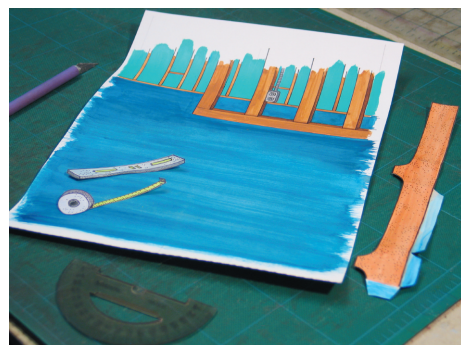
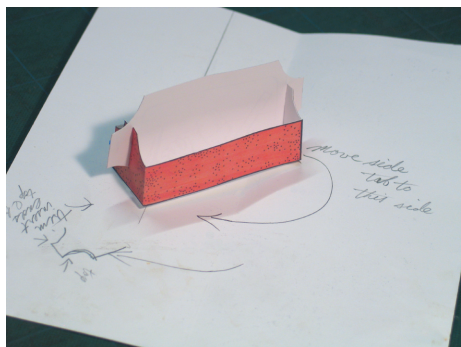
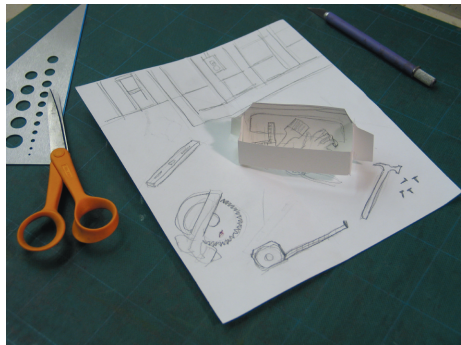
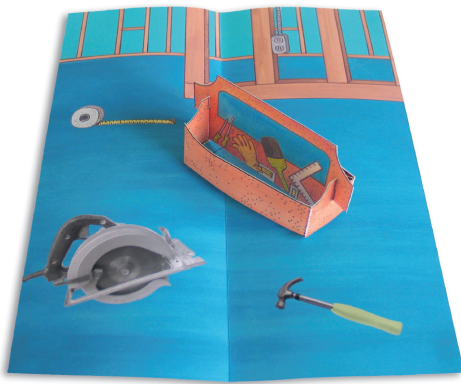




Engineering Paper

Carol Barton

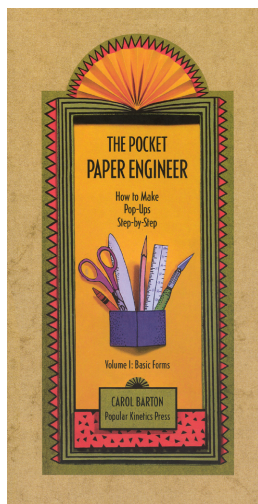
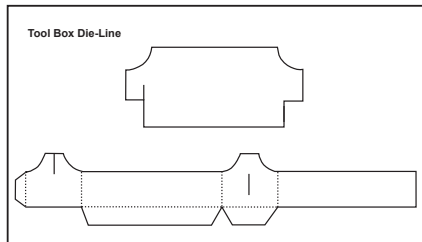
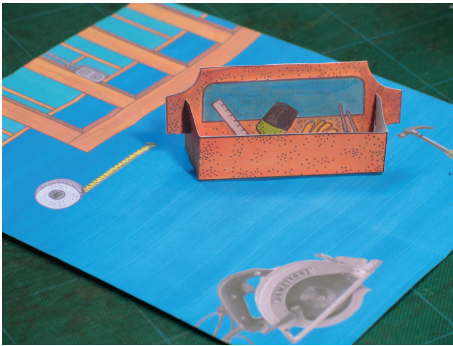
Hidden beneath the surprise of a pop-up page is geometry in motion, and the term “paper engineering” effectively describes the formative process of a pop-up’s design. Most paper engineers eschew the math in favor of a trial-and-error model-making approach to perfecting a pop-up mechanism, but the resulting construction invariably displays a mathematical logic evidenced in the graceful rise and fall of paper forms as a page is turned. The page is a lever in this machine, activating each paper mechanism with its movement. A pop-up must cross the fold in a page spread in order to work.

Books with moving parts have been around since the 13th century. These early texts were scientific treatises on subjects ranging from astronomy to human anatomy to Euclid’s geometric formulas. Such books employed simple movables - lift-up flaps and paper wheels called volvelles - to illustrate scientific principles and discoveries, and the paper mechanisms were manipulated by the hand of the reader. Children’s books did not appear on the scene until the mid 1600’s, and it wasn’t until the 1850’s that the true “pop-up” was born. Unlike the early movables, pop-ups required nothing more of the reader than the turning of the page for the mechanism to work.

In designing a pop-up page, I start with the most basic of tools: scissors, X-acto® knife, self-healing cutting mat, bone folder, and a glue stick or PVA. My initial dimensional model is a very rough sketch in pencil, constructed from 8 ½ x 11 inch white office paper. I glue down, rip apart, adjust, and remake the model until it begins to work with the illustration I have in mind. One of the real challenges in designing pop-ups is matching the concept and imagery to the appropriate structure. Most pop-up pages are built upon a handful of basic structures, and once you understand the dynamics of these structures you can combine them to design more complexity into the page.

When I have a rough working model, I start refining the drawing along with the pop-up form. Up to this point I’ve been concentrating on the paper mechanics and haven’t worried when a pop-up sticks out beyond the edges of the closed page; now I have to tweak the pop-up so it fits the page format. This is achieved in a number of ways: by reducing the scale of the pop-up, trimming it, tucking an element inward with an extra pleat, or enlarging the size of the page spread. I keep making tighter and tighter models with more complete pencil sketches until I have a perfected dummy.

The next step is creating the full-color illustrations. I transfer my pencil line drawings to my illustration paper using a light table, then work with whatever colored medium I’m using to create the finished images. I then scan these images into Adobe Photoshop, print them out, and construct them into illustrated dummies, refining the artwork in the process.



If I'm using photographic images, I usually take the photos myself to avoid any copyright issues. Again, I pull the pictures into Photoshop, isolate the sections I'm using for the pop-ups, and use the powerful Photoshop tools to manipulate each image until it fits the paper engineering.

If I'm designing just one copy or a small edition of the finished pop-up, I print out all of my completed pop-up parts in the desired number of multiples and construct them using simple production techniques - another successful pop-up piece. But if I'm preparing the pop-ups for a commercial print run, I also have to create a die line drawing. The die line is an exact line drawing showing all required cuts and folds, and is used by the diemaker to create the steel-rule-and-plywood jig necessary to cut and score each press sheet. A die looks like a cookie cutter set into plywood, with knife-sharp blades to do the cutting and dull, rounded blades to press in the score lines. The diemaker is skilled at copying the die line exactly, so any mistakes made in the drawing are repeated throughout the press run. Thus, it goes without saying that the die lines must be accurate.

Die cutting is the standard process used in producing commercial pop-up books because it's a very fast and efficient means of cutting large quantities of parts. However, book artists producing editions of fewer than 300 or 400 pieces should consider laser cutting instead. It's a slower process, but less expensive and capable of producing more detailed results. When I'm preparing a piece for laser cutting, I create an Adobe Illustrator file showing the cutting outlines for each part. The laser then follows these outlines, literally burning the cuts into the paper. I finish the pop-up by scoring and folding each part by hand, using a series of scoring jigs I design specifically for the project.

If you'd like to try some paper engineering, there are a number of sample projects on my web site, www.popularkinetics.com under the "Making" tab at the top of the home page. And if you want more, my how-to pop-up book series titled *The Pocket Paper Engineer* covers basic structures used in many of the pop-up titles on the market today. Paper engineering is a way to have a lot of fun with paper, while at the same time reinforcing your spatial, math, and three-dimensional design skills.