



## Using Cutting Machines for Projects

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## Overview

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### Circuit Playground Paper Art

This guide will cover how to use cutting machines to create paper art of the Adafruit Circuit Playground characters. We'll also cover topics on how to design artwork for paper crafting projects. We'll go over materials, tools and workflows for creating fun projects.

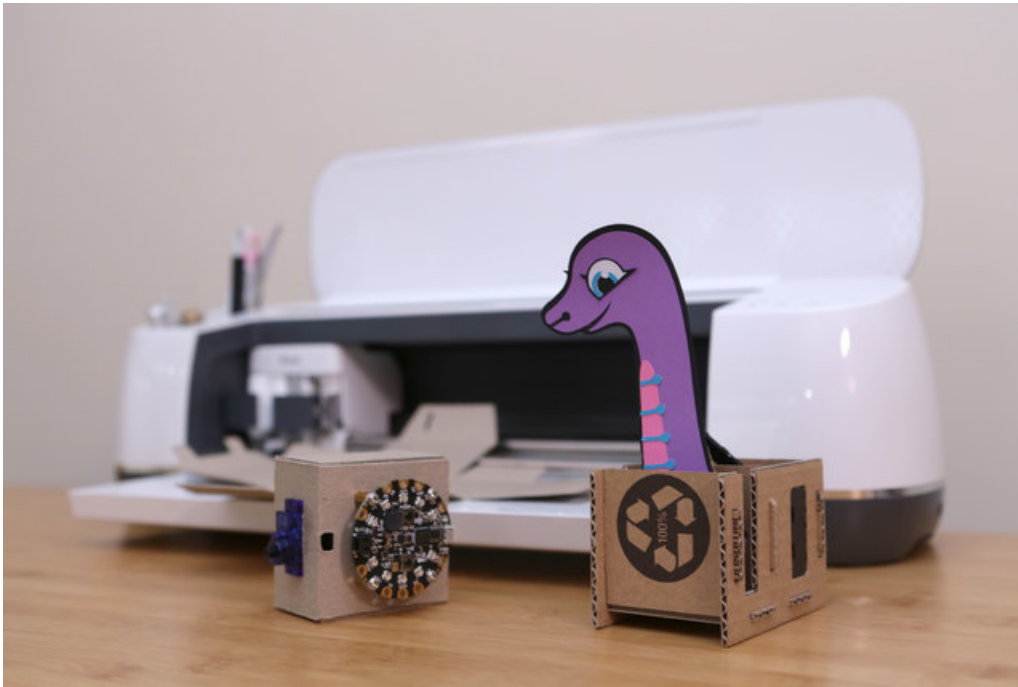
### Crafty Cutting Tool

Smart cutting machines are widely available, come in different sizes and are relatively easy to use. You can find these at your local arts & crafts stores and even department stores. These machines can cut a wide range of materials such as cardstock, chipboard, craft foam, rubber sheets and fabrics, just to name a few. So they're not just for cutting vinyl anymore! Newer models feature dual tool heads for scoring fold lines and pen plotting for handwritten type or outline artwork. Some of the newest features like, *print and cut*, allow you to precisely cutout graphics made with an inkjet printer.



### Maker/STEM Projects

There's a lot of ways to use these cutting machines in your projects. Combining different materials with colors and textures can make high quality looking objects with precise cuts and details. Mixing different mediums like 3D printing and paper crafting can make for unique designs that can both look and function together nicely. There's benefits to using cutting machines when compared to cnc milling or laser cutting. For example, it's more safe (no need for ventilation), less noisy, and less expensive. So these can be a good supplement to some of the more involved maker tools on the market.



Here's a few ideas we came up with. There's seriously lots of things we could add to this list. It's just a few that came to mind. Although a cutting machine can do the majority of the work, we feel the hard part is designing the artwork and coming up with the idea. Designing for manufacture is a learning process that happens best when working on a project.

- Boxes and Packages
- Enclosures, mounting structures
- Paper Art
- Signs, Banners, Posters, Cards
- Costuming
- Patterns, Details, Props, Apparel
- Electronics
- Solder stencils, solder masks, copper tape



## Tools & Supplies

Here's a handy list of tools and supplies you'll need to work with paper.

- Adhesive Cutting Mat
- T-square / Ruler
- Squeegee Tool
- Craft Knife/ X-Acto
- Weeding Tool
- Spatula
- [Blue stick \(Extra strength\) \(https://adafru.it/BvC\)](https://adafru.it/BvC)
- Cardstock (medium or heavy weight)
- [Chipboard \(30pt \(624gsm\) \(https://adafru.it/Bvw\)](https://adafru.it/Bvw)
- Self healing cutting mat
- Blue painters tape



# Materials

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## Material Presets

Cutting machines support a wide range of materials. For most paper art projects, there's tons of flavors of card stock. Chipboard is a great material for backing. Newer models can cut ~2-3mm thick chipboard, cardboard, craft foam, basswood and balsa wood. Most of the materials that are supported by the cutting machines manufacturer feature pre-made material profiles so it takes the guess work out of setting up cut jobs.

## Paper Thickness

Talking about all the different types of paper got me thinking about the way paper manufacturers talk about paper thickness. It's actually not common to see paper labeled by the actual thickness, instead it's categorized by "weight". Most paper will be label their weight in LBS (pounds, imperial) and GSM (grams per square meter, metric).



### Chipboard

This is a type of particle board made from reclaimed paper that is generally used as backing for notepads, photos and prints. It's also used to create cereal boxes and other type of packaging. This material comes in a variety of different thicknesses. We found [0.8mm thick chipboard \(https://adafru.it/Bvw\)](https://adafru.it/Bvw) works really well for project boxes.

- Material: Chipboard 0.8mm
- Cut Pressure: 350
- Multi Cut: 3x
- Blade Type: Fine-Point Blade



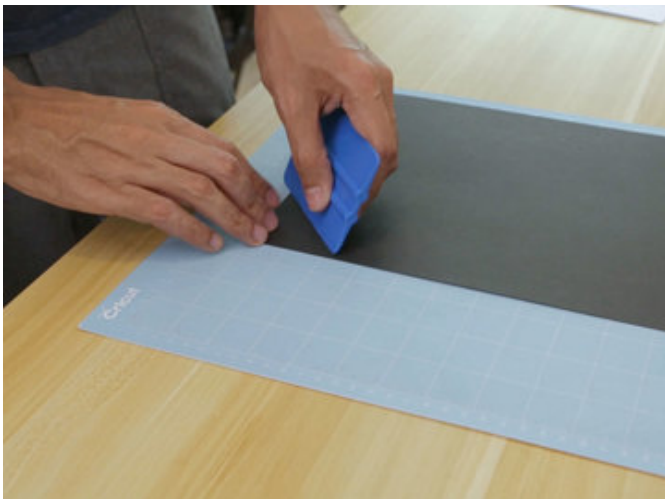
### Cardstock

This is a type of paper that is thicker than office or notebook paper but thinner than chipboard. This also comes in many different thicknesses, often referred as *weight*. Cardstock comes in lots of colors so we can choose from a huge selection. I got myself a hefty pack of cardstock on clearance so check out your local arts and crafts store!



## Adhesive Cutting Mats

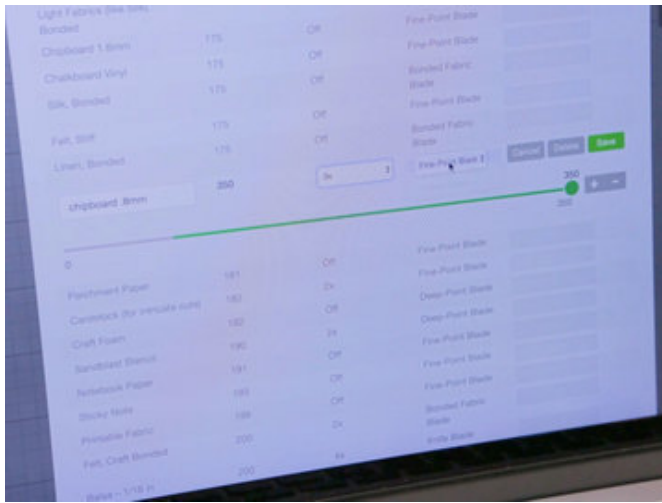
Material needs to be secured to a special mat in order to make precise cuts. These cutting mats have a tacky surface with a grid of lines and numbers for visual reference. These sticky mats are used to secure your material and helps keep everything together while cutting out your artwork. They come in different levels of stickiness depending on your material. You'll want to choose the right size mat that fits your make and model of cutting machine.



## Securing Materials

Chipboard is a thicker material that may require blue painters tape around the edges to keep the material from coming loose. Cardstock is much less involved and doesn't require extra tape. Just be sure use a squeegee to secure the material to the mat.





## Custom Material Profiles

When experimenting with new and different materials you might want to consider modify or create your own material profiles. Each new material can be assigned a profile that will tell your cutter how much pressure to apply when performing cuts, how many passes you'd like it to make and which blade to use.

In Cricut Design Space, you can manage all of the default profiles and create your own in the custom materials page. This can be accessed through the main menu (hamburger icon) in the top left corner of the site.

Main menu > Manage Custom Material > Add New Material

## Vector Artwork

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### Circuit Playground Characters

Download the **SVG** files for using with cutting machines and other tools. **Adabot**, **Blinka**, **Minerva** and **Crickit** are *ready to go* designs that can be scaled to any size. Use vector editing software like Inkscape to modify, convert or resize graphics. The files are hosted on [Adafruit GitHub Repo \(https://adafru.it/Bvy\)](https://adafru.it/Bvy).

<https://adafru.it/Bvy>

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### CAD

Software like Inkscape, Adobe Illustrator and Photoshop are generally used to create objects using vector graphics. Each piece of software features different UI so we won't be cover those specially here. Instead, we'll look at some examples to get an idea how create multi-colored objects and characters.

### Importing Vector Artwork

The **SVG** file format is the most common type for vector images. Raster images like **JPG** and **PNG** will need to be converted. Software for cutting machines like Cricut will automatically convert these files for you (search google for your make & model).

For exporting sketches from 3D modeling software like Autodesk Fusion 360, I suggest exporting as a **DXF** (Drawing Exchange Format) and then converting into an **SVG**. Be sure to set your desired units of measurements (inches/mm) in the file export menu. This way you get precise dimensions and avoid scaling issues.

### Layering Color Cardstock

Full color characters like Blinka can be made by layering solid colored shapes together. If we break down the image into just colored shapes, we can separate each piece as an independent object. Then we can cut out each shape in a different colors and reassemble them by layering them. Building the image by placing one shape on top of each another.

### Color Masking Technique

For some characters, certain features can be "masked out" in the form of a cutout that "reveals" a different colored layer underneath. Crickit's mouth and eyes are a great example of this masking technique. These details can be a little tricky to align back onto the head once it's been cut out. So these facial features can be cutouts that reveal a solid purple layer in the background. Another example, Minerva has a purple wave patterns across her body. Instead of cutting out each individual wave shape, we can redraw it as a self-contained stencil and cut it away from the top dark blue layer and reveal a purple color layer underneath. Last example, Adabot's limbs feature thin lines to represent individual segments. By merging and combining shapes to form thin slits we can containing them as a stencil and reveal a darker shade of blue.

### Optimize for Cutting

Converting existing artwork for cutting is a process that requires some planning. Let's use Blinka as an example again. Originally the black stroke around her is drawn as an outline and not a solid shape. Although we could cut this piece out *as is*, the paper cutout would be fragile and difficult to assemble. So we can easily fix this by removing the paths

that subtract from our shape. Having this piece as a solid shape creates a thicker backing.

## Separation for Articulation

For objects and characters with appendages like arms and legs, we can separate these elements as independent layers. This gives us the freedom to add articulation to certain body parts. For example, we separated Blinka into two main pieces so her head moves independently from her body. The desired effect might need redrawing of paths to make separate objects. Originally Blinka's head and neck wasn't drawn as a separate object so her coiled body had to be redrawn independently. This allows us to pivot her head back and forth with her neck in front of her body.

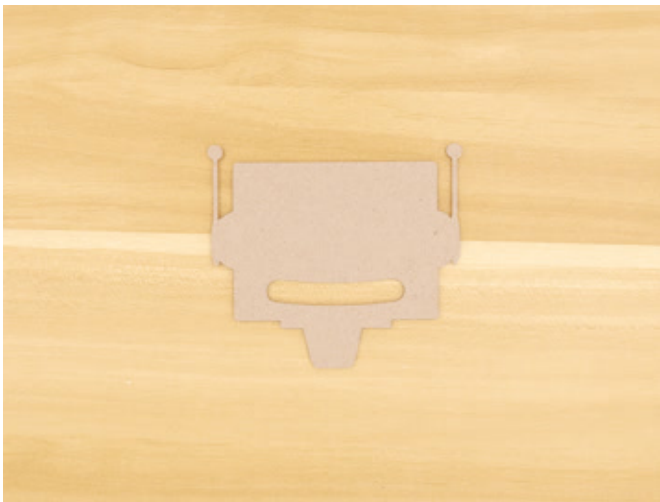
## Adabot

Adabot has six main pieces. The head, torso, two arms and legs are separated for articulation. You can glue the parts together or use paper fasteners as hinges. You'll need to punch holes into the material. Use mounting tack for temporarily holding them together. Using snaps could be a great way to make hinges as they can be easily detached.

### Glue Stick

I suggest using an extra strength glue stick to secure the layers together. The one I'm using is from Elmer's, called "Extra Strength", it goes on purple and dries clear. Just be careful with the thinner features. You'll want to make sure your parts are in right orientation when applying the glue. Line them up first and check to see if they're mirroring. Most of these shapes can be lined up nicely by squaring up the edges. If they're slightly off, you can adjust them by carefully sliding the layers to line them up.

Use a good amount of glue stick, especially near the edges. We don't want them to lift, so you'll want to cover as much as possible. For very small details like Adabot's ear cups, I use a pair of tweezers to wipe it on the tip of the glue stick. This way we don't cover the unwanted areas with lots of glue.



#### Adabot Head

Start with the brown colored layer as a backing – For this part we suggest using chipboard. Next is the white colored layer. The dark blue layer goes on top of the white. Next place the light blue over. The eyes and ear cups can be added last.

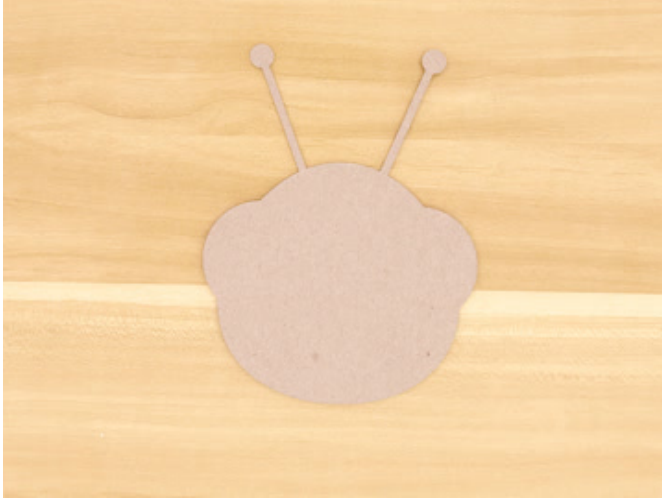


#### Adabot Body & Limbs

Start with the brown layers, again using chipboard as the backing. The torso is made up of four layers that go in this order: Brown, dark blue, white, and light blue. The arms and legs are only three layers, arranged in this order: Brown, dark blue and light blue.

## Crickit

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### Crickit Head

Start with the brown layer. Place the purple layer over the brown chipboard. Next place the light green over the purple. Position the blue eye layers over the light green. Lastly, place the white eyes over the blue.

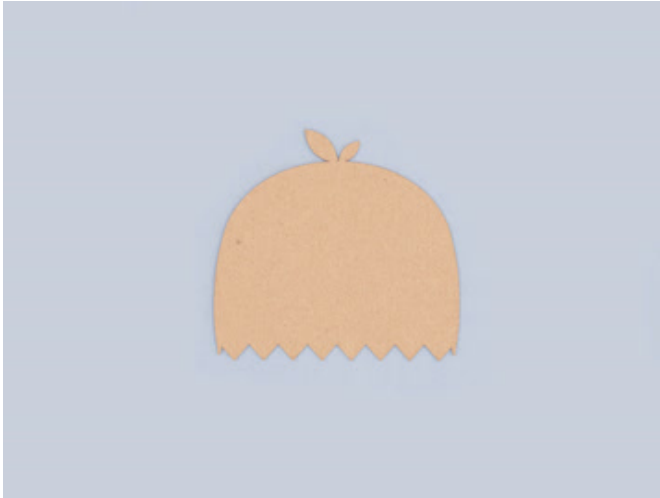


### Crickit Body

Start with the chipboard layer. Place the dark green layer over the chipboard. Position the blue layer on top of the dark green layer. Then, place the light green layer over the blue layer. Lastly, place the various shoe pieces over the dark green layer. Placing the white, blue, then purple layers.

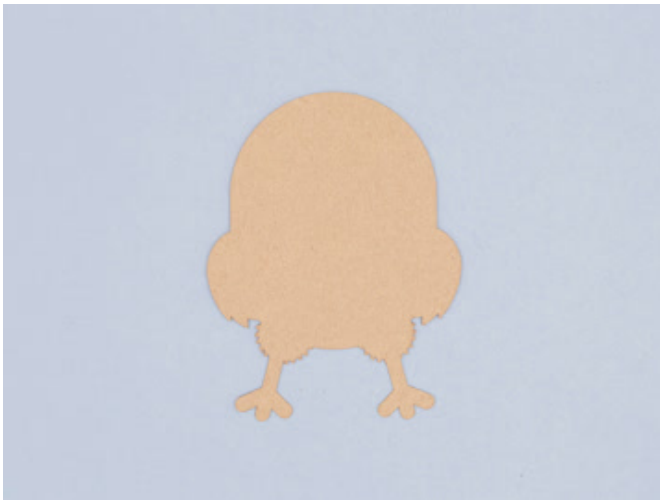
## Minerva

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### Minerva Head

Start with the chipboard layer first. Place the dark blue layer with (the one with no internal cutouts) over the chipboard. Position the pink layer over the dark blue. Now lay the light blue layer over the pink. The white goes over the light blue. The next dark blue layer features various cutout details. Lastly, the purple layer is placed over the dark blue layer.



### Minerva Body

Start with the chipboard layer. Light blue layer goes over the chipboard. Place the purple layer over the light blue. Lastly, place the dark blue layer over the purple layer.

## Blinka

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### Blinka Head

Start with the chipboard as the backing. Place the black layer over the chipboard. Position the blue layer over the black layer. Next place the pink part over the black. Purple layer is next, position it over the pink layer. For the eyes start by positing the blue piece into the eye area. The small white piece for the eye goes over the blue piece.



### Blinka Body

Start with the chipboard layer. Position the black layer over the chipboard. The blue layer goes over the black layer. The pink layer goes over the blue layer. Finally position the three purple parts over the pink layers. You'll want to dry fit them first to see if the parts need to be mirrored, if they do just flip them over until they are matching and lined up.