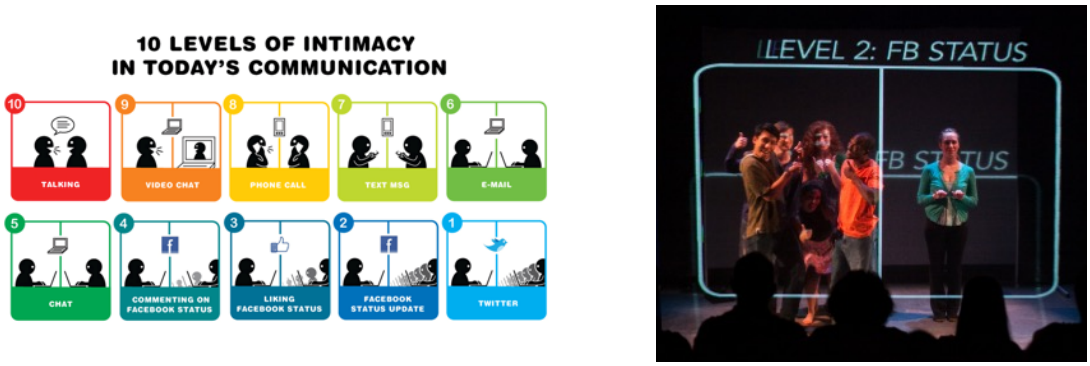


Figure 8: "The 10 Levels of Intimacy in Today's Communication" graphic by artist Ji Lee, which developed into the 10 Levels of Intimacy vignette in the performance. Production photo courtesy of Lawrence Peart.

Another beautiful moment in the workshops included the creation of what we titled "The Human Network," which became the ending the performance (See Figure 9). Beckham prompted the group with the question of what "loneliness looks like [in the body]" and told them to slowly travel the room and connect with another person. Without overt instruction, pairs connected to groups, and the end result was a gorgeous tableaux of connected bodies straining and slacking at their tethers. Some participants only

reached out with one hand, making a light connection, while others were in full body-contact. It was an engaging representation of how people need each other, seek connection, and choose to interact.

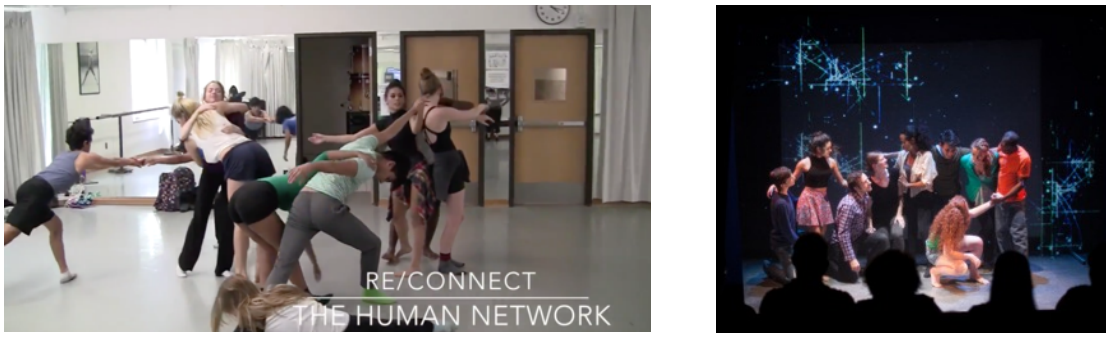


Figure 9: The Human Network in workshop and in the production. Production photo courtesy of Lawrence Peart.

It was very important to Belock and me to avoid placing blame on technology for the current cultural climate, or to praise it as some kind of savior, similar to Turkle and realtechnick. Technology is neither good nor bad—it is a tool, but it can be addictive. With this performance, we wanted to simply place a mirror before our audience. We aimed to provide an opportunity for reflection, and we stressed this parameter in every workshop event, allowing our team to create diverse work. By our official rehearsal period in March 2015, the workshop teams, Belock and I had developed a script framework that our final cast was able to build from and polish into a performance.

The Cohen New Works Festival and The Performance Venue

When selecting our performance space, Belock and I sought out an intimate space, but also a place that would be easily advertised. We were fortunate that every two years, the UT Department of Theatre & Dance puts on a campus-wide festival for new theatre and ideas called The Cohen New Works Festival (CNWF). We applied, were accepted, and through the festival, we received a stipend to produce the performance.

Additionally, we were able to offer course credit to our student collaborators (See Appendix F) through the CNWF, but most importantly, it provided us exposure to a wider audience. Typically, in the CNWF, productions share performance and rehearsal space. Because this performance was also our thesis work, and Belock needed to specifically arrange the space for projection purposes, we decided to hold the performance outside of the Winship Drama Building (where most festival productions are held), in the Student Activities Center black box. This choice was no mistake—we also wanted to put our performance in the hub of campus life, where many students share meals, study, procrastinate, and chat. In this space, we also chose to place our educational exhibits.

The "Behind-the-Seams" Educational Kiosk

The first part of education, evangelism, advertisement, or even expressing your feelings to another, is making your audience aware of the information you want to share with them. We wanted to advertise our performance to the campus, as well as the exciting technologies used in it. To accomplish this, I made an interactive exhibit table displaying the products used in the costumes, placed in the lobby outside of the performance. When theatergoers waited in line or just passersby stumbled upon the exhibit, they were able to try these new products and learn something about why and how they work. By placing a "science exhibit" in an nontraditional location, I had the opportunity to present arts and sciences on an equal and integrated plain.

It is one thing for a person to see a beautiful show, or to use an iPhone and believe it came from a magician—and while it feels wonderful when non-experts praise us for our talents, their ignorance can be detrimental. If the outside world is unaware of the effort that went into constructing technologies or building their entertainment, they can easily write it off. The mysteries of the sciences to an untrained eye are often viewed as too complicated to even try to understand, leading to a dearth in STEM (Science, Technology, Engineering, and Math) degrees in some cases, while the illusions of the arts lead some to believe "anyone can do that," negating their labor, and often restricting their funding. I wanted to remove the veil of my process because I wanted to show the crowd that this is

something that is possible to accomplish, yet not so simple that it is unimportant. We must all start somewhere, and the effort and the learning is as valuable as the finished product when you break new ground.

The educational exhibits were created to inform and inspire and Belock and I each created one. For Belock, it meant screening the documentary Connected by Tiffany Schlain in the performance space when the production was not happening, and a short interview video of Belock, assistant choreographer and performer Hallie Ward, and myself describing the process, playing before each performance. My display consisted of a 2' x 6' table and six large posters that showcased the technologies that went into the performance. I presented several types of micro-controller technology, including video of the final costumes reacting on a dress form, a variety of proximity sensor samples, and references to the products used. I wanted to show that these technologies were approachable, engaging, and fun, just as I had found them. Viewers could touch and interact with every part of the display, and they did so, gleefully. I was very happy to find that the exhibit encouraged viewers to seek out these technologies—many people asking me for more information—and sparked discussions about how science and art could be integrated.

Chapter 4: The Costumes of *RE/CONNECT*

Reaching Out: Building an Engineering Team

After Carvahlo returned to Portugal in May 2014, I spent the summer practicing simple circuits, teaching myself how to read schematics, and introducing myself to the basic coding language of Arduino. I also wrote additional grant applications, and researched possible functions for the costumes, while working remotely with Belock to organize our performance. However, despite all that I learned about electronics over the summer, I determined that I did not know enough to embark on such a large project alone.

For this reason, I reached out to the Cockrell School of Engineering again and heard from Victoria Bill, a Masters student in Electrical Engineering. Bill had been working in embedded systems and experimenting with Wearables herself, and was quite excited about the project. With her enthusiasm for the field, discerning eye, and patience, Bill proved to be an excellent tutor and partner. She wrote and altered code for the costumes, and used our work together as a teaching tool for her embedded systems class. She also designed a new micro-controller that contained all of the components we were using for this costume. Unfortunately, the parts available for her board were too bulky and fragile for a Wearable. The necessary alterations to strengthen and reduce the size required more research and development than we had time for, so we remained with our original design, which I will discuss later in this paper.

Design by Committee: Devising Costumes

Because of the devised nature of the production, and the fact that I was learning this new technology as I produced a show and led multiple teams (production team, engineers, stitchers, workshops, cast), I knew that designs and decisions were likely to change throughout the process. Knowing that the entire production process needed to move forward, I finalized the costume design in August of 2014 so I could begin prototyping work in the fall.

As mentioned earlier, it was important to me to create costumes that were not reactionary to the choreography or script, but rather ones that informed the development of these elements. I knew that I was interested in proximity-sensing Wearables and the importance of physical closeness, but the question was how to create something that would benefit all aspects of the performance. To this end, I consulted the group—most specifically our choreographer Beckham, co-lead/performer/media designer Belock, and engineer Bill—to arrive at the most visually interesting, and useful costume concept.

Specifically for Bill and I, we wanted to avoid the costumes becoming a "one-trick-pony." LEDs have been used on costumes in many types of performances, as have proximity sensors—and it is important and exciting to note that because Wearables are relatively new and open-source, they are quickly evolving. There is a good chance that as soon as this project is published, someone will develop something similar, and perhaps improve upon it. However, at the time this paper was published, I had yet to see both of these components incorporated into one costume, and in a way that the performers truly

controlled the costume's visual reaction. We wanted to do something different. We wanted to present the versatility of Wearables to our audience, which directly fed into Beckham's needs, offering her several options for movement.

The final costume design was meant to have three functions on each costume for versatility of choreography. The three functions of the designed costumes were:

- First, as two bodies approached each other and move to within a 10 foot range, they begin to glow, and increase in intensity until they reach a three-foot distance.
- From there, the LEDs would light in clusters underneath the proximity of a human hand (this was inspired by the Octolively kit I assembled over the summer See Figure 10).
- Finally, when the costumes were touched on any one of five conductive fabric touch pads, they would blink in corresponding patterns (this was inspired by my sample research of conductive fabric (See Figure 10).

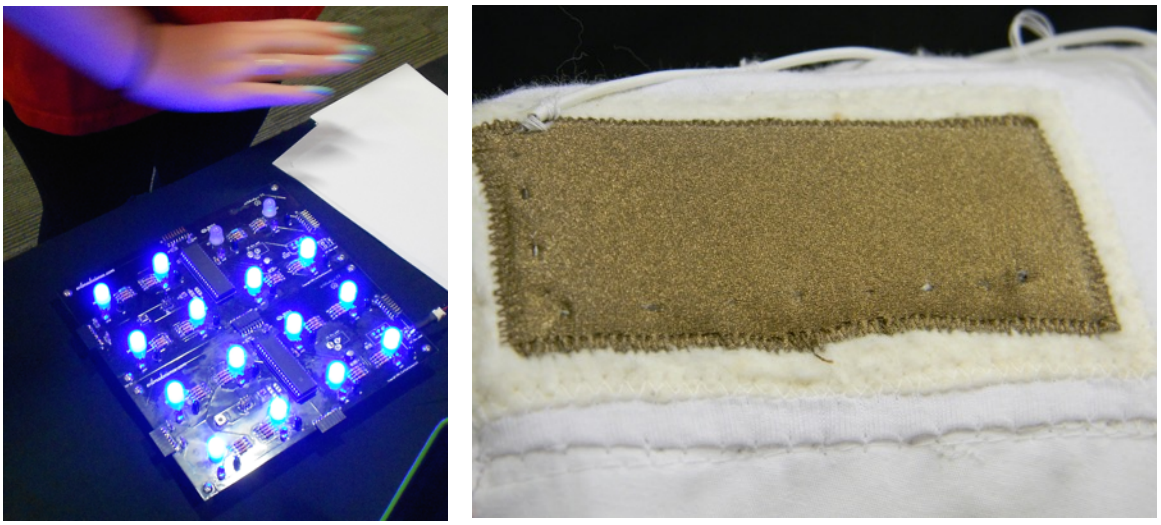


Figure 10: The Octolively interactive PCB table (left), Conductive fabric machine stitched onto cotton batting (right)

Beyond the electronic functions of the costumes, I knew they had to serve a visual design purpose as well. Belock and I wanted to cover the bodies in an organic, but thorough pattern of LEDs, in order to give a full glow appearance that "responded to the warmth of another person." We also wanted to visually reference the image of stars in space—acknowledging our fascination with night sky: before modern tools, people told stories and found each other by starlight. To avoid giving away this moment, all of these LEDs and electrical components were hidden in a textured pedestrian garment (sweaters) that were of a light grey color, to work as a projection surface for Belock's designs. Texture was chosen in order to hide the bumpy components, and to avoid a pixelated, "point-of-light" appearance. In my research, I found a previously existing Wearable dress designed by Mary Huang that was made of a variety of smocking textures that diffused the light and gave the costume a soft glow (See Figure 11).

Figure 11: Research image: scarf and dress by Mary Huang, used as aesthetic inspiration (Huang, Portfolio).

With the visual design decided, Bill and I had to select our materials; most importantly, above the design and appearance, the costumes had to be wearable. They needed to be comfortable and flexible for the performers, one of whom was Belock (the production team was still in the process of casting our second dancer into November 2014). Over the fall semester, Bill and I tested products that would be best for these costumes, worked out the schematic, and tested three prototypes before settling on the most final version before testing in rehearsal.

When selecting the electrical components, I had a few criteria. Whatever was selected had to be affordable, and easily programmable for inevitable alterations as I developed the costume and tried these new technologies on performers. I wanted LEDs that could be individually programmed, and could reach a brightness that would be visible, even under overhead lighting. I also wanted the ability to reprogram for other functions and future projects. For this reason, I chose Adafruit Industries' FLORA Neopixel. The Neopixel is a digital RGB LED that is available in a variety of layouts including grids, rings, and strips. Neopixels are designed for stitching, and lay flat to the body like a button. Because they are loose, and not attached in strip-form, I was able to arrange them in any way I wanted, much like one does with individual pearls, versus a string of pearls.

Neopixels (See Figure 12) are water-resistant, have a full, easy-to-understand code library, and are individually addressable. Normally, if the micro-controller pin were a light switch and the strands were christmas lights attached to that switch, standard

LEDs would all light at once when you turn the pin/switch on. Since the Neopixels are individually addressable, however, you can turn the pin/switch on and tell light #5 on the strand to turn on, without turning on the other bulbs on the strand, or you can tell light #5 to blink while all other lights are static and on, and so on. Standard LEDs are all or nothing, whereas the Neopixel actions can be specifically decided. Still, with these impressive capabilities comes a cost: the Neopixel is somewhat expensive. Compared to traditional "dumb" bi-pin bulb LEDs, which range from 25-50 cents each, the Neopixel is $2 per Wearable LED.

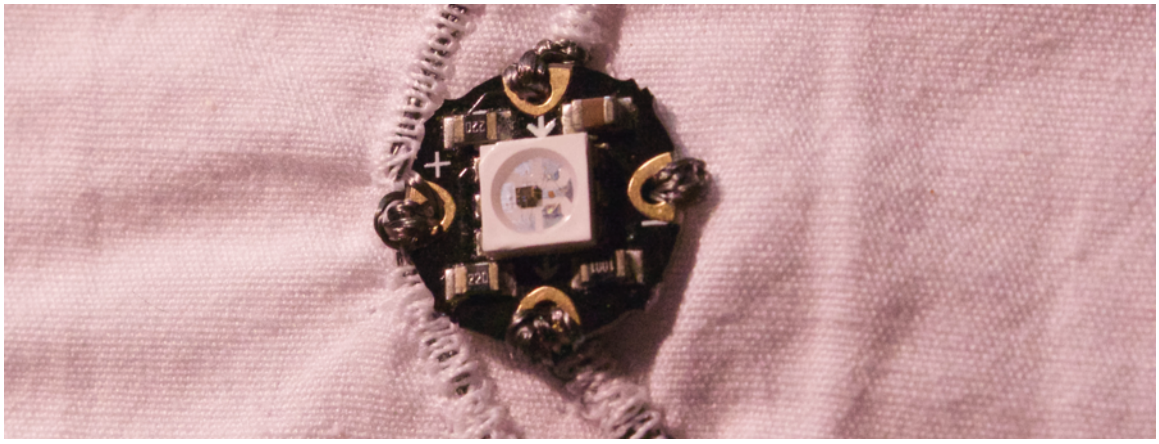


Figure 12: A FLORA Neopixel

In addition to the price of the Neopixels, I had to consider the cost of both real estate (how much space I had on the body of the costume), and power (how much energy it would take to power the LEDs). The other components selected for the costumes were an XBee wireless transmitter (for the long-distance function), which came with a Lilypad breakout board, conductive fabric strips for the capacitive touch function, and an infrared (IR) sensor pair. Bill and I decided upon the Sparkfun brand clear plastic IR pair because

they were low profile and worked in our sample tests (See Figure 13). A FLORA Neopixel is about the size of a dime. The Lilypad and Lilypad XBee are about the size of a silver dollar, as are the combined IR diodes & resistor pairs. The six conductive fabric strips (2”x3” in size) needed space as well. All of this needed to fit onto the bodies of our performers, who had 38” and 39” chest measurements.

Figure 13: (left) Sparkfun Infrared emitter and detector pairs (sparkfun.com) and pairs twisted with resistors and stitched to a carrier panel to make them Wearable (right).

I tested the space I had on each body by placing a mockup shirt onto dress forms that were the same sizes as my performers. When initially laying out the appearance of the garment, I used disappearing pens and paper stickers to mark out the component placement onto the costume, indicating each piece and wire (See Figure 14). Through this step, I was able to communicate my idea with my production team and determine what was aesthetically appealing to us all, decide how many Neopixels to order, and help Bill

figure out how to program the system, as well as estimate how much power each item would draw.

Figure 14: Two versions of the mockup layout process

At the same time I was arranging the system, Bill was testing the code and current draw. We found that if we put more than nine Neopixels on a line of conductive thread, or spaced the LEDs more than four inches apart, the entire strand would fail. That was because the Neopixels, with all of their features, require a lot of energy. In order to accomplish an LED matrix that reflected the organic arrangement of the original design, I had to stitch the LEDs in a less-direct pattern, and keep the space between them shorter

(See Figure 15). After taking into account price restrictions, pixel-per-strand limits, and the available area on the performers' bodies, we arrived at the arrangement pictured below. It allowed for a full, organic appearance, without the power or monetary expense of a perfect grid.

Figure 15: Arrangement of LED matrix on final costume.

The 3D Printing process

Another important design component of this project was the 3D printed Neopixel diffuser caps (See Figure 16). The caps are small plastic domes that soften the bright light of the LED. I chose to cover almost every Neopixel LED with a cap to give the costumes a more dynamic look. The texture of the sweaters granted some light diffusion, but the caps, and the way I chose to arrange them provided that "galaxy" image we had decided upon. We could have programmed individual Neopixels to be dimmer, which would have taken more memory space in the microchips on the boards, but the caps did more than bring the LEDs down in brightness—they also diffused the light, which was aesthetically appealing to us. The caps offered an interesting and fast solution for the design.

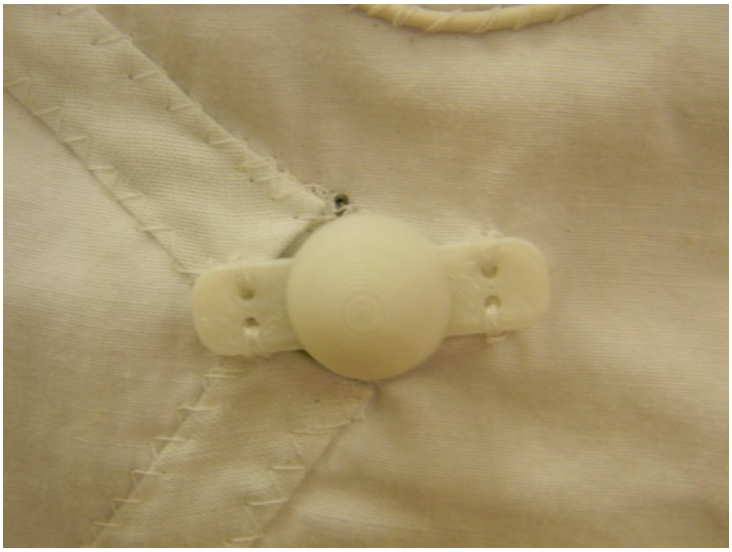


Figure 16: A 3D printed diffuser caps covering a Neopixel on the costume.

I found an open-source design for a 3D-printed Neopixel diffuser cap on github.com. Bill improved the design using Makerbot software, and made the dome a

little larger to fully cover the Neopixel. We utilized a Flashforge Creator Pro 3D Printer at the Longhorn Maker Studio in the Engineering Teaching Building (See Figure 17). We printed 105 Neopixel diffuser caps out of white 1.75mm Creator series ABS filament, which was free to us. In the standard process of 3D printing in a Flashforge machine, ABS filament coil is heated in and forced through an extruder and laid onto a warmed plate, which is inside of an oven-like box.

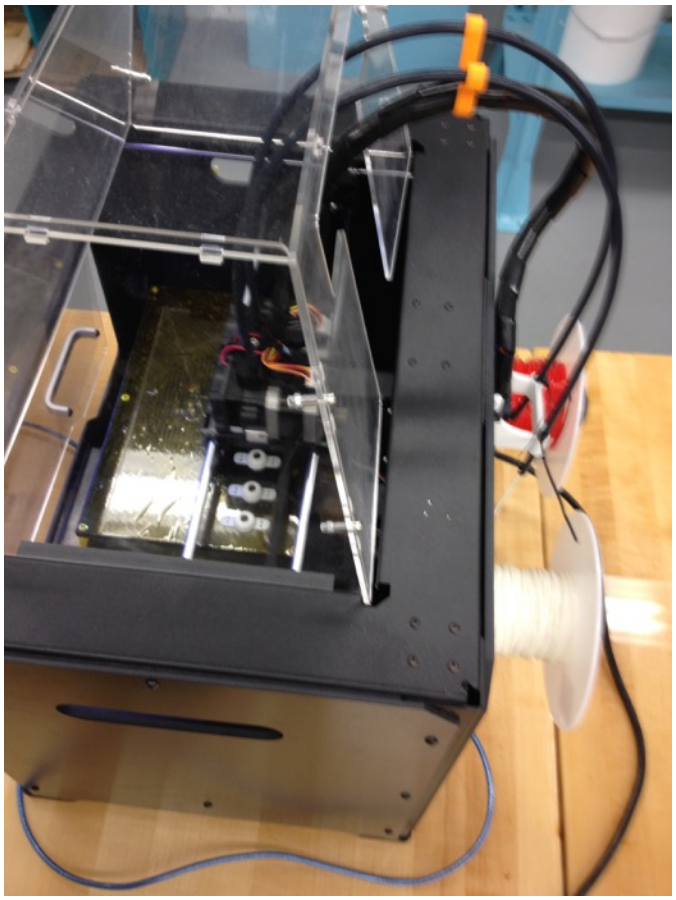


Figure 17: A bird-eye-view of the caps being printed in the Flashforge 3D printer. The spool of white ABS plastic is on the back of the machine, and heated and extruded through tubes that hang above the heated plate.

Typically, a thin layer of filament called a “raft” is laid down. The raft is meant as a frame for the object to be printed, and is to be scrapped. However, we found that printing without a raft resulted in sturdier caps, as the first layer of “real” filament was allowed to heat and melt into a solid piece, rather than the lattice as in the original design (See Figure 18). This process allowed for us to print 8 caps at once, and it took about 15 minutes per batch. It took about 3 hours and 15 minutes to print all of the caps. This process was much faster, cleaner, and more precise than what I could have done by hand.

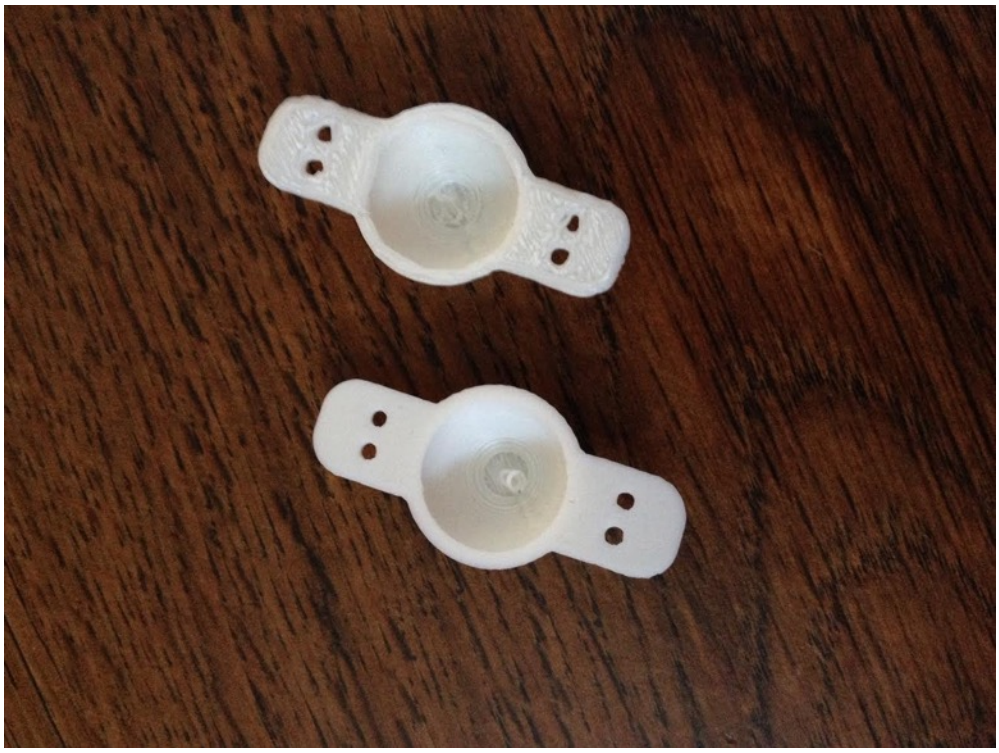


Figure 18: A cap printed with, and one without, a raft

The Costume Technician's Hand: Building a Wearable PCB

This process gave me the opportunity to utilize many of my costume technician's skills in new and unconventional ways. My draper's eye was used in arranging a clean-looking costume, taking into account electrical layout. I had to practice a light hand with some of the tiny electrical components, but a firm stitching technique to make strong electrical connections with the conductive thread. Teaching accurate machine stitching to my stitchers was very important as rails—the conductive thread lines that ran between Neopixels—need to be 1/4" apart to avoid crossing, but no further, to avoid taking up too much costume space. I even had to employ jewelry making skills in the first round of IR sensors by twisting tiny resistors and IR diode legs into perfect connecting spirals to provide stitching pads (resistors and IR diodes have not yet been manufactured in Wearable form, so I improvised). Most importantly, my pattern-making had to be clear and precise so as to communicate complicated information to new eyes.

As mentioned earlier, Bill and I began building the costume by drawing component placement on the garment with disappearing ink. This gave Bill the ability to code and assess power draw, and also allowed her to map out her schematic. A schematic is a paper representation of the hardware connections in electronics, made for the purpose of record and manufacturing. Engineers use symbols to indicate certain components and attachments that are not immediately recognizable to a common viewer. Bill created the schematic for the costume components, but used the format that reads easily to her field (See Appendix C).

The closest analog for a schematic in costume technology is a paper pattern. We use symbols to indicate things such as grain line, direction, and pleating, as well as notches to indicate connection points, rather than pins on a micro-controller. I had been studying electronics schematics over the summer, and can now understand them, but I am an exception in my field. If a small theatre is to find this technology approachable, it would have to be legible to their employees. Additionally, I had the stitching assistance of students with no experience with this notation system. In order for me to be able to hand this costume off to another person within my field, it was necessary for me to alter the schematic Bill made to accommodate a Wearable. Schematics do not typically show what the final product of the design will look like, but rather only which pin connects to another pin. It is a printed circuit board (PCB) design that maps out the length and layout of connections (See Figure 19). In this way, my pattern and costume became both schematic and PCB design for the Wearable costume (See Appendix D).

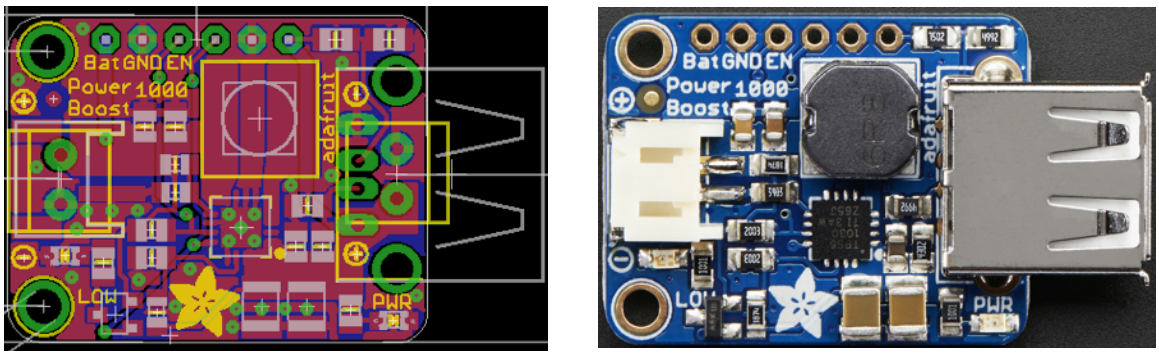


Figure 19: Left: A traditional PCB layout. Right: the finished PCB (adafruit.com).

The arrangement of a PCB, like a beautiful garment pattern, is an admirable feat. In this process, I created a new way of arranging my power (+) and ground (-) in my Wearables. Since ground and power can, respectively, cross themselves but not each other, I decided to create a grid of ground wires on the inner layer of cotton broad cloth. An electrical charge will follow the path of least resistance, so by making a gridded path, I offered more shortcuts for the current. While this is not dissimilar to how PCBs function, I have not yet seen anyone in my Wearables research do this (See Figure 20).

After all of the electrical hardware, one of the most important components was fabric for the body of the costume. We knew that whatever fabric we chose, it had to meet three criteria:

A. Performer comfort: the fabric had allow for body heat to escape, and the costume had to move with them.
B. Circuitry protection: the performers would sweat, and sweat could short out active circuits.
C. Material stability: While the knit conductive fabric does stretch, the conductive thread does not.

The simplest solution I came up with was layers. A PCB is often manufactured by laying circuitry into several insulated layers; in this costume, the fabric I chose served as said insulator.

1. The first layer was a “skin” layer, something like UnderArmor, to capture the performers’ sweat, and protect them from the potential discomfort of the steel

thread circuitry (there was no danger to the performers, as the voltage was less than 5 volts—the amount in a standard wireless landline phone).

2. The second layer was a cotton broadcloth, onto which the "ground grid" would be stitched (more on this later).
3. The third layer was more cotton broadcloth, upon which the Neopixels and their power and data rails, as well as the Lilypad, XBee, IR diodes/resistors, and the cotton batting-insulator and conductive fabric would be stitched.
4. The 3D printed caps were stitched on top of the Neopixel LEDs. On top of those components, the aesthetic edifice was stitched. The exterior were two different kinds of knits: 1) a grey polyester knit with a loose weave and a strong texture depth, draped and stitched to look like a shawl-collar sweater for Belock, the other a pulled grey v-neck sweater for Ward. It was important to us that the costumes looked like they came from the same world, but were not identical. I had to build Belock's sweater, as I had to cut holes for the sensors to poke through the material.

To facilitate movement, I made the interior sleeves out of a cotton spandex, and the sides of the interior shirts were made of the same material, to provide a sort of gusset. In fittings, we found that the costume could move, breath, and maintain its shape with no intervention. It was comfortable for the performers to wear, and it was easy to fit at the shoulders and side seams, should either performer gain or lose significant weight.

After a bit of research and testing our first prototype, we found that we needed to strengthen a few connections, particularly the "ground" and power rails. The conductive thread is not insulated like most wiring used in electronics, so some of the charge escapes the strand, denying power to the components. By laying three strands of 3-ply conductive thread together and zig-zagging polyester thread over them, binding them together, I fortified the connection and solved the problem of weak current.

Upon fixing the weak connections, I needed to find a way to reduce the number of wires and crossovers in the costume. In electronics, all circuits need to be completed with both a power and a ground connection. Each component required these attachments, in addition to their many data pins for sending and receiving information. Each Neopixel has four pins: one for ground, one for power, and two directional pins for data. Based on the aesthetic arrangement of the components, many wires were crossing over each other, which could lead to circuit shorts, if they were not properly insulated.

After I machine-zigged the 3 strands of conductive thread in the shape of the ground grid to the inner layer of cotton broadcloth, I machine-zigged the three strands of power rails on the outer layer. I then loaded the bobbin of 3-ply conductive thread into the machine, with polyester thread on top, and used a straight stitch to create the data rails, leaving long tails of conductive thread to tie to the Neopixels LEDs. After I finished my machine work with the conductive thread, I went back and hand-stitched each Neopixel onto its connection points (See Figure 20). I then flatlined the inner layer of

cotton broadcloth to the outer layer, and stab-stitched the ground connections on the Neopixels.

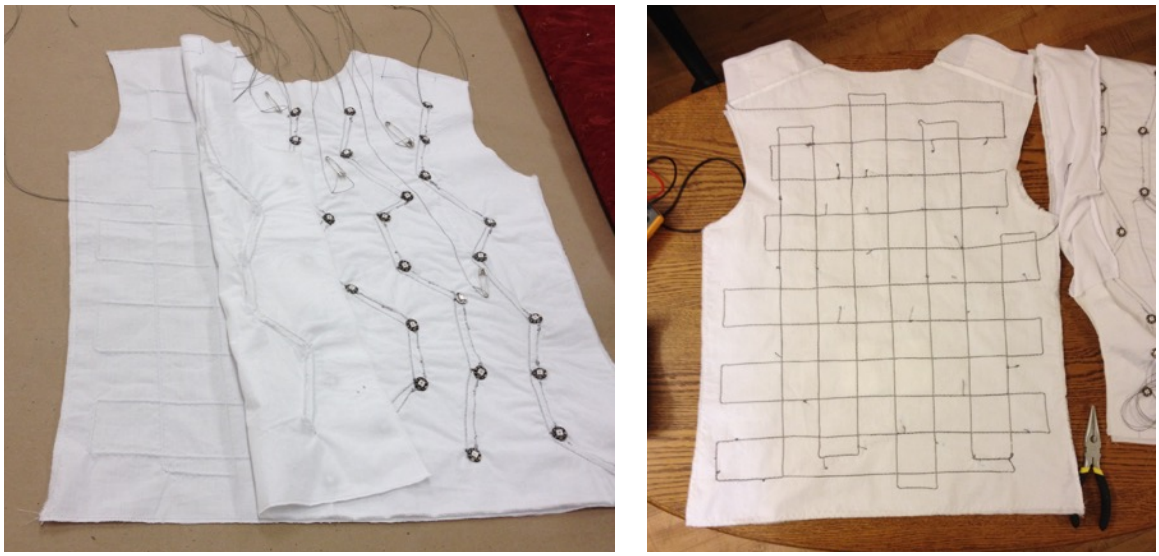


Figure 20: My Wearable PCB: (left) The Neopixels attached to the costume along the power and data rails. (right) The ground grid, with the Neopixel connections stab-stitched through.

It is also very important to note that when stitching with conductive thread, ease should be avoided. In traditional garment construction, when a ribbon, cord, or tape is appliquéd to a surface, ease is often worked in. As I discovered in testing the conductive thread, ease is detrimental to a strong electrical connection because knots can become loosened when the costume is worn. It is wise to tighten the knot of the conductive thread over the component, run the thread tail off if possible, dab the knot with Fray Check, and then use regular thread to lock the knot in place so the connection does not come loose from the component as the costume shifts on the dancer.

Prototyping hardware took longer than initially projected, and the final "skeleton" costumes were finished in late February. Because of our performance timeline, Beckham, Belock, and Ward, began rehearsing the pas de deux without the real costumes in early February. Much like one gives an actress a rehearsal skirt to practice movement in a period costume, I provided the group with dummy costumes (See Figure 21). The costumes were mock-ups with buckram-backed sensor indicators and padded weights stitched on, to serve as visual and physical reminders for choreography. Armed with these costumes and music from Taylor, the composer, Beckham found her movement.

Figure 21: Rehearsal costumes

Alterations & Finishing Techniques: The Code & The Costumes

Through the devising process—which allowed many elements to join and shape the performance simultaneously—the costume hardware design changed. Beckham discovered that the music, coupled with the skill of her dancing pair, inspired her to movement that could trigger the IR sensors before and more often than we planned. After a production meeting, I arrived at the decision to reduce the number of sensors—keeping the XBee transmitters (glowing at a 10 foot distance) on both costumes. Based on Belock's tendency toward staccato movement, and Ward's graceful legato, I chose to remove the IR sensor pairs from Ward's costume, and the capacitive touch sensors from Belock's. With this solution, Belock's costume would light in reaction to Ward's fluid movement, and Ward's costume would twinkle in response to Belock's targeted touch. This design change only allowed to further the visual concept of the important and unique relationships we form when we speak to another human being in person.

With the design problem was solved, the hardware and code needed to be altered. Bill had graduated from her Master's program in December, and this change occurred in February. The code she had created for the costumes was far beyond my ability to edit, and she had just begun a new job in a different state. She was able to put me in contact with one of her former undergraduate electrical engineering students, Rachel Lewis, in March of 2015. At the same time, Aaron Heidgerken-Greene (my friend who inspired me with his reed-switch ring) became available to help, working remotely from Minneapolis.

In the month before the production opened, the two used Bill's code as building blocks and finalized it.

Building from open-source code is a lot like altering a costume. A costume technician can build a garment from scratch to match a design, or they can pull existing garments and alter them to fit. The amount of work needed depends on how much costume (or code) already exists for your purposes. For the *RE/CONNECT* code, Lewis and Heidegerken-Greene treated Bill's code in this way. They did not have to begin from scratch, but there were some things that needed to be built back up for the evolving hardware arrangement.

Working with Lewis in person and Heidgerken-Greene remotely via Google chat and Chrome Remote Desktop made me realize just how large this project really was. I discovered that debugging takes nearly as much time in code as finishing does in garment construction. We also learned that once the costumes were completed in full scale—no longer as samples—the conductive thread gave us issue. Despite my strengthened 3-ply connections, the current struggled to reach some components due to underestimated power draw and resistance of the thread. Since the costumes were already assembled, I solved this by tightening and strengthening all connections with more strands of conductive thread, and in places that did not bend on the performers' bodies, solder.

Another component issue that arose upon full-scale completion was the original Sparkfun brand IR photodiode pairs Bill and I had selected. The sensors were chosen for their low profile, but it turned out that their ability to filter IR was not as great as

advertised, and they triggered in reaction to multiple kinds of light, not just IR. Lewis, Heidgerken-Greene, and I unsuccessfully tried several different methods to reduce their issues, including code filtering schemes, and creating a variety of IR pass filters with lighting gels (Lee brand Congo Blue and Primary Red, to be exact). In the end, we chose a new sensor type—the Sharp IR motion detector with Pololu carrier sold by Adafruit Industries (See Figure 22). While this sensor was larger than desired and not intended as a Wearable, it was sturdy, consistent, and simple to code. I painted them grey to match Belock's sweater, and the movement, projections, and distance of the audience from the performers made them less obvious. Unfortunately, I had to solder the connection on the carrier because the pins were too close together for conductive thread to be stitched tightly. I used stranded core wire to connect the sensors to the board, and while the insulated wire was bulkier and less flexible than I had wanted, it served its purpose well in the costume, and was not visible once the exterior was stitched.

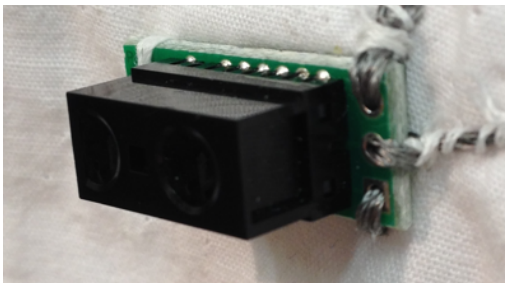


Figure 22: Sharp IR motion detector with Pololu carrier distributed by Adafruit Industries.

The capacitive touch costume had its own unique problems. I had to insulate the conductive fabric patches very thoroughly so they would not misfire when the performer wore the costume. I used several layers of cotton batting to do so, but as it turned out, that

was not enough to entirely insulate it from the performer's moving body. I eventually chose to use a molded sheet of 1/8" ABS plastic encased in pleather between the performer and the batting, as plastic is a more effective electrical insulator. I also did this on the CAP1188 breakout board. Much like the Sharp IR sensor with Pololu carrier, the CAP1188 required that I solder the connection with wire.

The largest problem we had with the hardware and code was letting go of what "should work, in theory." Since Arduino is relatively new, is designed to be accessible to non-engineers and applicable to a wide variety of projects, it's not yet perfected for Wearables. The software and hardware proved to be inconsistent and demanded many simple, but annoyingly time-consuming debugs. The irregular and unexpected problems became very frustrating, for it seemed that once we got one function working consistently, another would break, and so on. Because of cost, we tried our best to troubleshoot and make difficult components work, but because of time, decisions had to be made so we could move forward for the performance.

A time-consuming board communication difficulty was one of the reasons that we ultimately made the decision to cut the XBee transmitter for the performance. The other was the additional issue with memory space in the board. The code took up more space than anticipated. A larger microchip would solve this problem, but I was currently using the largest Wearable micro-controller chip on the market. Heidgerken-Green and Lewis tried their best to reduce the code space they had already written, but time and finicky hardware got in the way.

Chapter 5: Reflection

Many Hats and Herding Cats: My Role(s) in *RE/CONNECT*

When I began this project as a costume technician, I wanted to create an artifact that would allow technicians a voice in the devising process in relation to how a performance was shaped. I expected it to only be in regard to the pas de deux I designed for, but with the massive size the project grew to—and with my being one of a select few on our team familiar with a formal devising theatre process—I found myself wearing more hats than I had initially anticipated. As I learned, one cannot do just one thing in a devised piece they are producing—especially when that performance is part of a large campus-wide theatre festival.

Due to the difficulty of getting every team member in the same room at the same time (I think it happened twice in the entire year-and-a-half experience!), at several points in the process, I found myself serving as any combination of producer, director, stage manager, technical director, grant-writer, administrator, writer, film director, casting director, workshop leader, stand-in performer, advertiser, and researcher/dramaturge, as well as my intended role as costume designer, costume technician/hardware engineer, and costume project manager. While it was refreshing and reinvigorating to work in a studio on a devised project again, I spent much more time in rehearsals than I had initially expected to. Unfortunately, assisting in the rehearsals pulled me away from the costumes at times. This was especially true in the final three weeks leading up to the

performance.

As Heidgerken-Greene, Lewis and I spent afternoons trying to debug hardware and software, my nights were often given to directing rehearsals. Early mornings became the time I responded to rehearsal notes and venue prompts, while simultaneously supervising my team of undergraduate stitchers, as we altered hardware per the engineers' requests. It was a merry-go-round of changes in a tight time frame. I switched hats often and honed my ability to communicate with several different groups of people concisely and clearly. I admit that at each performance, I feared that something in the costume hardware would malfunction (thankfully it did not!), but all of the work, stitching-and-ripping, debugging, and rehearsal time paid off when the house opened for our first performance.

The Performance, Reception, and Next Steps

Due to our large team, the slow build of the project, our exposure through the festival, and the diligent marketing push by Belock and me, the show sold out online in a matter of minutes. After all of the work and research done for this piece, it was incredible to see it finally come together. The reaction to the final kiosk exhibit, the Wearable tech pas de deux, and the overall performance was overwhelmingly positive.

Upon this response, we were asked to add a performance at the end of the Festival week, and we chose to live-stream that show. While we had no method set up to track views, our entire cast and crew posted the link to their social media sites, and it was quickly shared from there. For those not on social media, we made access to the stream available on our archival website and playbill (See Figure 23).

Figure 23: The playbill for *RE/CONNECT* was a postcard with a QR link designed by Belock.

The CNWF allotted us response cards for our audience to fill out and two assigned professional guest respondents. Both our audience and our guest artists reviewed us with high praise, calling it "smart and beautiful," reacting to and seeing exactly what Belock and I had initially designed (Weller, 04/13/15, Austin). Different age groups had slightly different emotional reactions to the piece, as we had anticipated—the older generations finding it "frighteningly familiar," in some cases wishing the piece had a more overtly unhappy ending—and the younger finding it relatable. Another audience member told me he "actively reminded [himself] to keep [his] phone in [his] pocket" immediately after exiting the theatre (Weller, 04/15/15, Austin). The overall understanding—that we must recognize where our technology fits in our relationships with one another—was perceived universally (Weller, 04/15/2015, Austin). Both our official guest respondents and several others who voluntarily sought us out asked if we had plans to perform the piece again in other venues (Coniglio, 04/16/2015, Austin), and further develop the show into a full-length production. Pending funding and location, we absolutely do!

As for the educational exhibit, I was overcome with the enthusiastic response and conversation surrounding it. Each night, after one brave soul would begin the exodus, the kiosk became swamped with people interacting with the products (See Figure 24). The curious sounds and joyful laughter could be heard from the dressing rooms, and it even drew in a few non-theatre goers. Several

people asked if I would be interested in presenting the exhibit in their elementary, middle, or high school, and teaching a Wearables workshop. A few people from a variety of disciplines and age ranges even sought me out after the performances to inquire further about my process, and how they themselves can apply these technologies to their work (Weller, 04/2015, Austin). I was so pleased to overhear excited discussions of waiting audience members about the value of the arts and the sciences, and their integration.

Figure 24: The Kiosk Exhibit table.

The only comment that I received that was not overtly positive was that it was not inherently obvious to all audience members that the costumes were triggered by proximity and touch in the pas de deux. This was due in part to the choreography, but not the fault of it. As discussed earlier, the Wearable tech development took much more time and troubleshooting than initially anticipated, which stole rehearsal time from Beckham, Belock, and Ward. The rehearsal costumes could show where components were and how they felt, but not how

reactive they were. Belock and Ward claimed that the final costumes (See Figure 25) did not inhibit their physical movement because of their construction, but rather, the sensitivity of the sensors. Belock stated, "[In the IR costume] my movement was literally monitored at all times. I was suddenly being tracked on every move, forced to take ownership for […] decisive, or indecisive movements" (Belock, 04/21/2015, Austin). As choreographer and performer, Ward found it a "welcomed challenge" finding the balance between exhibiting the costumes' function and the romance of the movement:

> It gave more weight and importance to the movement—in order for the costumes to work, the movement had to work with it. The interactiveness and added imagery of our costumes made our physical and emotional connection stronger while choreographing and performing. This enhanced not only our characters onstage but the interconnected world as a whole that we were attempting to create in the entire show. These costumes were of course a positive experience. With every new endeavor comes troubleshooting and challenges. We're at the point where dance and movement can benefit from new possibilities in technology to help us say more with our bodies. It's a good reminder that there is always a way to reinvent and approach movement differently to work alongside technology. (Ward, 04/26/2015, Austin)

Now that the garments have been completed and performed in, what the costumes, performers, and the choreographers need is more time to explore this relationship.

Figure 25: Belock (left) and Ward's (right) finished costumes with Ward's exposed "skeleton" (far right)

Artistic directors of Troika Ranch, and our guest respondents, Mark Coniglio and Dawn Stoppiello, stated that "regardless [of the proximity reaction not being clear], the [pas de deux] moment was magical and beautiful," and "absolutely belonged in the piece as is," but that "an entire show could be dedicated to exploring uses for those costumes," and based on all of the other themes Belock and I wanted explore, there just was not time for it in this performance (Coniglio, Stoppiello, 04/16/2015, Austin). The artistic director of Stuart Pimsler Dance Theatre in Minneapolis inquired if we may use these technologies in a future piece together (Weller, 04/16/15, Austin). I look forward to an opportunity to further develop the costumes, find new ways to improve the hardware layout, and apply them to another performance in the future.

Future Wearables Applications

The steep learning curve and research experience of this project has been incredibly invigorating. I am so grateful for all of the support I have received throughout the process, and I am humbled and honored to be attracting the interest of several groups to continue this research. Upon graduation, I hope I can find the funding and time to create a product that I now know would have made the entire development process easier. While I essentially developed a Wearable circuit board, it would have been most helpful to my costuming process if a platform existed for designing and "printing" a woven one. Leah Beuchley (inventor of Lilypad) had started developing needle-felted circuit boards in wool felt with her MIT students, but she has since left MIT, and there is no indication that she ventured into knits or cottons--which is what would be most useful for theatrical performances.

In electronics, if possible, hardware is arranged on a single printed circuit board (PCB). The PCB is designed using the schematic as reference, and often, the design is sent to a manufacturer to print. A PCB is designed and built so that one can take as little space as possible in as linear and organized of a structure as possible. A PCB is made by laying down a layer of metal to conduct all of the ground (this is why I made the ground grid on the inner shell), some layer of non-conductive material (cotton fabric in my case) with gaps for wires to poke through after the layers have been joined (stab stitching through all layers, in my case). Then a power grid is laid down, with the same process (the outside layer of the costumes), another insulating layer (cotton bias tape casing), and

then the data/signal circuitry (also on the outside of the costumes and covered with bias tape).

I chose to restrict the layers of fabric I used because more layers equal more trapped body heat on a dancer. The costume was already four layers total (two layers of cotton, plus the skin layer of underarmor, and the decorative sweater exterior). Additionally, crossed circuits and noise often happened in my project due to fuzzy or loose conductive thread knots, and the uninsulated nature of conductive thread. Despite my best efforts to tighten them and Fray Check each knot, they would still loosen and fuzz after wearing. A woven PCB would allow me to arrange my schematic on one or two layers of fabric with thorough circuitry insulation, to allow more air flow, and a simpler stitching arrangement. It also would have offered the opportunity to avoid crossing circuits or electronic noise.

Conclusion

The greatest difficulty for me in this process was limiting myself. Both in the performance, and in the costume production, I wanted to learn everything, build everything, and explore every topic in great detail, from all possible angles. I assembled my wonderful team knowing that I could not do it all, but often found myself tempted back into the old habit of being over-involved. Despite myself, I found the performance, the product, and the process to be a great success. The process did not always go as I had originally envisioned, and the Wearable technology products required more troubleshooting than initially expected, but the whole project still became something beautiful, moving, educational, and inspiring for the wider Austin community. For that, I am immensely proud of myself and my team. At the start, I put the unnecessary parameter on myself that this thesis had to be a final perfect product of something, as if I would stop working on this project—or stop learning and studying, upon my graduation date.

After the incredible reaction to the work, Belock and I are in discussion about the continuation of the production of *RE/CONNECT* in other venues as early as Fall 2015. After all I have learned about collaboration, devising, team management, educational outreach, Wearable technology, and my own artistic methods from this process, I certainly intend to continue and improve upon all of this research. Turkle describes my feelings best:

> We transgress not because we try to build the new but because we don't allow ourselves to consider what it disrupts or diminishes. We are not in trouble because of invention but because we think it will solve everything. A successful analysis disturbs the field in the interest of long term gain; it learns to repair along the way. One moves forward in a chastened, self reflective spirit. Acknowledging limits, stopping to make the corrections, doubling back–these are at the heart of the ethics of psychoanalysis. A similar approach to technology frees us from unbending narratives of technological optimism or despair. (285)

As an artist, I am forever driven by my desire for perfection. This production, and each of its facets were a prototype to be forever improved upon, revised and revisited, just like the tools we develop for communication. It is not perfect, and there may never be a "complete" version, but we should keep trying, reworking, sharing, and pausing to reflect as we go. By synthesizing the techniques of the traditional costume technician with an ever-evolving technology, I have begun a new conversation between the arts and sciences. By using the avenue of a theatrical performance with the costumes as the vehicle, I have made a statement about the importance of human connection. Look up from your screen. Reach out to another person. You may be surprised at the reaction.

Appendices

Appendix A: IRB Approval Form

OFFICE OF RESEARCH SUPPORT

THE UNIVERSITY OF TEXAS AT AUSTIN

P.O. Box 7426, Austin, Texas 78713 · Mail Code A3200
(512) 471-8871 · FAX (512) 471-8873

FWA # 00002030

Date: 03/11/15

PI: Kristen A Weller

Dept: Theatre and Dance

Title: RE/CONNECT

Re: IRB Expedited Approval for Protocol Number 2015-02-0046

Dear Kristen A Weller:

In accordance with the Federal Regulations the Institutional Review Board (IRB) reviewed the above referenced research study and found it met the requirements for approval under the Expedited category noted below for the following period of time: 03/10/2015 to 03/09/2016. *Expires 12 a.m. [midnight] of this date.* If the research will be conducted at more than one site, you may initiate research at any site from which you have a letter granting you permission to conduct the research. You should retain a copy of the letter in your files.

Expedited category of approval:

☐ 1) Clinical studies of drugs and medical devices only when condition (a) or (b) is met. (a) Research on drugs for which an investigational new drug application (21 CFR Part 312) is not required. (Note: Research on marketed drugs that significantly increases the risks or decreases the acceptability of the risks associated with the use of the product is not eligible for expedited review). (b) Research on medical devices for which (i) an investigational device exemption application (21 CFR Part 812) is not required; or (ii) the medical device is cleared/approved for marketing and the medical device is being used in accordance with its cleared/approved labeling.

☐ 2) Collection of blood samples by finger stick, heel stick, ear stick, or venipuncture as follows: (a) from healthy, non-pregnant adults who weigh at least 110 pounds. For these subjects, the amounts drawn may not exceed 550 ml in an 8 week period and collection may not occur more frequently than 2 times per week; or (b) from other adults and children2, considering the age, weight, and health of the subjects, the collection procedure, the amount of blood to be collected, and the frequency with which it will be collected. For these subjects, the amount drawn may not exceed the lesser of 50 ml or 3 ml per kg in an 8 week period and collection may not occur more frequently than 2 times per week.

☐ 3) Prospective collection of biological specimens for research purposes by non-invasive means. Examples:
   (a) Hair and nail clippings in a non-disfiguring manner.
   (b) Deciduous teeth at time of exfoliation or if routine patient care indicates a need for extraction;
   (c) Permanent teeth if routine patient care indicates a need for extraction.

(d) Excreta and external secretions (including sweat).
(e) Uncannulated saliva collected either in an un-stimulated fashion or stimulated by chewing gumbase or wax or by applying a dilute citric solution to the tongue.
(f) Placenta removed at delivery.
(g) Amniotic fluid obtained at the time of rupture of the membrane prior to or during labor.
(h) Supra- and subgingival dental plaque and calculus, provided the collection procedure is not more invasive than routine prophylactic scaling of the teeth and the process is accomplished in accordance with accepted prophylactic techniques.
(i) Mucosal and skin cells collected by buccal scraping or swab, skin swab, or mouth washings.
(j) Sputum collected after saline mist nebulization.

☐ 4) Collection of data through non-invasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing. (Studies intended to evaluate the safety and effectiveness of the medical device are not generally eligible for expedited review, including studies of cleared medical devices for new indications).
Examples:
(a) Physical sensors that are applied either to the surface of the body or at a distance and do not involve input of significant amounts of energy into the subject or an invasion of the subject's privacy.
(b) Weighing or testing sensory acuity.
(c) Magnetic resonance imaging.
(d) Electrocardiography, electroencephalography, thermography, detection of naturally occurring radioactivity, electroretinography, ultrasound, diagnostic infrared imaging, doppler blood flow, and echocardiography.
(e) Moderate exercise, muscular strength testing, body composition assessment, and flexibility testing where appropriate given the age, weight, and health of the individual.

☐ 5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for non-research purposes (such as medical treatment or diagnosis).
Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(4). This listing refers only to research that is not exempt.

☒ 6) Collection of data from voice, video, digital, or image recordings made for research purposes.

☒ 7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.
Note: Some research in this category may be exempt from the HHS regulations for the protection of human subjects. 45 CFR 46.101(b)(2) and (b)(3). This listing refers only to research that is not exempt.

☒ Use the attached approved informed consent document(s).

☐ You have been granted a Waiver of Documentation of Consent according to 45 CFR 46.117 and/or 21 CFR 56.109(c)(1).

☐ You have been granted a Waiver of Informed Consent according to 45 CFR 46.116(d).

Responsibilities of the Principal Investigator:

1. Report immediately to the IRB any unanticipated problems.

2. Submit for review and approval by the IRB all modifications to the protocol or consent form(s). Ensure the proposed changes in the approved research are not applied without prior IRB review and approval, except when necessary to eliminate apparent immediate hazards to the subject. Changes in approved research implemented without IRB review and approval initiated to eliminate apparent immediate hazards to the subject must be promptly reported to the IRB, and will be reviewed under the unanticipated problems policy to determine whether the change was consistent with ensuring the subjects continued welfare.

3. Report any significant findings that become known in the course of the research that might affect the willingness of subjects to continue to participate.

4. Ensure that only persons formally approved by the IRB enroll subjects.

5. Use only a currently approved consent form, if applicable.
   Note: Approval periods are for 12 months or less.

6. Protect the confidentiality of all persons and personally identifiable data, and train your staff and collaborators on policies and procedures for ensuring the privacy and confidentiality of subjects and their information.

7. Submit a Continuing Review Application for continuing review by the IRB. Federal regulations require IRB review of on-going projects no less than once a year a reminder letter will be sent to you two months before your expiration date. If a reminder is not received from Office of Research Support (ORS) about your upcoming continuing review, it is still the primary responsibility of the Principal Investigator not to conduct research activities on or after the expiration date. The Continuing Review Application must be submitted, reviewed and approved, before the expiration date.

8. Upon completion of the research study, a Closure Report must be submitted to the ORS.

9. Include the IRB study number on all future correspondence relating to this protocol.

If you have any questions contact the ORS by phone at (512) 471-8871 or via e-mail at orsc@uts.cc.utexas.edu.

Sincerely,

James P. Wilson

James Wilson, Ph.D.
Institutional Review Board Chair

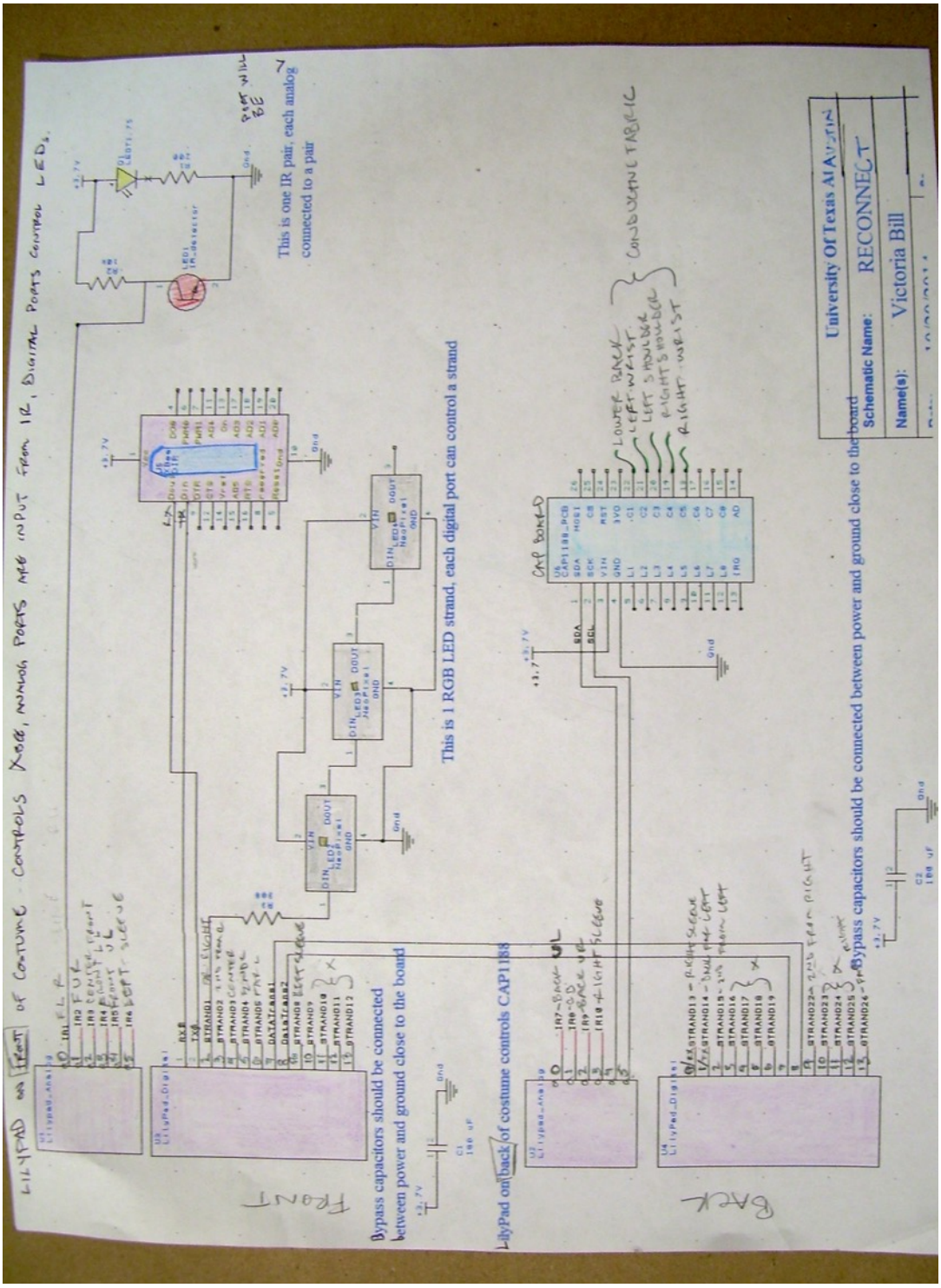
Appendix B: Production Budget

COSTUMES			
Product	**Number**	**Cost**	**Total Cost**
Lilypad 328 Mainboard Sewable Microcontroller	4	16.96	67.84
Xbee chip	2	12.71	25.42
Xbee breakout board	2	12.71	25.42
Conductive Fabric	2	9.95	19.90
Capacitive Touch Breakout board	1	12.69	12.69
Sharp IR sensors w/ Pololu Carrier	8	6.95	55.60
Chainable, sewable, programable Neopixel LEDs	200	1.99	398.00
LiPoly Battery	4	10.30	41.14
Adafruit PowerBoost 5v breakout board	4	14.95	59.80
3-ply Conductive Thread bobbin	18	5.95	107.10
3D Printing 200 LED diffuser caps	105	FREE through MakerSpace	FREE
Shirts for prototyping	4	8.00	32.00
Sweaters; knit fabric yardage	1; 4 yds	Free; 10.00/yd	40.00
Cotton Broadcloth for "skeleton" layers	4 yds	5.00	20.00
Cotton knit for "skeleton" layers	3 yds	8.00	24.00
Ensemble Costume	6+	FREE Costume Stock or Personal	FREE
Resister Pack	2	7.96	15.92
Shipping of all components			200.00
TOTAL			1,144.83

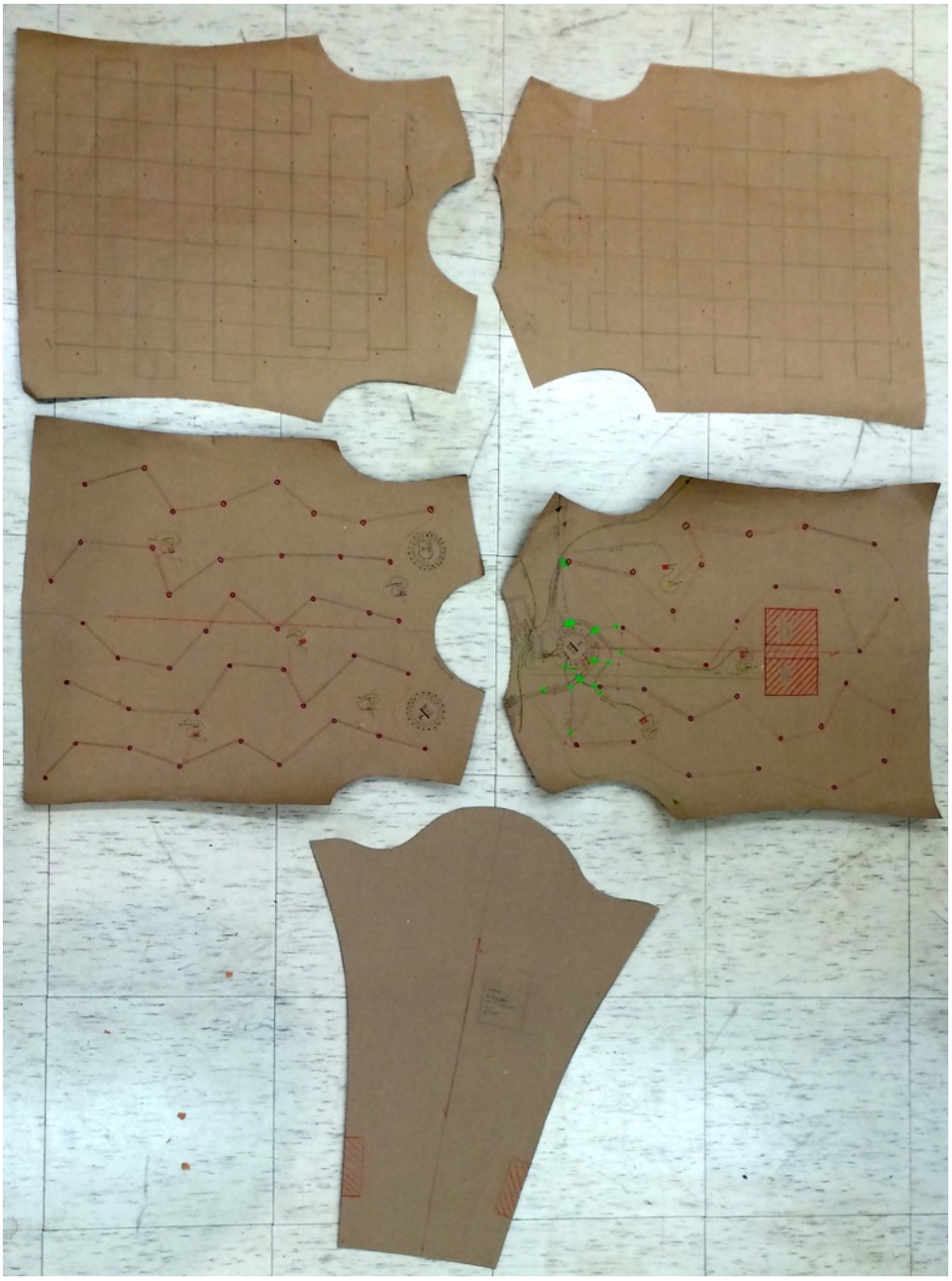
(Continued)

Costumes KIOSK			
Product	Number	Cost	Total Cost
Poster Printing	12	1.00	12.00
Foam core	6	1.00	6.00
Makey Makey kit	1	50.00	50.00
Octolively interactive PCB table	2	35.00	70.00
Octolively power adapter & AVR programmer	1	39.71	39.71
Pack of Jumper wires resistors, & LEDs	1	10.00	10.00
Arduino Uno board	1	24.95	24.95
Flora board	1	24.95	24.95
Coated Solid and Stranded Core Wire	3	2.00	6.00
Circuit Scribe conductive ink Pen	1	25.00	25.00
Paper for Conductive pen	1 pad	FREE	FREE
iPad & Mac computer	1 each	Borrowed/FREE	Borrowed/FREE
Docent	1	FREE (me)	FREE (me)
USB Cables	4	9.99	38.96
TOTAL			307.57
Projection Kiosk			
Product	Number	Cost	Total Cost
Camera, lights, green screen for Recording	1 set	FREE through TD department	FREE
Projector for screening	1	Rented from UTiM	FREE
Scrim	1	part of performance	(already paid)
Educational screening license "Connected" by Tiffany Schlain	1	295.00	295.00
TOTAL			295.00
Projection/Production			
Product	Number	Cost	Total Cost
Hard Drive	1	80	80
Grey Sharkstooth Scrim	1	399.99	399.99
"Screen Goo" for coating scrim	1	200.00	200.00
RP Screen	1	Rented from UTIM	FREE
Stock video & animation content	1 subscription	100	100
Scenic Materials		105	105
Lighting Materials		FREE through CNWF	FREE
Masking Materials		FREE through CNWF	FREE
Venue rental	1	FREE through UT SAC	FREE
Artist Labor		FREE through Independent Studies	FREE
Shipping			80
TOTAL			964.99
GRAND TOTAL			**2,687.37**

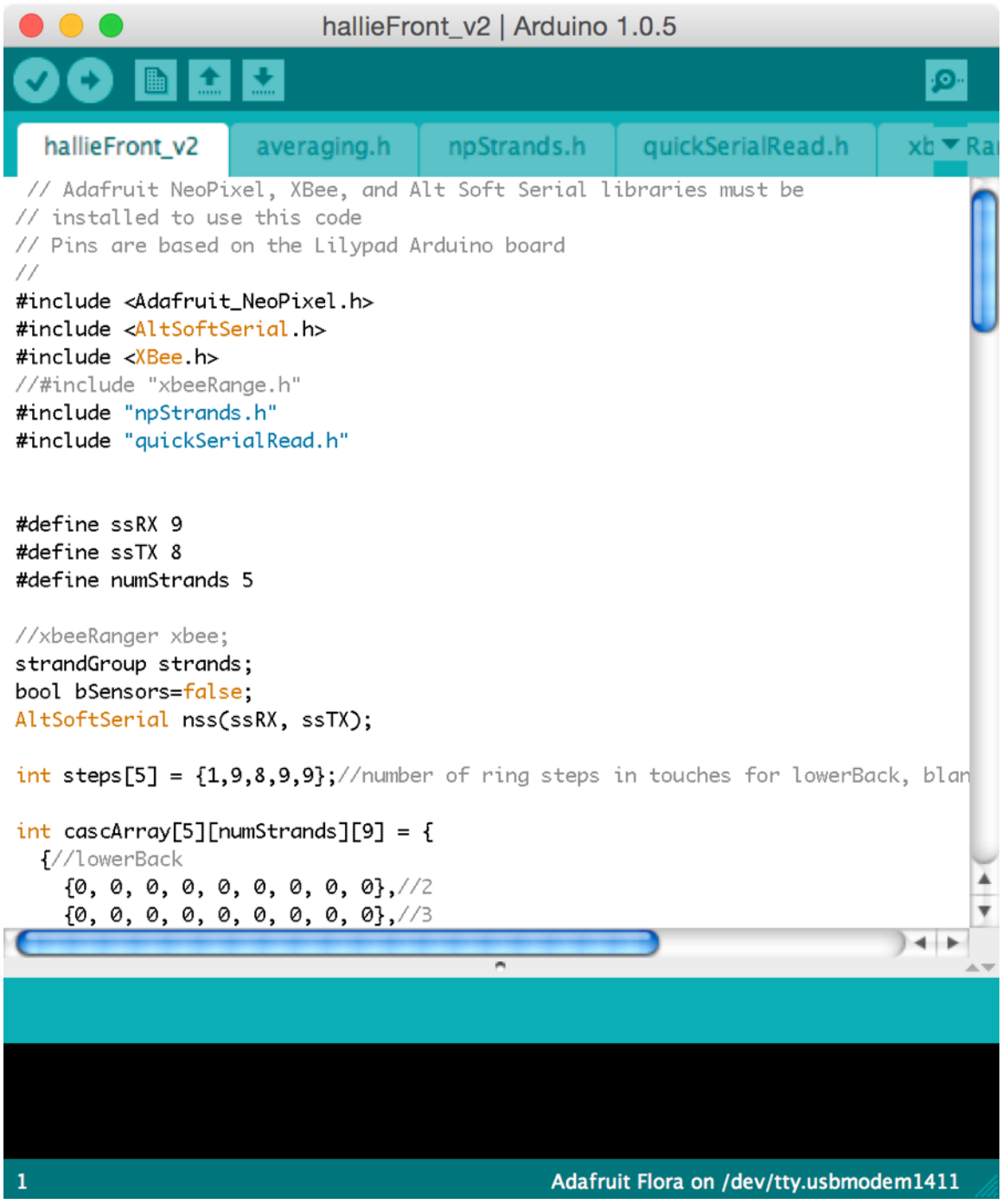
Appendix C: Original Schematic



Appendix D: Costume Pattern



Appendix E: Costume Code



Arduino Software window

Hallie (Capacitive Touch) Front & Back

```
 // Adafruit NeoPixel, XBee, and Alt Soft Serial libraries must be
// installed to use this code
// Pins are based on the Lilypad Arduino board
//
#include <Adafruit_NeoPixel.h>
#include <AltSoftSerial.h>
#include <XBee.h>
//#include "xbeeRange.h"
#include "npStrands.h"
#include "quickSerialRead.h"


#define ssRX 9
#define ssTX 8
#define numStrands 5

//xbeeRanger xbee;
strandGroup strands;
bool bSensors=false;
AltSoftSerial nss(ssRX, ssTX);

int steps[5] = {1,9,8,9,9};//number of ring steps in touches for lowerBack, blank, leftSho

int cascArray[5][numStrands][9] = {
  {//lowerBack
    {0, 0, 0, 0, 0, 0, 0, 0, 0},//2
    {0, 0, 0, 0, 0, 0, 0, 0, 0},//3
    {0, 0, 0, 0, 0, 0, 0, 0, 0},//4
    {0, 0, 0, 0, 0, 0, 0, 0, 0},//5
    {0, 0, 0, 0, 0, 0, 0, 0, 0},//6
  },
  {//leftWrist
    {9, 8, 7, 7, 6, 6, 6, 6, 0},//2
    {8, 7, 6, 5, 4, 5, 4, 4, 0},//3
    {8, 7, 6, 5, 5, 4, 3, 3, 3},//4
    {7, 6, 5, 5, 4, 3, 2, 2, 0},//5
    {8, 7, 6, 5, 4, 3, 2, 1, 1},//6
  },
  {//leftShoulder
    {4, 5, 5, 6, 7, 8, 9, 9, 0},//2
    {4, 5, 6, 7, 7, 8, 8, 8, 0},//3
    {3, 4, 5, 5, 6, 6, 6, 6, 7},//4
    {2, 3, 3, 4, 5, 5, 5, 7, 0},//5
    {1, 2, 2, 3, 4, 0, 4, 5, 4},//6
  },
  {//rightShoulder
    {1, 2, 3, 3, 4, 4, 4, 4, 0},//2
    {2, 3, 4, 5, 6, 5, 6, 6, 0},//3
    {2, 3, 4, 5, 5, 6, 7, 7, 7},//4
    {3, 4, 5, 5, 6, 7, 8, 8, 0},//5
    {2. 3. 4. 5. 6. 7. 8. 9. 9}.//6

   {//rightWrist
     {6, 5, 5, 4, 3, 2, 1, 1, 0},//2
     {6, 5, 4, 3, 3, 2, 2, 2, 0},//3
     {7, 6, 5, 5, 4, 4, 4, 4, 3},//4
     {8, 7, 7, 6, 5, 5, 5, 4, 0},//5
     {9, 8, 8, 7, 6, 7, 6, 5, 6}//6
   }
 };

 void parseSerial(String str){
   Serial.print("Received ");
   Serial.println(str);
   if(str.charAt(0)>48&&str.charAt(0)<57){
     int value =int(str.charAt(0))-48;//str.substring(str.indexOf('=')+1).toInt();
     cascade(cascArray[value], steps[value]);
     Serial.print("Received ");
     Serial.println(value);
   }
   else if(str.startsWith("sensors"))
     bSensors=str.substring(str.indexOf('=')+1).toInt();
 }

 void setup()  {

   int lightPins[5] = {2,3,4,5,6};
   strands.init(lightPins);

   // start serial
   Serial.begin(9600);
   // and the software serial port
   nss.begin(9600);

   sirl.init(nss,parseSerial);
   // now that they are started, hook the XBee into
   // Software Serial
   //xbee.init(0x005E,nss,strands);
   //xbee.setThresholds(0x35,0x27);


 }

 void loop() {
   sirl.idle();
   //xbee.idle(Serial);
 }

 void writeLights(String str){
   int val = str.substring(str.indexOf('=')+1).toInt();
   strands.writeAllLights(val,val,val);
 }

 void refreshNeoPixels(int array[numStrands][9],int val){

    for(int i=0; i<numStrands; i++){
      strands(i).setByArray(array[i],val);
    }
  }

  void cascade(int array[numStrands][9],int steps){
    for(int i=1; i<=steps; i++){
      refreshNeoPixels(array,i);
      delay(40+i*10);
    }
    strands.writeAllLights(0,0,0);
    strands.writeAllLights(0,0,0);
    //delay(1000);
  }
```

```
//#include <CapacitiveSensor.h>
#include <Adafruit_NeoPixel.h>
#include <AltSoftSerial.h>
#include <XBee.h>
#include <Adafruit_CAP1188.h>
#include <Wire.h>
#include <SPI.h>
#include "capWrap.h"
#include "npStrands.h"
#include "quickSerialRead.h"

// AltSoftSerial always uses these pins:
//
// Board          Transmit  Receive   PWM Unusable
// -----          --------  -------   ------------
// Arduino Uno        9         8         10

#define ssRx 8
#define ssTx 9

#define numStrands 4

AltSoftSerial nss(ssRx, ssTx);

strandGroup strands;

bool bSensors=false;

int steps[5] = {5,6,7,7,7};//number of ring steps in touches for lowerBack, blank, leftSho

int cascArray[5][numStrands][8] = {

  {//lowerBack
     {4, 3, 3, 2, 2, 2, 0, 0},//4
     {4, 3, 2, 1, 1, 1, 1, 2},//2
     {4, 3, 2, 1, 1, 1, 1, 2},//11
      {5, 4, 3, 2, 3, 2, 2, 2}//12
  },
  {//leftWrist
     {1, 2, 2, 3, 4, 5, 0, 0},//4
     {1, 2, 3, 4, 4, 5, 5, 6},//2
     {2, 3, 3, 4, 5, 5, 5, 6},//11
      {2, 3, 3, 4, 4, 5, 5, 6}//12
  },
  {//leftShoulder
     {1, 2, 2, 3, 4, 5, 0, 0},//4
     {1, 2, 3, 4, 4, 5, 5, 6},//2
     {2, 3, 3, 4, 5, 5, 5, 6},//11
      {2, 3, 3, 4, 4, 5, 5, 6}//12
  },
  {//rightShoulder
     {3, 4, 5, 5, 6, 7, 0, 0},//4

    {3, 3, 4, 5, 5, 6, 6, 7},//2
    {2, 3, 4, 4, 4, 5, 6, 6},//11
     {1, 2, 3, 3, 2, 0, 4, 5}//12
  },
  {//rightWrist
    {3, 4, 5, 5, 6, 7, 0, 0},//4
    {3, 3, 4, 5, 5, 6, 6, 7},//2
    {2, 3, 4, 4, 4, 5, 6, 6},//11
     {1, 2, 3, 3, 2, 0, 4, 5}//12
  }
};

void writeLights(String str){
  int val = str.substring(str.indexOf('=')+1).toInt();
  strands.write4AllLights(val,val,val);
}

void parseSerial(String str){
  if(str.startsWith("lightState")){
    //writeLights(str);
  }
  else if(str.startsWith("sensors")){}
    //bSensors=str.substring(str.indexOf('=')+1).toInt();
}

void capHandler(int rxVal){
  int   rec   =   (rxVal+1)/2;//converts from pads 0,1,3,5,7 to 0,1,2,3,4
  //nss.print("pad=");
  nss.println(rec);
  Serial.println(rec,DEC);
  cascade(cascArray[rec],steps[rec]);
}

void setup() {
  // only have 1st board talk to computer

  int temp[numStrands] = {4,2,11,12};
  strands.init(numStrands,temp);
  Serial.begin(9600);

  //cap.begin(0x29);
  capWrap.init(capHandler);

  nss.begin(9600);

  sirl.init(nss,parseSerial);
}

void loop() {
  //sirl.idle();
//  if(bSensors) //this was causing the cap sensors to never register
  capWrap.idle();

  for(int i=0; i<numStrands; i++){
    //strands(i).rainbow();
  }
}

void refreshNeoPixels(int array[numStrands][8],int val){
  for(int i=0; i<numStrands; i++){
    strands(i).setByArray(array[i],val);
  }
}

void cascade(int array[numStrands][8],int steps){
  for(int i=1; i<=steps; i++){
    refreshNeoPixels(array,i);
    delay(50+i*15);
  }
  strands.writeAllLights(0,0,0);
  delay(1000);
}
```

Ryan (Infrared) Front & Back:

```
#include <Adafruit_NeoPixel.h>
#include <XBee.h>
#include <AltSoftSerial.h>
//#include "FreeMemory.h"
#include "averaging.h"
#include "npStrands.h"
#include "IR_control.h"
#include "xbeeRange.h"

#define ssRX 8
#define ssTX 9

const int numSense = 5;

strandGroup strands;
IR_input sensors[numSense];
xbeeRanger xbee;
//AltSoftSerial SoftSer(ssRX, ssTX);

String inputString ="";         // a string to hold incoming data
boolean stringComplete =false;  // whether the string is complete


int irArray[5][9]={
    {2,2,2,2,1,1,1,1,0},
    {2,2,3,1,1,1,1,1,1},
    {2,2,3,3,3,3,5,5,0},
    {4,4,3,3,3,5,5,5,1},
      {4,4,4,3,5,5,5,5,5}
};

void writeLights(String str){
  int val = str.substring(str.indexOf('=')+1).toInt();
  strands.writeAllLights(val,val,val);
}

bool bSensors =false;

void parseSerial(String str){
  if(str.startsWith("lightState"))
    writeLights(str);
  else if(str.startsWith("sensors"))
    bSensors=str.substring(str.indexOf('=')+1).toInt();
}

void setup(){
  Serial.begin(9600);

 // SoftSer.begin(9600);
//   sirl.init(Serial,parseSerial);

  //xbee.init(0x009E,Serial,strands);

  //xbee.setThresholds(0x35,0x27);

  //Serial.println(freeMemory());

  int temp[5] = {2,3,4,5,6};

  strands.init(temp);
  for(int i=0; i<numSense; i++){
    if(i!=3&&i!=4) sensors[i].bind(i,strands,irArray);
    else if(i==3) sensors[i].bind(4,strands,irArray);
    else if(i==4) sensors[i].bind(3,strands,irArray);
    //sensors[i].setThreshold(20);
  }

  pinMode(13,OUTPUT);
 // strands.writeAllLights(0,0,0);

}

void loop(){
  /*for(int i=0; i<5; i++){
    strands(i).rainbow();
    //strands[i]->test(255,0,0);
  }*/
  //sirl.idle();
  if(bSensors||1){
    for(int j=0; j<numSense; j++){
      sensors[j].idle();
    }
  }
}
```

```
#include <Adafruit_NeoPixel.h>
#include <XBee.h>
#include "averaging.h"
#include "npStrands.h"
#include "IR_control.h"
#include "xbeeRange.h"
#include "quickSerialRead.h"
//#include "FreeMemory.h"

const int numSense = 3;

strandGroup strands;
IR_input sensors[numSense];
xbeeRanger xbee;

String inputString ="";         // a string to hold incoming data
boolean stringComplete =false;  // whether the string is complete

int irArray[5][9]={
    {1,1,1,2,2,2,0,0,0},
    {1,1,1,1,1,2,2,2,0},
    {3,3,3,2,2,2,2,2,0},
    {3,3,3,3,3,3,2,2,0},
     {0,0,0,0,0,0,0,0,0}
};

void writeLights(String str){
  int val = str.substring(str.indexOf('=')+1).toInt();
  strands.writeAllLights(val,val,val);
}

bool bSensors =false;

void parseSerial(String str){
  if(str.startsWith("lightState"))
    writeLights(str);
  else if(str.startsWith("sensors"))
    bSensors=str.substring(str.indexOf('=')+1).toInt();
}

void setup(){
  Serial.begin(9600);
  sirl.init(Serial,parseSerial);
  int temp[5] = {4,2,9,12,5};
  strands.init(temp);

  for(int i=0; i<numSense; i++){
    sensors[i].bind(i,strands,irArray);
    //sensors[i].setThreshold(20);
  }

  //Serial.println(freeMemory());


    pinMode(13,OUTPUT);
  }

  void loop(){
    if(bSensors||1){
      for(int j=0; j<numSense; j++){
        sensors[j].idle();
      }
    }
  }
```

Appendix F: List of Collaborators

Performers:
Sean Tecson
Ryan Belock
Amber Wall
Mae-Rose Hill
Tyler Michael Cullen
D'Lonte Lawson
Kathryn Victory
Lizette Chapa
Hallie Ward

Musicians:
Ammon Taylor (Piano)
Jenna Wright (Percussion)
Ilia De la Rosa (Cello)

Costume Team:
Victoria Bill (Hardware Engineer)
Rachel Lewis (Embedded Systems Engineer)
Aaron Heidgerken-Greene (Electronic Integration Specialist)
First Hand: Kelly Decker
Stitcher: Elizabeth Jones
Sticher: Neha Sukumar

Production Team:
Stage Manager: Kristian Wolf Piña
Co-Producer/Costume Designer: Kristen Weller
Co-Producer/Projection Designer: Ryan Belock
Movement Specialist: Andrea Beckham
Choreographer: Hallie Ward
Composer: Ammon Taylor
Associate Composer: Jenna Wright
Lighting Designer/PD Engineer: Matt Smith
Playwrights: Lydia Blaisdell, Joanna Garner, Kristi Rice, Eva Suter
Dramaturg: Chase Gladden
Assistant Projection Designer: Kaiwen Fa
Technical Director: Madison Russ

Support:
UT Austin Integrated Media Department
UT Austin Student Activities Center Black Box
The Cohen New Works Festival Presented by Broadway Bank

Appendix G: Script from *RE/CONNECT*

An interdisciplinary exploration of the fascination with technology and intimacy

April 13-17, 2015
SAC Black Box Theatre
University of Texas at Austin
Part of the Cohen New Works Festival presented by Broadway Bank

Exploring loneliness, community, and intimacy through the medium of visual, aural, and corporeal relationships with projections, music, and text, RE/CONNECT asks what is a right relationship to technology? In an era of intense interfacing with i-devices and avatar identities, this interdisciplinary performance prioritizes what the performing arts contribute to understanding the relationship of humans to each other, both on screen and off. Where does a human find their identity in an increasingly digital world? MIT psychologist Sherry Turkle posits, "We are lonely, but afraid of intimacy."
Does the internet, smartphones, and infinite apps deprive us of our humanity? Do social networks deprive the people who use them of a fuller knowledge of human intimacy? These vignettes and narratives of music, movement, and media aim to explore concepts of human-to-technology relationships, communication, and to deepen our understanding of how humans connect.

RE/CONNECT

An interdisciplinary exploration of the fascination with technology and intimacy

April 13-17, 2015 | SAC Black Box Theatre, University of Texas at Austin
Part of the Cohen New Works Festival presented by Broadway Bank

Performers:
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Playwrights: Lydia Blaisdell, Joanna Garner, Kristi Rice, Kristen Weller, Eva Suter
Dramaturg: Chase Gladden
Assistant Projection Designer: Kaiwen Fa

Costume Engineers:
Hardware Design & Code Development: Victoria Bill
Embedded Systems & Code Development: Rachel Lewis
Code Development: Aaron Heidgerken-Greene

Advisors:
Costume Technology: Jim Glavan
Projection Design: Sven Ortel
Acting: Quetta Carpenter
Research: Megan Alrutz
Dance Costume: Yacov Sharir
Percussion: Thomas Burritt

Support:
The University of Texas at Austin Student Activities Center Black Box Theatre and Space Reservation Desk
The Cohen New Works Festival presented by Broadway Bank

RE/CONNECT ABSTRACT

Exploring loneliness, community, and intimacy through the medium of visual, aural, and corporeal relationships with projections, music, and text, *RE/CONNECT* asks what is a right relationship to technology? In an era of intense interfacing with i-devices and avatar identities, this interdisciplinary performance prioritizes what the performing arts contribute to understanding the relationship of humans to each other, both on screen and off. Where does a human find their identity in an increasingly digital world? MIT psychologist Sherry Turkle posits, "We are lonely, but afraid of intimacy."

Does the internet, smartphones, and infinite apps deprive us of our humanity? Do social networks deprive the people who use them of a fuller knowledge of human intimacy? These vignettes and narratives of music, movement, and media aim to explore concepts of human-to-technology relationships, communication, and to deepen our understanding of how humans connect.

RE/CONNECT

An interdisciplinary exploration of the fascination with technology and intimacy

PRE SHOW

The audience enters a room with a looming tablet that swipes through the internet. Expert 'vloggers' (video-bloggers) appear and impart their wisdom to whoever's watching. We see a large text heading "Internet-i-quette" on top of the following entries:

If you're dating someone, you're required to like their new profile picture.

Never write a Facebook status long enough to require a "see more" click.

The safest cover photo is you with a group of people.

Your snapchat story should never be longer than 60 seconds.

Don't argue with your parents on Facebook.

If your Instagram photo has less than 11 likes, take it down.

Knock on my door, don't text me "i'm here"

Never like your own picture. Anywhere. Ever.

Don't over hashtag.

Don't reply with "k".

IF you are in a long term relationship and you change your profile picture everyone thinks you broke up

Be wary of the like button when Facebook stalking

Don't hashtag "hashtag".

"THE ABSOLUTE TOP ABREVS TO LIVE BY ACCORDING TO THIS AUTHOR" suddenly appears as the heading over the following entries:

DAB - Drunk ass bitch (or Down ass bitch)

SMH - Shake my head

TTFN - Tata for Now

SOML - Story of My Life

On pointe - on fleek

BGBS - Bitches get back seat

YAAAAS

Totes def

Check my snap

Troll - punk

BAE or BB -

Grexting - Group Texting

YOLO - You Only Live Once

GTFO - Get The Fuck Out

BFFLs

AF - as fuck

DTF - down to fuck

Twinsies

Boo-thang

Turn Up

Turnt

Suddenly, a girl walks out with her computer like she's been mindlessly watching all of the videos for far too long. It's time to stop. She closes her laptop and the video shuts off.

CELL PHONE SYMPHONY (Pt. 1)

_____

Everything stops and it seems the first scene will begin. A person tells the crowd to silence their phones; marimba cell-phone symphony happens. The person gets frustrated that they cannot locate where the cell phone ringing is coming from. The ringing stops. We'll hear more of this symphony later…

Good Evening/Afternoon and welcome to RE/CONNECT!

Invites audience to clap

Thank you all for coming today. We have a fantastic show for you. But…before we begin, we would ask that you turn off all phones and electronic devices, so as to not distract the actors or other audience members.

Thank you again! And enjoy the show!

phone rings

Ooops! Looks like we've got a few stragglers here (laughs)…you just shut that off and I'll….

walks away

phone rings

Turn off all electronic…

phone rings

Turn…

phone rings

Enjoy the show.

OVERTURE

Giant iDevice scrolls through YouTube clips, email, websites, Facebook, common online activities, perhaps some auto correct conversation fails, scroll across the device. We see signs of people logging on, creating profiles, social avatars, choosing their identity, choosing false identities, everyone wants to view many things online and be viewed many ways online. Eventually the media narrows on two social profiles and their conversation begins…

LONG DISTANCE

Two partners occupy separate areas of the stage through this. They're each somewhat engaged in various tasks, but also on their phones. We see the text on the projection screen. Or do they say it out loud? The sounds and silence of texting. Maybe this conversation already started during the overture?

Michael

Thinkin about u

Emily

Sorry it took me so long to reply
What's up?

Michael

(…) *that dot thing that means someone is typing...for a while*

Emily

Love you

Michael

Just missing u
;-)

Emily

Break's over :(
Still on for later?

Michael

Hell yeah!!

Emily

Don't fall asleep in class
Again
=P

Michael

Got literally a gallon of coffee

:/
See u tonite <3

Emily

cant wait
:-* (kissy face or face with hearts for eyes)

A transition with movement or something.

Michael

@twittergirla This dog looks exactly like your brother. Tell me it's not true.

Emily

@twitterboyb Buzzfeed's 20 Dogs That Fail at Life

Michael

@twittergirla (Dog picture)

They switch to texting because this is getting too hawt for twitter.

Emily

(picture of a small dog)

Michael

(picture of a dog in a hat)

Emily

(cartoon dog picture)

Michael

(dog in bathing suit picture)

Emily

(Nick Offerman holding a handful of bacon)

Michael

I surrender.

Emily

Trump card =P
<3

Another transition. We're into sexytime Skype date.

Michael

Can you hear me? I can't hear you. Lemme reset my internet.

Emily

Hi babe. How's your week going?

His video cuts out

Emily

Oh. I lost you.

She can goof around and make faces into the Skype mirror. She's got a beer.

Meanwhile he is furiously messing with his laptop to fix the internet. His internet returns. She's making a very silly Mick Jagger faces while dancing about to Miss You by The Rolling Stones.

Emily

Hear that song?!

Michael

Can you hear me now?

Emily

Yeah. It's *Miss You*. Get it?!

Michael

Yeah. I can't hear it though. It sounds funny.

Emily

Oh shit. Okay.

She turns off the music.

Michael

How was your day?

Emily

Same chapter different day

Michael

Yeah, livin the dream

Emily

Actually, the printer broke and I *fixed* it.

I feel so fucking handy.
Do you see these muscles?

Michael

I see ‘em

Emily

Yeah, you like that?

Michael

Mayyybe.

Emily

How’s what’s-his-face?
Still got a baton up his ass?

Michael

Of course. He’s maestro.

Emily

Oh poor guy.

Michael

Will you read me your copy of *The Dubliners*?
I wanna hear those dirty passages you got highlighted.

Emily

Next time.

Michael

Dang

Emily

For real, how was class?

Michael

I’ve still got my composition due tomorrow so I can’t talk long.

Emily

So let’s do this.

She presses a button.
Miss You comes on loud. They have a Skype dance party & dance around for each other’s amusement.

Michael's music is playing too, but a few seconds behind. It's charming & goofy.
After a moment: a bang on Michael's wall.

Michael's Roommate
(offstage)
Dude. Cut it out. I'm trying to watch Walking Dead.

Michael
Sorry.
Makes a face.

Emily
Love you.

Michael
Love you too.

Emily
Oh! I bought my ticket today.

Michael
Awesome.

Emily
67 days!

Michael
We can do it.

Emily
Goodnight.
I'll text you after lunch.

Michael
Sweet dreams.

TRANSITION:
A big hand swipes all contents off the Giant iDevice and swipes on the next episode.

LEVELS OF INTIMACY

A living diagram tracks through different levels of communication. Bodies transform their bodies in order to tableau from one level to the next. A projected boundary box and surroundings fade from one level to the next to support the necessary environment changes. A voice narrates the text that is projected large over the

NARR.

(In an almost Siri-like voice)

There are several levels of intimacy one may choose when deciding to interact with another human being.

Level 1: Twitter

Level 2: Facebook Status

Level 3: Snap Chat

Level 4: Facebook Message

Seque to…

CLOSING THE BOOK (Pt. 1)

It's time to quit Facebook…for now. The following message is projected in real-time as it is delivered as a comedic monologue.

Miranda

Hello World,

Starting today I will be Departing from Facebook for a while. Now, now don't cry I've come to this decision over lots of self-reflecting and soul searching (yoga you know). You see there comes a time in your life when you must look at where you are, and where you want to go, and I've come to that point.
I need a change.

Yours,
Forever and Always,

(Smile and Wink)

Miranda

(*False Exit)*

But if you need me, as I know some of you might, I will be using the Facebook messenger app, so I won't really be THAT far away. Also, if anything monumental happens, I will just HAVE to post about it, for you all have to know about it. BUT I will NOT be posting regularly. I really do need the "cleanse" from Facebook.

(*Looks to one audience member)*

Since you don't know me, I use to post a lot in the past, hehe… A Lot.
Yours,
Forever and Always,

(Smile and Wink)

Miranda

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

NEWS ITEMS

_____

Poetry that finds itself into the internet space. Perhaps overlaps with movement.

Rupert Murdoch
and the speakers
in the newsroom
playing the sound of typewriters typing for people who did not grow up writing on typewriters

this projected nostalgia
via technology
no one here has ink on there hands everyone pushing in ear buds against the clackety clack

the dot dot dot
in the circle
the messenger says you are typing you are typing
the dot dot dot
hanging vacant
all of this promising
you have something to say
and I am waiting
in peculiar anxiety
like staring at a pot
about to boil

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

CALLING CARDS

or
let's take a second and think about calling cards
not as a metaphor
but as a physical object
By Eva Suter

_____

futuristic reflections on technological advances; Movement monologue? Pre-filmed

the purposed thing they were back in the day
when their were not telephones

or wires really
I'm pretty sure
but not sure there were not wires
maybe they coexisted with telegrams
but not many people would have one

when did they start using telegrams?
and when did homes get electricity so that it was
much easier to stay up all night
reading a book
or talking to someone who was there
or writing letters and novels in letters
there were a lot of novels made out of letters
but when did the telephone come in so in?
in all the artificial light you
could sit and talk the hours away the miles away
into the unending night

hen did they put in the TVs?
but that doesn't matter as much and when
was the computer? and the internet
and at some point before the electric type writer was very important
and then everyone talked in blocky green letters and at that point it was
a pretty limited club like the people with the telegrams
everyone else was still talking on their phones
checking messages on answering machines
with funny messages recorded celebrity impersonations there were
miniature cassette tapes full of celebrity impersonations to use as
the outgoing message on your answering machine coming home the red light blinking

somewhere green text blinking and all the blinking like the 12:00 12:00 12:00
the microwave clock because the storm last night and the power went out when
was it that they outlawed power? that was after and the people with
the answering machines and the doctors and drug dealers with
the beepers would flash numbers and tell them secret things in code
on the computers everything was going to be in code and the same with the cell phones
which were bricks and fit neat in your pocket and were so small and not as small and
there was talking to people who were not at the grocery store at the grocery store there
was calling people at work and at the store and hitting the keys so many times to send
letters post cards the codes that were promised on the internets and video phones like
the Jetsons? you could make a cutout version of your face if you wanted cam girls to
see the best side of you and when did they outlaw electricity?

when was that? when was the last time letters were written on paper instead of

whispered into bottles and tied to the backs of rats? when did you have to start tipping the rats? when did that happen, right? and the calling cards tied to the feet of sparrows to invite the neighbor over for daylight conversation before sunset and curfew and nights used to be so long, right? when did they invent the cards? calling cards faces on them smiling the details of the message taken in messages of sent? and pheromones? when was it that they used to speak? when did we start these pheromones? I heard they used to speak with mouth and type with fingers and never even heard of light color-coded mists like our grandfathers had

I heard they didn't even have properly developed antennas that's just a story
I'm sending my sent message and you'll know by the warmth in your center and
you will come here and share stories about the larvae and hive life oh hive life how did anyone get by before the hives what was this static energy that they banned and the codes we don't even have to pheromone anymore we know each other so well

we can just bask in each other's electromagnetism

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

TWITTERVERSE

Small group and/or monologue scrolls through the most current trending topics and headlines of the day (yes, the exact day of the performance!) A human (or few) will attempt to deliver the wealth of information that Twitter offers all in one breath (phew!)

TRENDING:
Current Trending Tweets, hashtags, and Facebook news delivered at an inhumanly fast pace.

All disperse with:

BREAKING: Matthew McConnaughey is handing out free Gordoughs donuts @ UT SAC!!! #Yummy

CLOSING THE BOOK (Pt. 2)

They're still here…

Miranda

I just wanted to update y'all on my progress, because I know it has been a while. I've been getting a few Facebook message, and I wanted to like you know, I MISS YOU TOO!

Anyways, my "cleanse" is going beautifully. I feel as though I am getting so much done. They always say it is more about the process then the finally result and I feel like I understand that now. It speak to my inner… aura… I don't know if you can tell but I am glowing right now. Without Facebook I feel like a new person, but don't worry I am still me!

Yours,
Forever and Always,

(Smile and Wink)

Miranda`12

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

WRITER'S BLOCK

Two actors stand far apart from each other, facing the audience, both staring intently at their phones. They never send a full conversation, just struggle with what they might say. We see their text message edits projected larger than life. Unbearable silence.

ONE

hey

Sends it. We see it displayed as a sent message.

TWO

hi

Sends it. We see it displayed as a sent message.

what's up?

Sends it. We see it displayed as a sent message.

ONE

not much

Sends it. We see it displayed as a sent message. Starts typing again.
The agonizing "…" displays on their side of the sent messages.

i love you.

Deletes it. The text was never sent. This goes on…

TWO

Starts typing again.
The agonizing "…" displays on their side of the sent messages.

i want to fuck you.

Deletes all except "I want to." Tries to find the perfect end of the sentence.

ONE

i want to go down on—

Deletes all except "I want to." Tries to find the perfect end of the sentence.

TWO

make love—

Deletes it.

ONE

lick every part of—

Deletes it.

TWO

tie you up and—

Deletes it.

ONE

hold your hand—

TWO

take you for ice cream—

Pause.

They both delete all except "I want to."

Pause.

ONE

get coffee

Deletes it.

TWO

so walking

Deletes it.

ONE

sit quietly, saying nothing

Deletes it.

TWO

just be in the same room. On the same block.

Deletes it.

(frustrated, bursts out)

How do I…?

ONE

(out loud)

I don't know what to say!

clears text.

types again.

not much

Sends it.

Pause.

TWO

cool

Sends it.

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

SHUT DOWN

A personal relationship needs to be shut down.

Large face talks on the tablet

You know that friend that seems to know everything and everyone, but doesn't seem to know anything about you?

Projection cuts to real person, standing in a pedestrian area. People walking about at normal tempo.

So, I'm having problems with a friend like this, and I can't seem to shut him off. I mean, he once was the apple of my eye, but now I feel disconnected from him. You know what I mean? I see him every day and I rely on him too much. I mean, I really appreciate him always being there to back me up, but he monitors everything I do. I think I need to just get away from him for a while.

Suddenly everything in the world slows down. Very slow. Our speaker remains at a normal tempo. Focus has shifted.

Okay. Confession time: I just realized that this is an unhealthy relationship, but I think recognition is the first healthy step towards dealing with the problem. I ignore his basic needs and complain when he does anything wrong even though he is literally always there for me.

He's my social outlet, and my comfort when I'm bored. He is always willing to help me with my homework, yet most of the time we just end up on Facebook or tumblr, and then I get angry blame him when I realize I'm behind.

You know? He's one of those guys who are well-informed and well-connected, but he literally has no filter. Almost every night he interrupts my work to warn me I use him too much and he's running out of energy to keep up with me. One time he even notified me that too much of my life is pouring into his space.

It makes me feel so isolated when we spend hours alone together and we don't actually get anything done. And I know I'm not the only one who complains about how slow he can get, even though he's always eager to be kept up to date. I don’t know what his deal is! Look, I know I'm not giving him enough credit for what he's worth. When we're together we do plenty of fun things

Suddenly everyone resumes moving normal tempo.

like iMessage, iChat, iWeb, iPhoto, iMovie, iBook, iPad, iPod, but for goodness sake, Mac, I'm losing my mind, I think it's time we unplug.

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

LONELY

What does it mean to be lonely? Michael's voice is heard. Emily dances a solo. This is her true passion over writing. Other voices take over the delivery of the text through video clips.

Lonely was not the voice you hear on the wind sometimes
Though you're kind of sure it was

Lonely was not the shade of light from the TV screen
The subtle pulsations of color from the you tube channel
The girl in all those pictures
So many pictures

Lonely might have been the girl
In all those pictures
So many pictures

The girl and the partner
And the dog and the child
The letter never sent back in the days when letters were sent often

Lonely was not a flavor of novelty ice cream

Lonely was the taste of envelope glue

Lonely was the smudge of ink on the hand

Lonely was the forgetting of all the calls to be made
Lonely was lunches and coffees never had

And the pictures of that girl
And the taste of envelope glue

And the in that one picture
The one with the dog
That she still looks like a girl
Who might have loved you
In middle school
High school

That temporary job
That cross town bus that one time

Lonely was not the cartoon dog
And lonely was not bulleted lists
Lonely was not the video clips of knife sharp wit

But all of it tasted like envelope glue

Back when you sent letters

And lonely is the channel video shorts and fascinating lists
And lonely is the hole

And where the time went
And where the girl went
And where the screen light gets pulled toward
Giant soup bowl black hole
And the endless pictures
Going back far
And far
And forever

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

LEVELS OF INTIMACY

Continued

NARR.
(In an almost Siri-like voice)

There are several levels of intimacy one may choose when deciding to interact with another human being.

Level 5: Email

Level 6: Text Message

Level 7: Letter

Level 8: Phone Call

Level 9: Video Chat

immediately segue into

FACE TIMES

Two sets of people have the same conversation on Skype: 1 *is an annoyed teenager waiting for a role/scholarship/good news,* or a *hopeful expecting spouse awaiting news about the sex of their baby with* 2 *their mother or deployed partner.*

Video window opens

1

Hi

2 (mother) fumbles with FaceTime; (spouse) is in a grainy video window

2

Hi

1

I can't hear you

2

Hello? Here, let me move, maybe that will help?

1

That's better/that's not better/there/wait, go back…now I can't see you

2

Better? Did I get it?

1

Yes

2

okay, hi

1

Hi

2

How are you?

1

Same old same old, you know?

2

Oh No news?

1

Not yet

2

Oh Maybe soon

1

I’m just waiting

2

It will happen

1

I know What about you?

2

Oh, it’s still hot here

1

Sounds terrible

2

Can’t complain, I guess. What are you doing this weekend?

1

Going out with the gang

2

That sounds fun

1

Yeah, hopefully How about you?

2

Like you said, same old same old

1

I see

2

I love you

1

Love you too

2

Let me know what you find out

1

As soon as I do

2

Bye

1

B—

video cuts out. Immediately cut off by the MC

Cell Phone Symphony (Pt. 2)

The cell phone ringing comes back. Our announcer from the previous cell phone announcement returns from backstage, chastising the audience and clearly frustrated the ringing has returned and will not shut off. The announcer takes a phone away from another person on stage, leaving them isolated, by themselves, without any technology. The ringing persists and evolves into a beautiful symphony. Movement and marimba cell phone tones create a beautiful cacophony of sound, movement, and builds from this first scene of loneliness to a large community.

Finally, after the 4th Cell phone ring interruption…

MC

(after attempting to stay cool under pressure as cell phones have erupted in sound)
Leave them at home!!!! I'm making a radical assertion. People who love Theatre...do not drag your friends along. Leave them at home and tell them they are NOT ALLOWED to come with their cell phones which they check at their chests during the show. The fifteen people in the audience tonight who just had to talk to someone else lit up the house sporadically all night. Little cracks of ignorant lightning in a storm of disrespect. Not to mention the full on video game the child was allowed to play to keep her occupied during the "boring play". Keep it at the movies if you must... Ruin that medium if you must.... But get off our play ground or in the words of the lord, stay the hell out of my temple!!!!

The ringing echoes back, and turns into a symphony and all is transformed through music and movement, resolving in a beautiful community of people…The MC is defeated.

TRANSITION:
All exit except…

RUDE

Two people are waiting for a bus. Each is on their phone. One puts their phone away and addresses the other.

1

Um, excuse me, hi…What is there to eat around here?

2 Starts putting phone away, opens mouth to speak, is interrupted by:

Siri

I've found 6 restaurants within walking distance.

2 opens mouth to speak, is interrupted by:

Siri

Eight more within a two mile radius.

1

Oh…haha, I suppose. Do *you* have a favorite?

2 opens mouth to speak, is interrupted

Siri

Here is a list of highest rated restaurants in your area by price.

1

Oh. That's…yeah. That's handy. Thanks.

Awkward pause, both return to their phones.

1

(*tries again)*

So how about this weather?

Siri

It is currently 82* and sunny in Austin Texas.

1

(*increasingly annoyed)*

What about them Longhorns?

2 tries to speak, is spoken over

Siri

The University of Texas at Austin Longhorns have a season record of 6-7.

Pause

1

How are *you feeling* today?

2 Opens mouth…

Siri

Michael's Sleep Cycle app indicates he woke up in a neutral mood 45 minutes ago and his Facebook status says, "Waiting for the bus with some awkward chick."

1 & 2 blink at each other. Bus sound indicates arrival. Lights go out.

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

CLOSING THE BOOK (Pt. 3)

A video entry this time. It interrupts the space

Miranda

Hi, me again.

Some of you feel that this change seem sudden, but not really. If you know me you know I need this change, this dynamic ground shaking turn of events to spice my life up. I know it is hard for some of you to understand, but sometimes we have to be willing to break out of these...umm… shells we place ourselves in and we need to SHAKE THINGS UP! LIKE T-SWIZZLE!

And this is just how I am doing that.

(smile)

I'll still be around, so don't forget me… But for now. I am signing off.

Yours,

Forever and Always

(Smile and wink)

Miranda

SUPER TEXT COUNTDOWN: *There's a count down of the days till they (A & B) see each other next, starting at 67. This count down can start during the vignettes as needed or can happen here. This time lapse may include an Instagram scroll, daily internet activities, perhaps some physical manifestations of the way technology works with our bodies*

ROMANZA

Emily & Michael begin on opposite sides of the stage and gradually get closer through this. Their clothing starts to glow when they reach each other. When they touch and move their bodies, the clothing reacts and lights up in tandem with their movement and touch patterns.

And suddenly -- For the first time in more than 67 days they (Emily & Michael) are together, in the same physical space. Maybe (most likely) this is a dance. Maybe there's music reminiscent of their previous Skype dance-off. They do not speak. They re-discover each other.

Michael

It's good to see you.

Emily

Shut up.

She smashes her face into his. Make-out! Joy! Physicality!

They take selfies after having related to each other with touch for a while. Their pictures of fun times take over the space.

LEVELS OF INTIMACY

Continued

NARR.
(In an almost Siri-like voice)

There are several levels of intimacy one may choose when deciding to interact with another human being.

Level 10: Talking

Level 11: Listening

Transition to…

TRACES FROM A ROMANCE AT A DISTANCE

Poetry that finds itself into the internet space.

You're better at the internet than I am When I see you in chat
With all the glowing golden light
I am in the hallway with the fluorescents

I want to do an image search of real life and pull all the things closer
that look like you
the indentation of that tree

the strangers at the concert
the old farmhouse in the distance all come closer
I pull them closer
because you are far away

when we're in the same room
it feels less real
like we're both robots
like we're artificial representations all this messy flesh

all our smells and hands like when we venture near we're animals
we're dogs
sniffing

TRANSITION:

A big hand swipes all contents/people off the Giant iDevice and swipes on the next episode.

INTIMATE

_____

Emily & Michael find themselves relaxing into their places on a bed or couch. Only now they bring their electronic devices with them. Very close physically, but perhaps very emotionally distant?

CLOSING THE BOOK (Pt. 4)

_____

Michael opens a YouTube clip. It's a viral video. Of Miranda talking about Facebook. Maybe it's the same video from earlier?

Miranda

(Tries holding self together)

I am sorry for posting so much guys. I just… this has been really hard on me. I did say I would be posting occasionally, who know occasionally was a synonym for always! I'm I right… I am really trying. Hey don't give me that look.

I wanted to thank all of you for being so great throughout my journey of Facebook-less-ness. I really do love y'all, like so much. I promise to be strong, and draw from the strength I get from all of you!

(re*gains composure)*

Yours,
Forever and Always,

(Smile and Wink)

Miranda

CYBER WIDOWS

_____

A & B in bed together in their comfy pants. They're half-watching viral videos on Facebook. Michael is typing on his laptop. Emily is playing a game on her phone with the sound on. This goes on for a while.

Emily

What are we even watching?

Michael
It's some viral video of a super obsessed Facebook girl.

Emily
What?

Michael
We can watch something else.

Emily
No, it's fine.

They return to their respective devices.
Emily gets a text. Laughs at it. Doesn't explain the joke.

Michael
(writes a text message)
Hey
sends it
Miss you
sends it

Emily
(looks at him)
I'm right here.

She closes her laptop.
They look into each other's real live eyes.
Suddenly their connection grows into a large human network.
The themes of the Overture/Cell Phone Symphony return.

SHUT DOWN

Someone "powers down" the Giant iDevice

POST SHOW

Levels of Intimacy suddenly comes back, only this time…

LEVELS OF INTIMACY

Continued

NARR.
(In an almost Siri-like voice)
There are several levels of intimacy one may choose when deciding to interact with another human being.

Level 3.5: Instagram

(picture of a delicious donut)

Giant iDevice turns back on, scrolls through YouTube clips, email, websites, Facebook, common online activities

Glossary

3D Printing: A process for making a physical object from a three-dimensional digital model, typically by laying down many successive thin layers of a material (from Google dictionary).

For this project, Victoria Bill and I utilized a Flashforge Creator Pro 3D Printer at the Longhorn Maker Studio in the Engineering Teaching Building, room 1.222. We printed 105 Neopixel diffuser caps using an open-source design from github.com (modified by Victoria), and white 1.75mm Creator series ABS filament.

Bread Board: A plastic board full of holes with metal rails beneath, used for prototyping circuits.

Neopixel: Adafruit Industry's brand of individually-addressable RGB color pixels, based on the WS2812 ad WS2811 LED/drivers, using a single-wire protocol (from the Adafruit Neopixel Überguide, adafruit.com).

Micro-controller/microcomputer: A small computer on a single circuit board. It is programmable for input and output, and can be connected to sensors, GPS, motors, lights, etc.

Arduino: A brand of micro-controller and accompanying open-source software. A single-board, open-source, and inexpensive micro-controller, designed to make using electronics in other disciplines more accessible, and to be immediately useful to the application developer, reducing time spent developing controller hardware. Uses C or C++ Code for programming.

Lilypad (by Sew Electric) and FLORA (by Adafruit Industries): Brands of sewable, wearable micro-controllers like Arduino.

Open-Source: Code and software developed to be freely shared and modified by any user.

Wearable Technology/Wearables: A category of micro-controlled electronic devices that can be worn on the body. This includes items such as Google Glass, the Apple Watch, the FitBit, Phillips Lumalive LED fabrics, "Smart" or eTextiles that can sense changes in body temperature, or environmental pollution, among many others.

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