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Thesis Studio, Research and Writing I
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Brief on Prototype Three - Soft Circuits

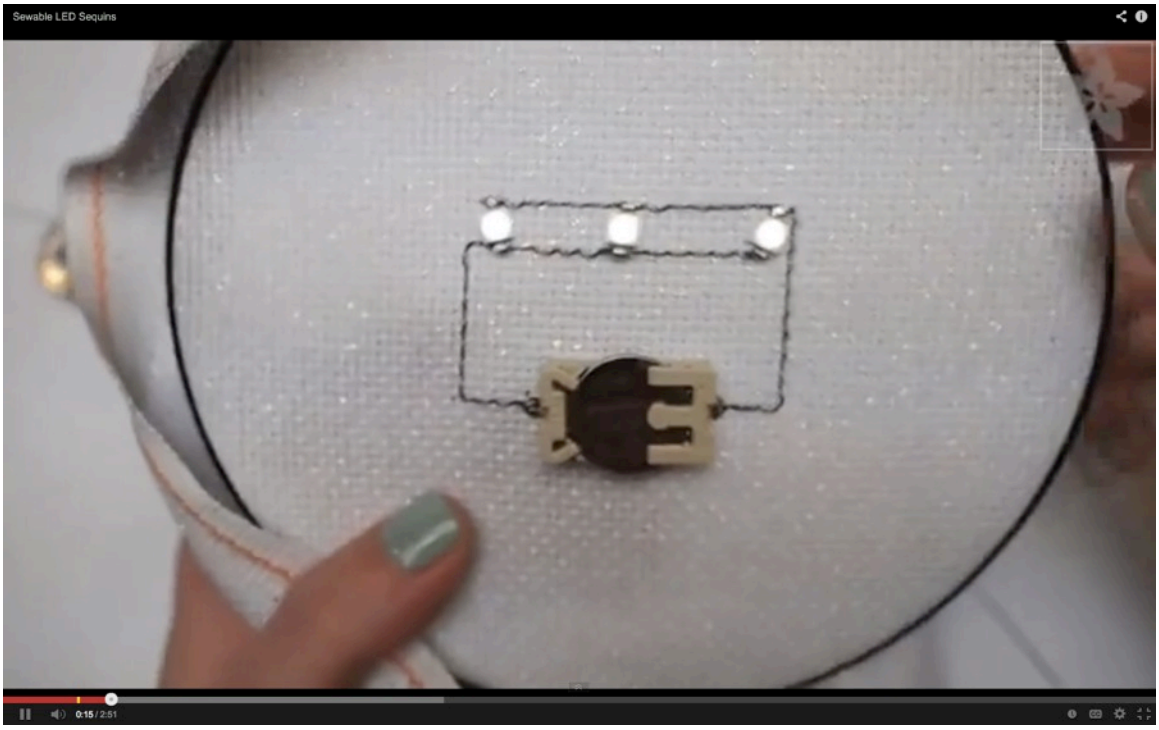
Design Question

My third prototype addresses the questions: What is a soft circuit with parallel LEDs? What are the components for it, and what is an effective way to create one with conductive thread? How can a battery be included in the circuit without creating bulk?

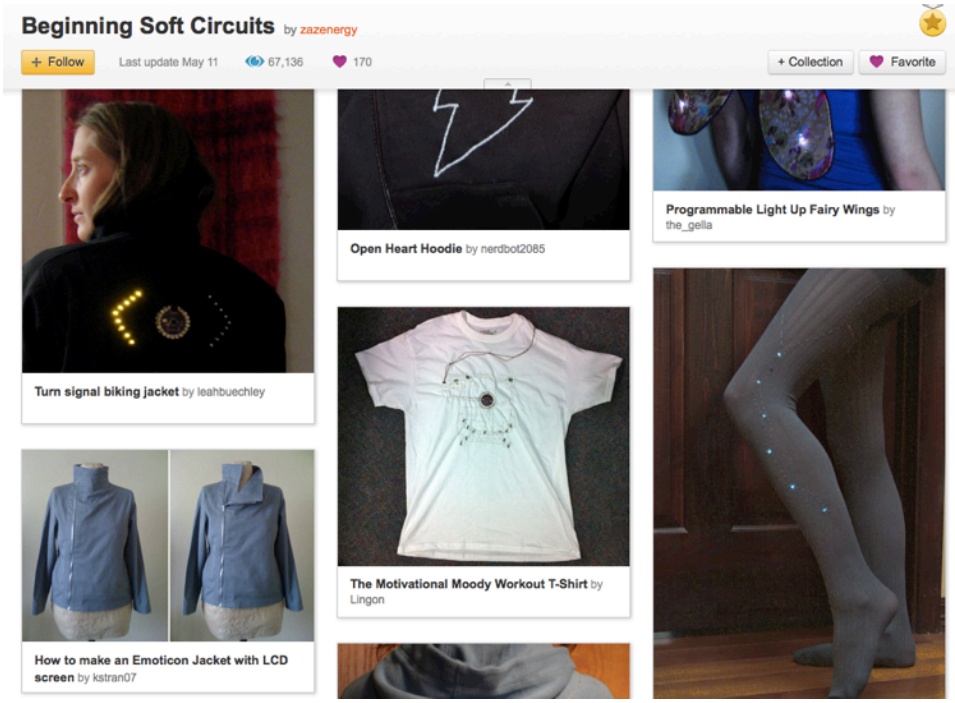
This prototype consists of two parts. Both include a physical muslin sample demonstrating the technique, and a how to step-by-step tutorial with visual references for each step. The first sample is a basic soft circuit, executed with three parallel LEDs and a hard shell Lilypad battery holder. The second one is an inventive technique of hiding a coin cell battery into a garment hem. With these two prototypes I investigate the basics of soft circuit integration into garment construction and document the steps needed to execute each one. With this process of exploration I would like to showcase some of the fundamental steps needed to start building soft circuits as a natural extension of a garment. These sample techniques can be integrated within a larger concept-based collection

Research, Domains and Precedents

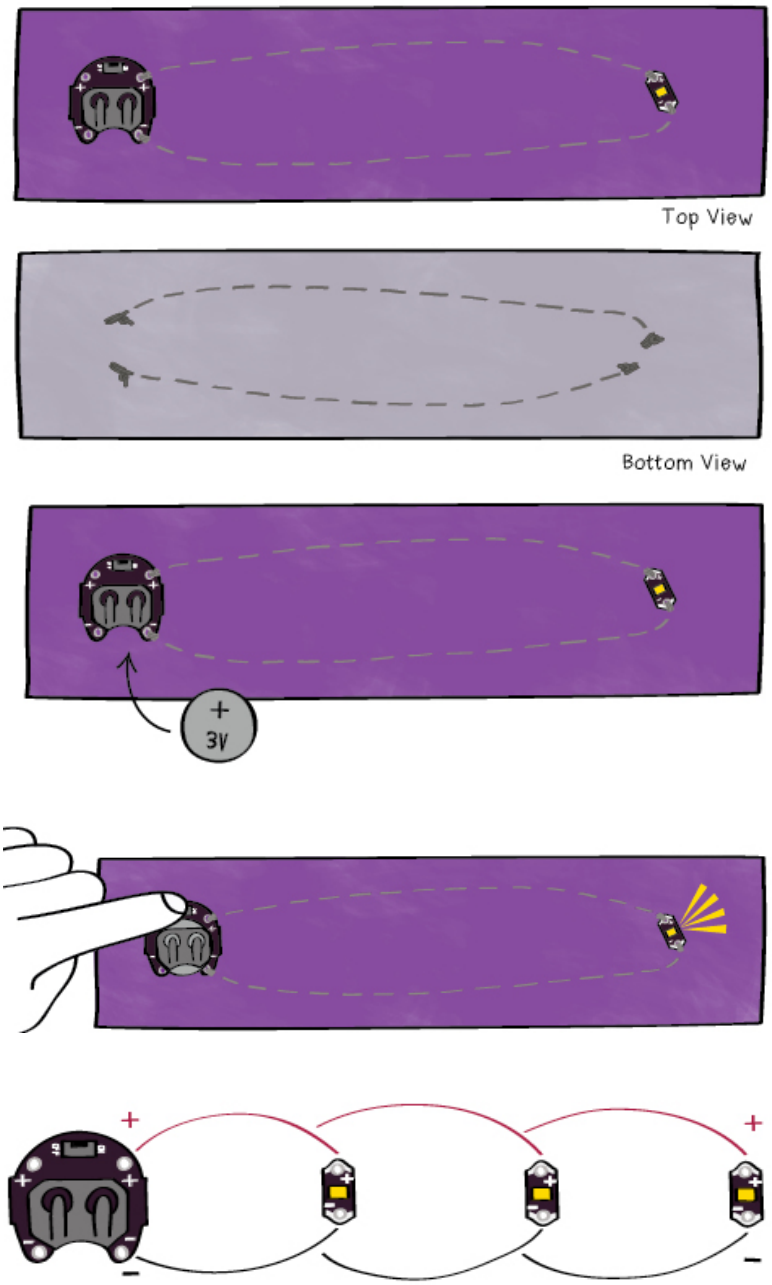
My research started with investigating online existing sources for soft circuit tutorials. Within the first stage I was looking for examples of video tutorials for stitching parallel LEDs with conductive thread. One of the most useful resources I found was the Adafruit Learning System. Becky Stern from Adafruit industries provides clear and concise directions in a video format and guides the viewer through the full project from needed materials to a finished product. Her video “Sewable LED Sequins” is a model video for me in terms of giving comprehensive instructions. The below photo is a screen capture of this video.



Another great source for soft circuit projects is Instructables.com, featuring projects from Leah Buechley. Projects on that website tend to be geared specifically for use with the Lilypad, and not so useful for this particular prototype.



Visiting this website brought me to the MIT High-Low Tech media group lead by Leah Buechley, which explores the intersection of computation, physical materials, and traditional crafts. The general tutorials and how to directions from this domain are extremely useful in this beginner stage, but the design aesthetics of the featured projects do not meet the expectations of a fashion designer. I also reviewed her latest book “Sew Electric” and found easy to understand directions with clear steps on how to build basic soft circuits with single or parallel LEDs.



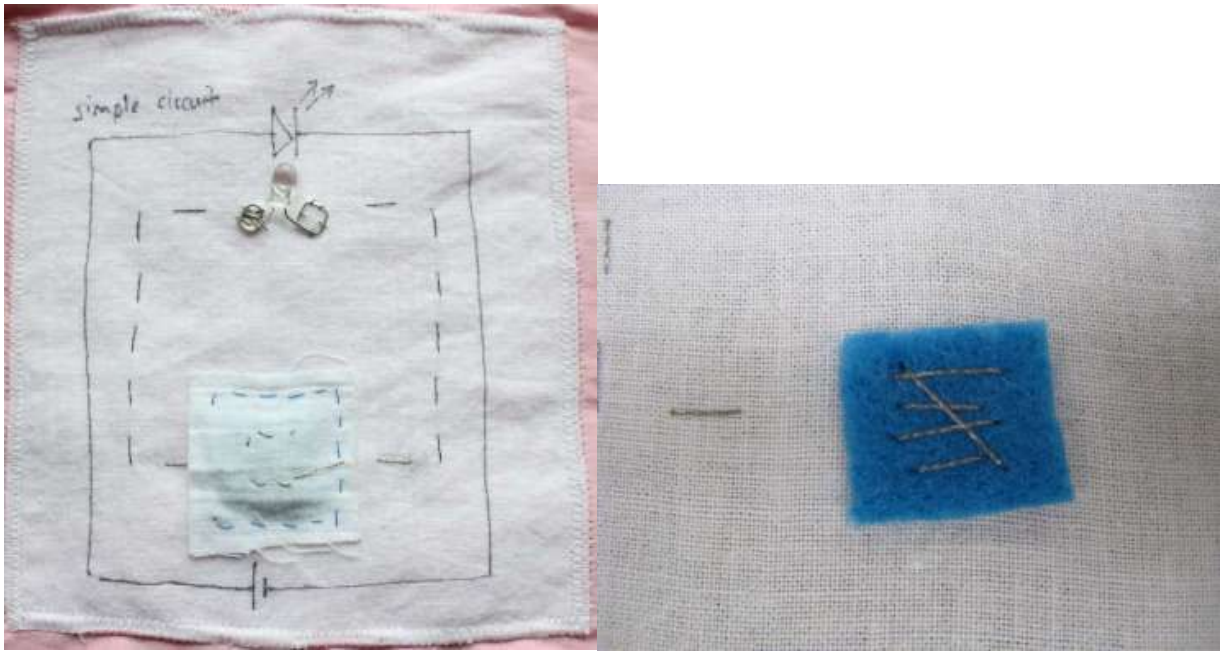
Other domains of interest, which I reviewed included Kobakant, How To Get What You Want, Plusea, Ladyada, Make Magazine, etc. but for the purposes of this particular prototype I am satisfied with the basic projects from the above-mentioned websites. They serve as an excellent guideline for the basic instructions I need for this particular prototype. Most of the unused, but mentioned here sources include projects with other materials like conductive inks or conductive tape, which are irrelevant to this particular prototype.

For sample two I researched existing fabric enclosures, which would be suitable for a garment. The following examples were the only ones I found so far:

Neoprene battery pouch from Plusea.

Laser-cut stretch battery pocket from Plusea.

Muslin square patch with conductive thread stitched leads from Katie Dektar.



The lack of examples for this sample was both frustrating and exciting, as it provided an opportunity to innovate and create my own. This appeared to be an opportunity to develop a functional and useful technique.

Project Concept

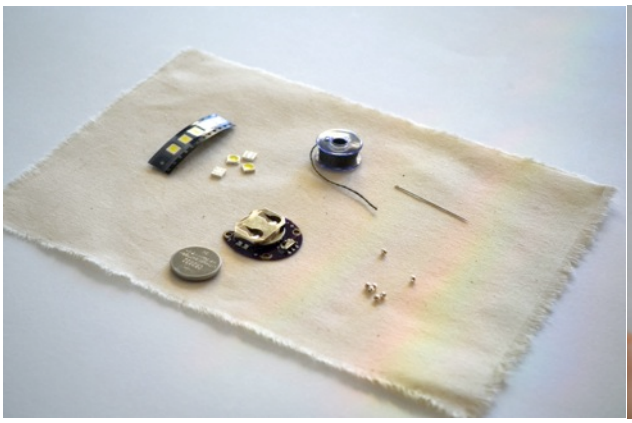
The concept for this project consists of creating two muslin samples. One to showcase a soft circuit with three parallel LEDs, sewn with a conductive thread, and another one demonstrating the steps of how to create a hidden pocket incasing a coin cell battery with conductive leads. Each sample is accompanied by a step-by-step visual tutorial providing the necessary knowledge for designers to work with soft circuits. This is not a definitive guide of how to develop a particular project, but a source of basic steps, which aims to encourage creativity and design thinking! It aims to provide the basic tools and knowledge so designers can create within their own fashion concept.

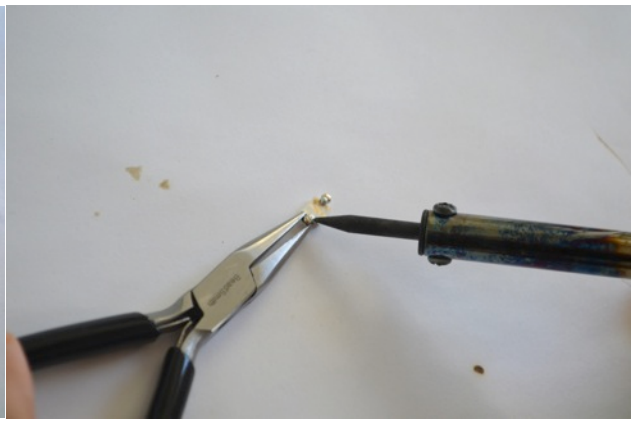
Methodology

First Sample – Conductive Thread Soft Circuit With Parallel LEDs

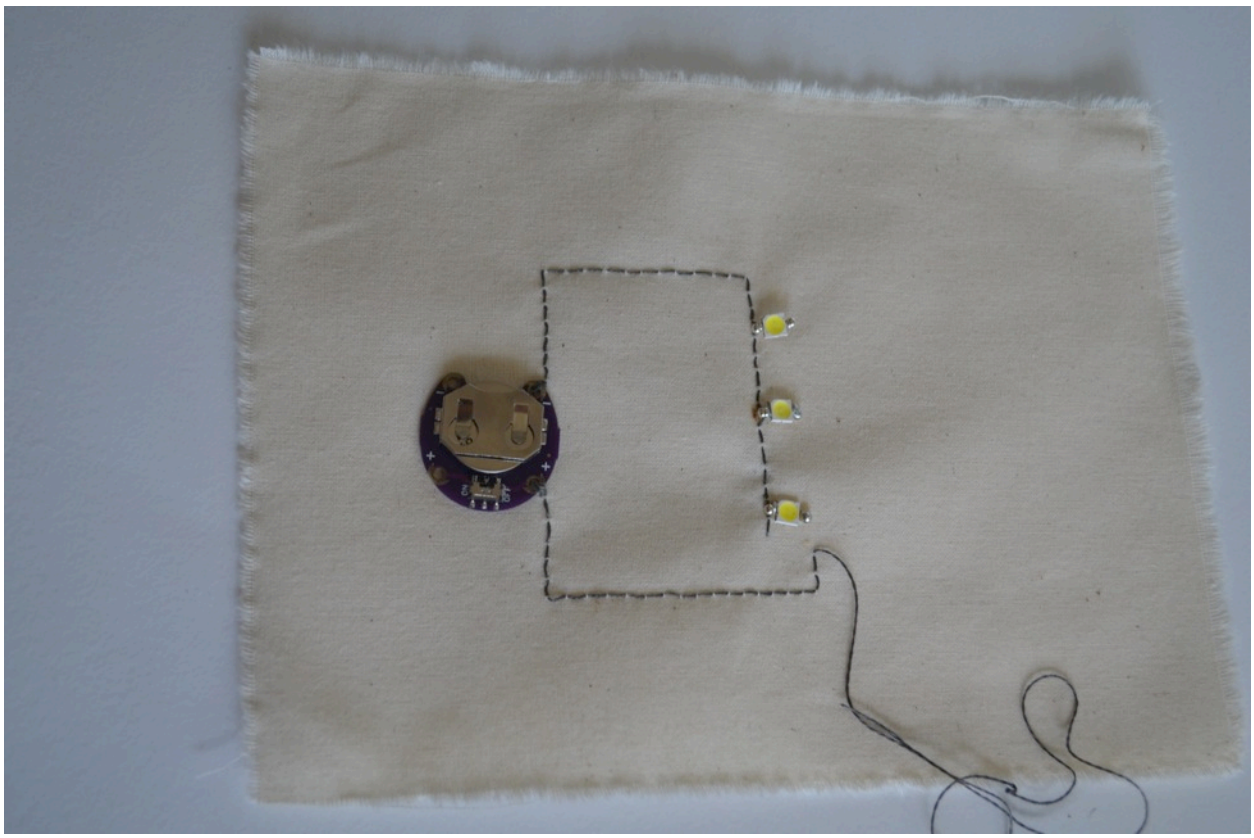
The initial stage started with determining a uniform size for the sample swatches that would fit future ideas and would make sense in a larger collection of samples. I chose to use muslin as the base fabric, because muslin is the quintessential fabric used for draping in fashion design. It is recognizable to any designer and speaks the fashion language. For example the embroidery cross-stitch fabric used in the Adafruit video with Becky Stern has a connotation of crafts and homemade projects instead of one for fashion designers. Choosing a fabric like muslin places the project in the desired category for professional designers.

The first steps for this project were to gather the needed materials, draw the circuit and placement for the battery holder and LEDs. For this particular project I used flat LEDs, which cannot be sewn directly on the muslin and needed to have silver beads attached to each lead. Each silver bead was individually soldered to each side of the LED. That process turned out to be tedious and unreliable. My conclusion was that it would be much more practical and efficient to use the Lilypad sewable LEDs.





The next step was to position the battery holder in place and attach it with conductive thread, then stitch along the drawn lines to the first LED, matching the negative side of the battery holder to the negative side of the LED. In this particular sample I lined up all LEDs and sewed all the negative sides first, and then continued with the positive leads. The photograph below shows the soft circuit with the battery holder, and the conductive thread seam line connecting all the negative sides of each LED.



The completed sample has a closed circuit with three parallel LEDs, powered by a 3-volt battery enclosed in a Lilypad battery holder with a switch.

Each step of the process was carefully photographed and included in a step-by-step tutorial as seen below.

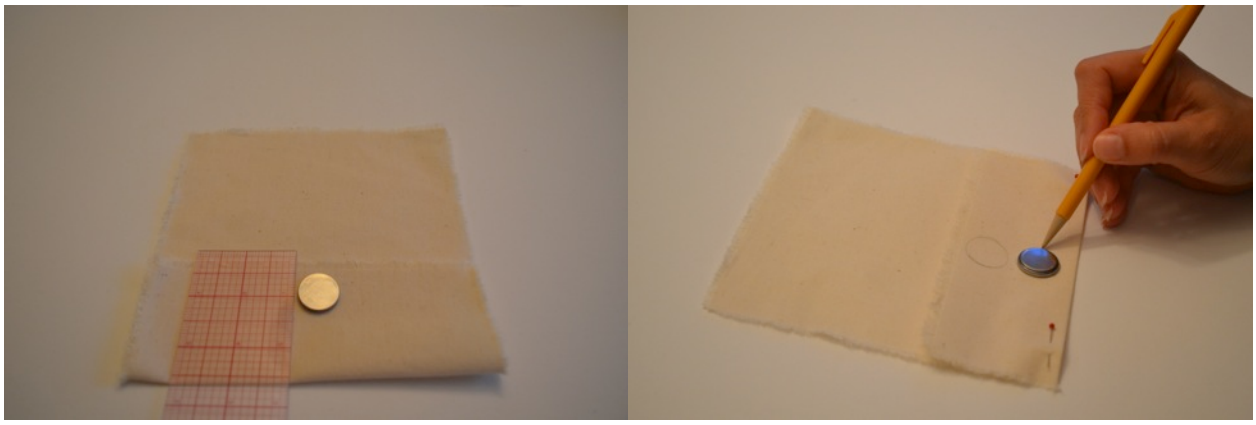
Second Sample – Battery Holder Incased Within the Hem

This inventive method was conceived after my frustration with the hard case. Its rigid structure is incapable of following the drape of the fabric and interrupts the natural flow in any soft material. It adds extra bulk to the project and becomes uncomfortable. Part of the motivation behind this technique was also the lack of any battery holders at my disposal, due to a late order. After searching through all known domains I did not discover any viable solutions, which could hide the battery successfully within the structure of the garment with no visible stitches on the outside, and satisfy the high standards of a professional fashion designer.

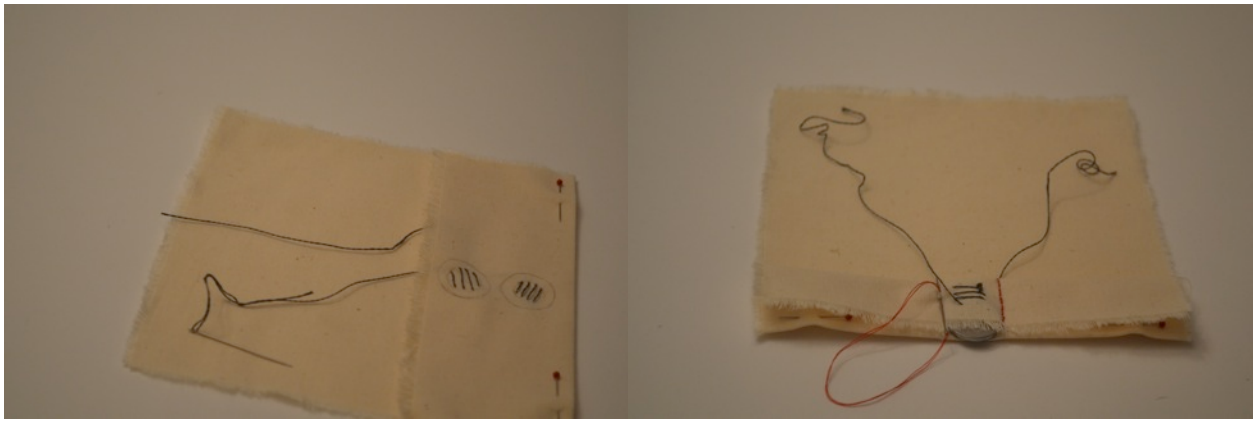
For this sample I tested various methods of folding the fabric and considered various seams. Although not ideal, the most sensible approach appeared to be hiding the battery in the hem of the garment. The hem in most cases is wide enough to accommodate the width of the battery and is often folded twice to create extra weight and hold the garment shape better. That

allows the battery to be successfully hidden within the folds of the hem and fixed in place with the stitches within the separate layers. The following images trace the steps of creating that hem pocket and give step-by-step directions for its completion.

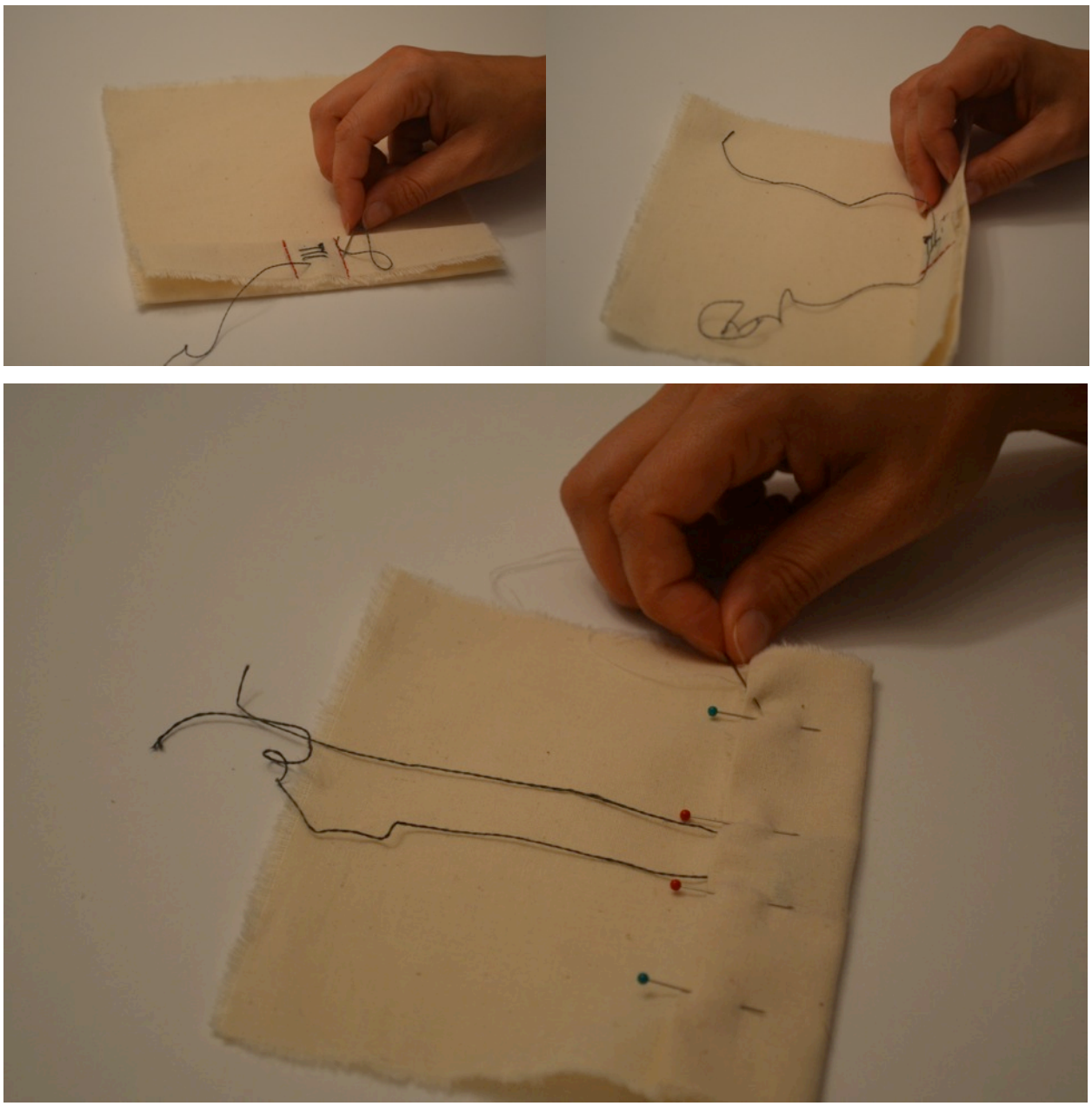
First measure the battery and allow for sufficient fabric to be folded twice over it. (Left photo) Then trace around the battery on both sides of the fold line (right photo).



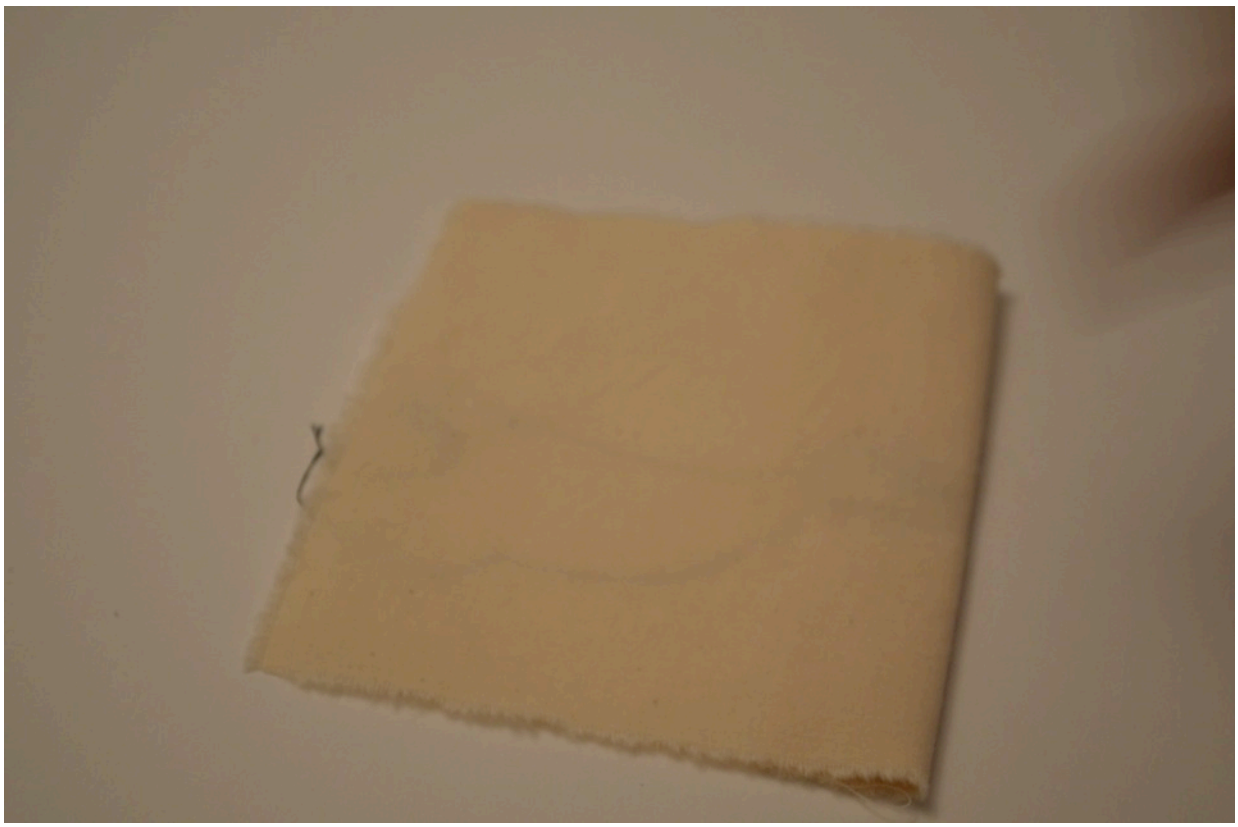
Stitch cross-stitches on each side of the fold to establish the contact to each side of the battery and leave enough thread to continue your project. (left photo). Fold over the top layer of the seam allowance, mark the battery width and stitch on both sides to create the pocket enclosure. (right photo)



Mark “positive” and “negative” and stitch each thread to a pocket side seam so they don't touch and short the circuit. (left photo) Then fold the seam one more (right photo) and blind-stitch it closed, leaving space for each battery to enter its pocket space. (below photo)



The completed hem can hold as many batteries as needed in the hem, creating a much softer drape for the garment and reduces the bulk at the hem. As seen below the blind stitches do not show on the surface of the fabric.



Findings

The first sample is successful in creating a soft circuit with a conductive thread and three parallel LEDs, and creating a step-by-step tutorial. The conductive thread creates a reliable connection from the power source to the LEDs. Using flat LEDs with attached silver beads is tedious and requires either additional equipment or the help of an extra person. The beads do not stay in place, often fall off at the lightest touch and overall do not provide a reliable connection. I also suspect that I shorted at least one of the LEDs while soldering the beads to it. As a result the LEDs on this sample do not all light up.

My conclusion is that it would be much easier to use sewable Lilypad LEDs. They are flat, small, and have premade holes on each side, creating a convenient and functional product, which can be easily attached to any fabric. This sample would have to be redone with sewable LEDs in order to create a functional tutorial.

Another finding from this experiment is that I need to have a professional set up with proper lights and a background for photographing each step of the process. Although for this prototype I had white foam boards and worked during daylight, I realized that the light shifted

throughout the day and the boards were not sufficient. After extensive research I found tabletop professional lights and a white fabric soft box (or light tent), which can hold the sample while diffusing the light on all sides. Such a set up would create a professional background and lighting and would allow me to create professional quality photographs for the Fashion and Technology textbook or an accompanying website.

In my opinion the second sample is much more successful. I created and documented an inventive technique, which would be very helpful in garment construction. It demonstartes a functional and aesthetically pleasing solution to the problem of attaching the battery within the soft circuit. Although I am pleased with the results from this experiment, this sample also needs to be redone and photographed with a professional background and lighting set up.

Other steps for this particular prototype include creating new ways to hide the battery by utilizing various seams within the garment. Such possibility is the French seams, which is created with multiple folds. This process can be continued with a variety of sewing techniques and expanded to actual garments at a later point.

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