Make: Tech DIY

Easy Electronics Projects for Parents and Kids

Ji Sun Lee
Jaymes Dec

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Please address comments and questions concerning this book to the publisher:

Make:
1160 Battery Street East, Suite 125
San Francisco, CA 94111
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Make: unites, inspires, informs, and entertains a growing community of resourceful people who undertake amazing projects in their backyards, basements, and garages. Make: celebrates your right to tweak, hack, and bend any technology to your will. The Make: audience continues to be a growing culture and community that believes in bettering ourselves, our environment, our educational system—our entire world. This is much more than an audience; it's a worldwide movement that Make: is leading and we call it the Maker Movement.

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The authors would like to dedicate this book to our good friend Robert Moon, who loved working with technology, crafts, and children.

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Preface

The idea for this book came during Ji Sun Lee's first visit to Maker Faire in 2007. Held at the San Mateo County Event Center in California, this was the second annual festival of making, craft, and technology projects organized by Make Media. Ji Sun was at the Faire to exhibit a project called the "Interactive Cake." Inspired by her then two-year-old daughter building cakes with her blocks, this project was a three-dimensional puzzle that formed a cake when assembled. Electronics embedded in the cake lit up, played songs, and even sensed when the candles were blown out.

While at the Maker Faire, Ji Sun noticed that many of the projects on display were not as appealing to girls as they were to boys. She also reflected on the fact that in her 15 years of working in information technology, she had met very few other women in the field. In response, she came up with the idea for *Tech DIY*, a series of sewing circuit projects that are meant to

attract and teach technology to girls and their mothers. Later on, Tech DIY expanded its audience to include all kids and adult electronics hobbyists. This book is the culmination of nine years of research and workshops with Tech DIY projects.

Why This Book?

There was a time when kids could take apart the technological world around them. In garages, basements, and other makeshift makerspaces, children would disassemble, poke around, and occasionally reassemble radios, telephones, and VCRs. Many influential scientists and engineers attribute their desire to enter their professions to tinkering around and playing with the parts of these devices to discover how they work.

Sadly, these opportunities to take apart and then repurpose, or hack, contemporary technologies are becoming less frequent. As modern devices shrink in size, they are made up of more embedded circuits and integrated electronics. Good luck finding any screws to open your modern smart phone, for instance. And if you do expose the circuits in your laptop, it is very difficult to isolate and reuse the tiny components; and besides, by doing so, you just voided your warranty. The fact is that most new technologies are not meant to be taken apart, or repurposed. They are designed to become obsolete and be discarded for the "next great thing."

At the same time, we live in a world where learning about technology is important for everyone, not just budding computer scientists or electronic engineers. We are surrounded by technology and it plays an increasingly important role in our lives. If children don't have opportunities to tinker and play with technology, they become more alienated and unfamiliar with how their world works. Thankfully, there is a movement afoot that could solve this dilemma.

Many people around the world are exploring creative applications of technology that often combine traditional crafts with electronics or computing. Supported by open source hardware and software, as well as communities and websites that specialize in sharing projects, the Maker Movement is helping people use technology to challenge, shape, and change the world around them. Technological materials and tools are increasingly becoming less expensive and more accessible to children.

The authors of this book are both educators who are passionate about empowering students with the abilities and skills needed to express themselves with technology. We hope that by introducing children to circuits through familiar crafts and materials like sewing and thread, we will allow them to feel more comfortable and confident when they approach and learn about electronics.

Who Is This Book For?

This book is for children, parents, and educators who want to learn about electronics and enjoy working with crafts and soft materials, like sewing and embroidery. We have found that children over the age of 10 are able to finish these projects with minimal help.

This book is not simply a series of craft projects. Our goal is to teach our readers about the basic principles of working with technology, from electronics to programming. You will learn how to turn on an LED, make a switch, understand series and parallel circuits and the relationship between electric current and voltage, learn how to use sensors and integrated circuits, and learn how to use solar energy. Since this book is aimed at children, we chose not to use solder to make the circuits in this book. Instead, the projects use conductive thread, eliminating the risk of respiratory problems or burns.

Chapter 1

Before You Start

Before beginning any project, you'll want to gather all of the necessary tools and materials. In this chapter, we introduce some of the more common supplies that you need when you're sewing circuits. We also describe some of the basic stitches that are used in embroidery and sewing.

Needlework Tools and Materials

Figure 1.1 shows the most frequently used tools and materials for sewing and embroidery. You can purchase these items at any hobby or craft store or online.

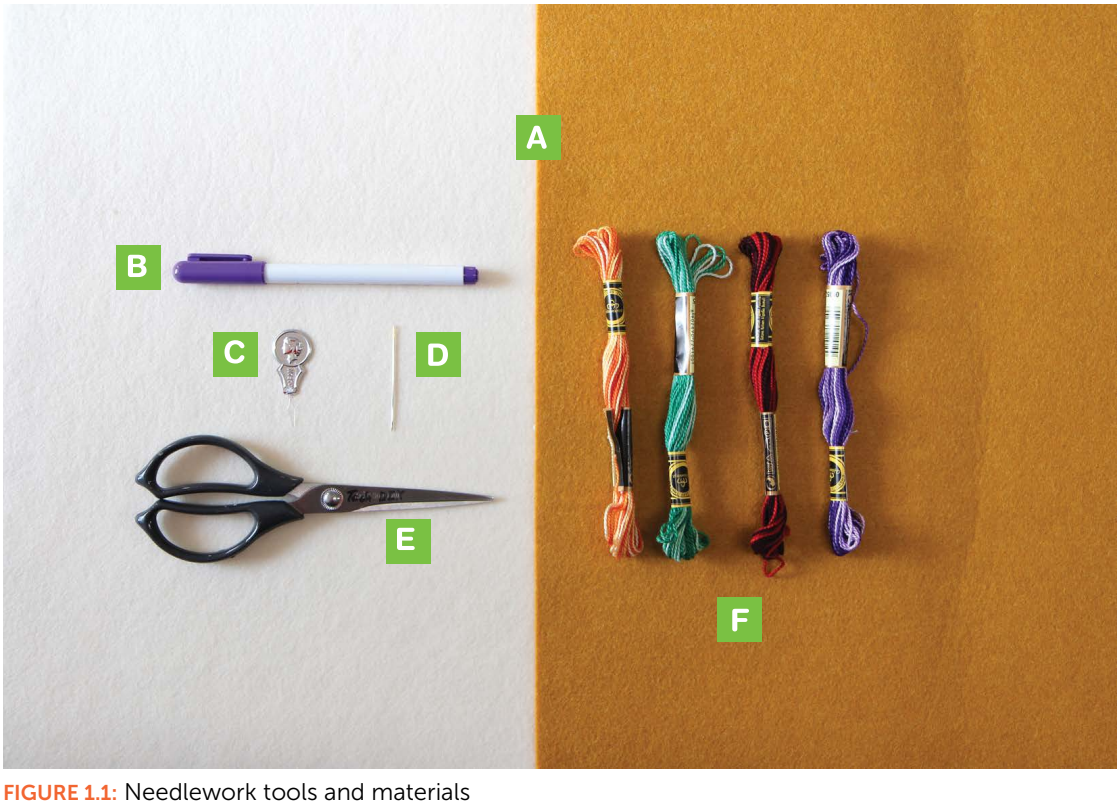


FIGURE 1.1: Needlework tools and materials

A **Felt**—It is easy to find felt in various colors and sizes. Look for it at any hobby shop or online craft supply store. If felt is too expensive, you can use any other fabric, including old clothing, for these projects.

B **Chalk pen**—Chalk pen markings are easily removable. You can purchase these pens anywhere that sells sewing supplies.

C **Needle threader**—It can be really difficult to thread a needle, especially with embroidery floss or conductive thread. Make sure you have several needle threaders available because they can get damaged easily.

D **Needle**—A needle with a larger eye is easier to thread. If a child will be using the needle, it is better to start off with a blunt embroidery needle rather than a regular sewing needle. However, when you are sewing with conductive thread, you will need to use a #5 needle or smaller to get it to go through the holes in the battery holder.

E **Scissors**—Most projects in this book use sheets of felt, so common paper scissors will work fine. However, fabric scissors work better on thinner fabric.

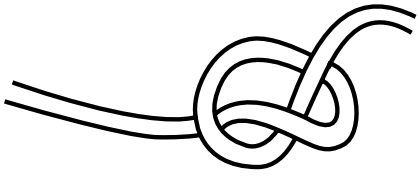
F **Embroidery floss**—Embroidery floss, or stranded cotton, is made up of six threads that are twisted together. It comes in hundreds of colors and you can buy it anywhere that sells craft, hobby, or sewing supplies.

Basic Needlework: Knots and Stitches

The following are a few stitches and knots you should know in order to use embroidery or sew circuits. Feel free to refer back to these instructions as you work on the projects in this book. Many great video tutorials online also demonstrate these stitches.

TYING THREAD AT THE BEGINNING

When you start sewing, tie a simple overhand knot at the end of your thread to keep it from passing through the fabric.



TYING THREAD AT THE END

When you are done with a line of stitches, poke the needle about halfway through a bit of the fabric. Wrap the thread around the sharp end of the needle two or three times (see Figure 1.2). Hold the thread and fabric still as you pull the needle through the loops. Make sure your knot is nice and tight before you cut off the loose end of the thread (see Figure 1.3). If you are sewing with conductive thread, it is a good idea to put a dab of clear nail polish or fabric glue on your knot to keep it from unraveling.

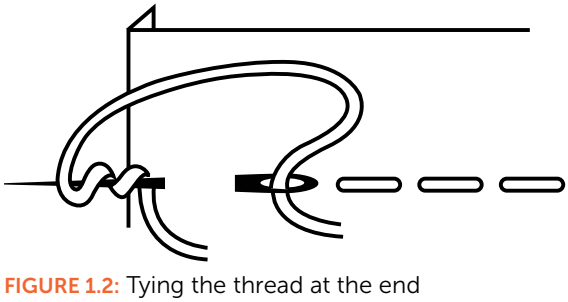


FIGURE 1.2: Tying the thread at the end

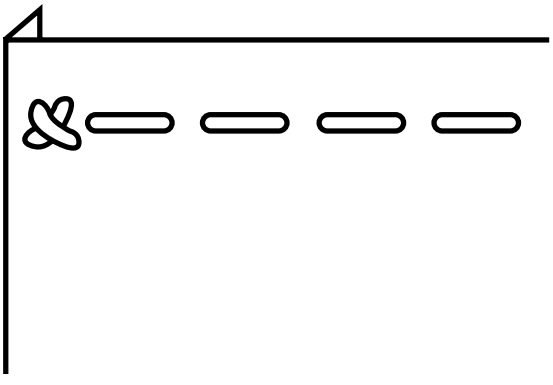
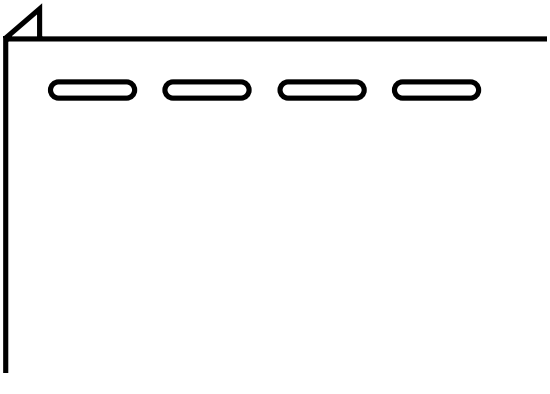


FIGURE 1.3: Finished knot at the end of your thread

THE RUNNING STITCH

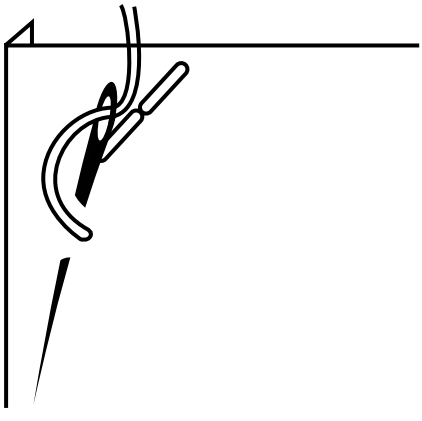
This is the most basic of stitches. Poke the needle over and then under the fabric at regular intervals. You can make your stitches large or small depending on how you want the stitch to look.



THE BACK STITCH

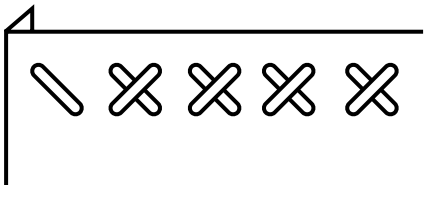
This is the most commonly used stitch in embroidery. It can look beautiful with colored thread. When you poke your needle up to begin a stitch, move the needle back to poke it down through the hole where your thread went down on your last

stitch. After that, stitch out farther forward from the last time you poked your needle up, and continue that process of going back to the end of your last stitch before moving forward.



THE CROSS STITCH

This is a great stitch for adding color and texture to embroidery projects. Form X shapes on one side of the fabric by starting with a series of parallel angled stitches; then turn the fabric around and stitch back the other way to finish the Xs.



Sewing Circuits: Tools and Materials

Figure 1.4 shows the tools and materials that are more specific to sewing circuits. You probably won't find most of them in craft stores, so you'll have to order them online. You can find a list of recommended suppliers at the website for this book: www.techdiy.org.

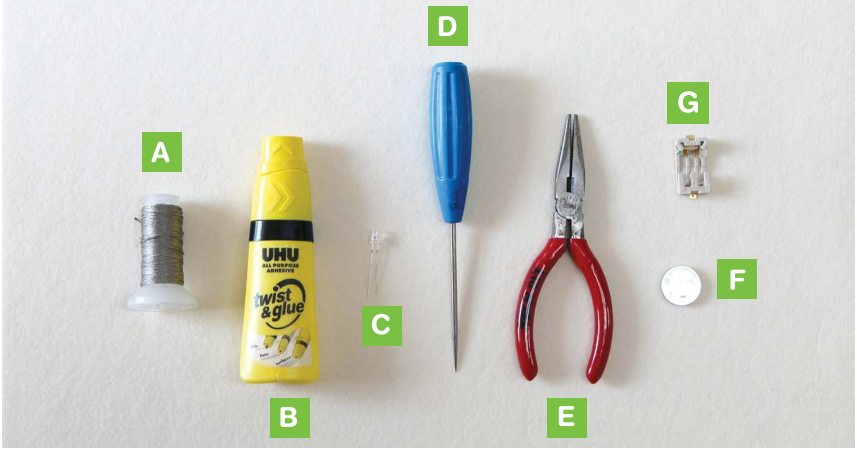


FIGURE 1.4: Tools and materials for sewing circuits

A **Conductive thread**—Ordinarily electronic circuits are made with wires and metal. However, the projects in this book use conductive thread. You can purchase conductive thread from online stores like adafruit.com or sparkfun.com. Some craft stores carry metallic thread; please notes that this thread is *not* conductive and won't work for sewing circuits.

B **Glue**—You can use glue to attach battery holders or other objects onto felt sheets. Glue is also good for keeping conductive thread knots from coming undone. We recommend a fast-drying fabric glue.

C **LED**—LEDs, or light-emitting diodes, come in several colors and sizes. For the projects in this book, we use LEDs that are 5 mm (millimeters) in diameter. You can choose whatever colors you like.

D **Awl**—We use a sewing awl to poke holes in felt sheets so that we can insert LED legs or other electronic components. Any pointy, sharp tool will work, but be careful when poking holes in fabric so you don't accidentally poke yourself!

E **Needle-nose pliers**—Pliers make it easier to connect conductive threads to LEDs or other electronic components. We will use the pliers to wrap the legs of the LEDs into coils. Needle-nose, or long-nose, pliers are best.

F **Battery**—The projects in this book use small, three-volt (3V) coin cell batteries. This type of battery is commonly called a CR2032. These are easy to find at most stores that carry batteries.

G **Battery holder**—The battery holders for these batteries are a bit harder to source. For the projects in this book, you want to find a battery holder that is easy to sew with. We recommend this one: https://www.adafruit.com/products/653. These holders have small holes you can sew through. You'll have to use a #5 sewing needle or smaller to get through them.