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Paper Engineering & Pop-ups

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- Strategically cut, fold, and shape paper with the help of numerous photos and illustrations
- Take your creations from two to three dimensions
- Develop your own unique paper crafts

Rob Ives

Expert paper engineer and crafter



***Paper Engineering
& Pop-ups***

FOR
DUMMIES[®]

by Rob Ives

Professional designer and paper engineer



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Wiley Publishing, Inc.

Paper Engineering & Pop-ups For Dummies®

Published by
Wiley Publishing, Inc.
111 River St.
Hoboken, NJ 07030-5774
www.wiley.com

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Published by Wiley Publishing, Inc., Indianapolis, Indiana

Published simultaneously in Canada

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Library of Congress Control Number: 2008943497

ISBN: 978-0-470-40955-8

Manufactured in the United States of America

10 9 8 7 6 5 4 3 2 1



About the Author

Rob Ives is a full-time designer and paper engineer. He has had a number of books published on the subject, but he spends most of his work time running his paper automata Web site at www.flying-pig.co.uk.

Rob started his career as a primary school teacher, but gradually his enthusiasm for paper engineering took over, and finally in year 2000 he left teaching and began work as a self-employed designer. Since then, he has returned to schools and colleges to give talks and run workshops.

Rob lives in Cumbria in the UK with his wife Pauline and his two children, Martha and Elliot.

Dedication

This book is dedicated to Pauline, Martha, and Elliot — the lights of my life.

Author's Acknowledgments

Thanks to all the people at Wiley Publishing who have helped with this project. It has been a fascinating process, and I have appreciated the help and support all the way through.

A special thank you goes to Chad Sievers, my project editor, who has been so helpful and supportive throughout the project. He has been a calm and reassuring voice in the teeth of rewrites, edits, loads and loads of artwork, and looming deadlines! Thanks to Danielle Voirol, whose help with editing has been invaluable and much appreciated. Thanks also to Michael Lewis, the acquisitions editor, without whom none of this would have been possible. Literally!

Thanks also to Miranda Caroligne for her enthusiastic help in the early stages of this project. Finally, thanks to my family for all their patience and support as I once again disappeared to the word processor.

Publisher's Acknowledgments

We're proud of this book; please send us your comments through our Dummies online registration form located at <http://dummies.custhelp.com>. For other comments, please contact our Customer Care Department within the U.S. at 877-762-2974, outside the U.S. at 317-572-3993, or fax 317-572-4002.

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Introduction

Don't let paper fool you — it isn't just for drawing and writing. Paper is flexible and easy to cut, and it can be surprisingly strong when you fold it. Those qualities make paper a great building material for all kinds of art projects. And yes, you can still decorate the surface of your paper projects, even though a lot of them look good in white.

Paper engineering and making pop-ups are hobbies that anyone can take part in — from schoolchildren to retired people, from the businessman who wants a relaxing, creative project to work on in the evenings to the schoolteacher who wants a hobby she can share with her pupils. The skills are easy to pick up, and the tools you need are inexpensive and easy to get hold of.

Using some simple techniques, you can express your creative side by making these delightful paper creations, and when you're done, you have the pleasure of sharing the fruits of your creativity with your family and friends. Building on these skills, you can soon have the ability to design and make your own pop-up and paper-engineering projects.

About This Book

My aim in writing this book is to share my love of paper engineering with you and to show you just how easy and rewarding it is to take up this fascinating pastime. Although I tell you how to add color and embellishments to your projects, the focus is on putting paper together in creative ways. This book introduces all the major aspects of paper engineering, including making simple pop-up cards, designing storybooks using pop-ups, and making animated paper models. You can find info on basic concepts and techniques, along with complete projects with step-by-step instructions. I also discuss the design process itself, from seeking inspiration and getting your ideas down on paper to making the transition from sketch to completed model.

This book offers you, the beginning paper engineer, a chance to get your feet wet. I introduce many different types of paper engineering and present basic projects for most types. As you become more familiar and comfortable with working with paper, you may want to try more advanced and different types of projects. I suggest you look on the Web and at other books for inspiration.

You can read this book from start to finish, but you don't have to. I designed *Paper Engineering & Pop-ups For Dummies* so you can start with whatever project or technique interests you most. If you need extra information, just follow the cross-references.

Conventions Used in This Book

To help you find your way around this book, I use the following conventions:

- ✓ I use *italics* to emphasize words and to highlight new terms or words that I define.
- ✓ **Bold** indicates the action part of numbered steps or the keywords in a bulleted list.
- ✓ **Monofont** is for Web addresses. Note that when this book was printed, some Web addresses may have needed to break across two lines of text. If that happened, rest assured that I haven't put in any extra characters (such as hyphens) to indicate the break. Just type in exactly what you see in this book, ignoring the line break.
- ✓ All measurements in this book are marked in inches. Most of the diagrams include the inch symbol ("), but for those that don't, you can safely assume that inches are being used.
- ✓ In the figures, I use the following symbols:
 - **Dotted or dashed lines:** Score lines, where you fold the paper
 - **Solid lines:** Cut lines
 - **Gray area:** Where to glue
- ✓ Unless otherwise stated, all card/paper in the projects is A4 or letter size (8½" x 11") and has 230 micron (9 thousandths of an inch) thickness. For more on paper thickness, see Chapter 2.

What You're Not to Read

You don't need to read some parts of this book. *Sidebars*, the areas of text on a gray background, are there to add a little background information, perhaps a little color or an interesting anecdote to do with the subject being discussed, but they're not vital to your understanding of the subject.

Foolish Assumptions

I've made a few assumptions while writing this book. These assumptions can help smooth the way as I pass my enthusiasm for paper engineering on to you. I've assumed the following — I hope it's not too foolish!

- ✓ You're interested in paper engineering and pop-ups and want to be able to make and possibly design your own pieces.
- ✓ You're willing to spend a small amount of money buying some simple tools, such as scissors and a cutting mat.
- ✓ You have a few basic skills, such as the ability to measure and cut accurately. (Don't worry too much about this, because I help you with some more specialized cutting skills in the book.)

How This Book Is Organized

I organize this book into five parts. The first four deal with different aspects of paper engineering, and the fifth part is a *For Dummies* staple. Here's a preview.

Part I: Introducing the Magic of Paper Engineering

If you're new to paper engineering, you want to start right here. This part has four chapters that give an overview on all aspects of the subject. I give you the lowdown on just what paper engineering is. I talk about paper and card and give you some guidelines on setting up your own paper-engineering workshop. The part finishes off with a chapter on how to use the tools of the trade safely and effectively.

Part II: Going Flat Out: Commencing with Creative Paper Crafts

This part helps you get down to making some projects that are flat or can fold flat. It starts with some simple but effective paper-engineering crafts, including greeting cards that you can make for your friends, and moves on to introduce you to making pop-up cards using a whole variety of techniques. The final chapters in this part show you how to make other pop-up and pull-tab mechanisms and how to string several pages together into a book. Don't worry — I offer you loads of hands-on projects and plenty of illustrations to help you on your way.

Part III: Paper Sculpture and Animation: Adding Some 3D Life to Paper

This part covers paper sculpture and shows how you can fold, cut, and crease paper into fun 3D designs. This part also introduces the concept of paper automata, the fascinating world where models come to life through some simple mechanisms. Using plenty of projects, I go through the basics of paper automata. You get tips on using cams, levers, other mechanisms, and linkages, along with advice on making sure everything fits together.

Part IV: Drafting Your Own Designs and Creations

In this part, I show you the best ways of coming up with ideas and how to take these ideas from sketches to the finished model. I show you how color can enhance your designs and how to make fantastic paper models you can be proud of. I also show you how computers can help you with your paper engineering, including a section on free software you can easily use. And to round everything out, I talk a little about how you can make some extra money from your new hobby.

Part V: The Part of Tens

No *For Dummies* book would be complete without a Part of Tens. In this part, I go through ten helpful hints for making the best of your paper engineering and give you ten tips on designing and varying models.

Icons Used in This Book



In the margins of *Paper Engineering & Pop-ups For Dummies* (as in all *For Dummies* books), you see icons to help you find your way through the text. Here's what those icons mean:

This icon points out ideas and techniques that can make your project a bit easier.



Some techniques you need over and over. They're marked with the Remember icon. Take note of the techniques this icon highlights.



Be careful! This icon helps you avoid hurting yourself, damaging your equipment, or messing up your project. Keep an eye out for this one; it'll save you time, money, and possible injury.

Where to Go from Here

I always like to start with the hands-on stuff, so you may want to grab a pair of scissors and a ruler and head for one of the many projects in this book. If you like greeting cards, you may like to start in Chapter 5 with one of the simple projects. If you're interested in making moving models (paper automata), then head straight for Chapter 10. Those of you with a more artistic leaning may be more interested in making a paper sculpture. If so, go to Chapter 9. Just check out the table of contents or the index for a topic that interests you and flip to that chapter. You can jump in wherever you like and jump about from section to section. Of course, if you're new to paper engineering, I recommend that you at least read through Chapter 4 before you start the projects so you get a good grasp on safety and techniques.

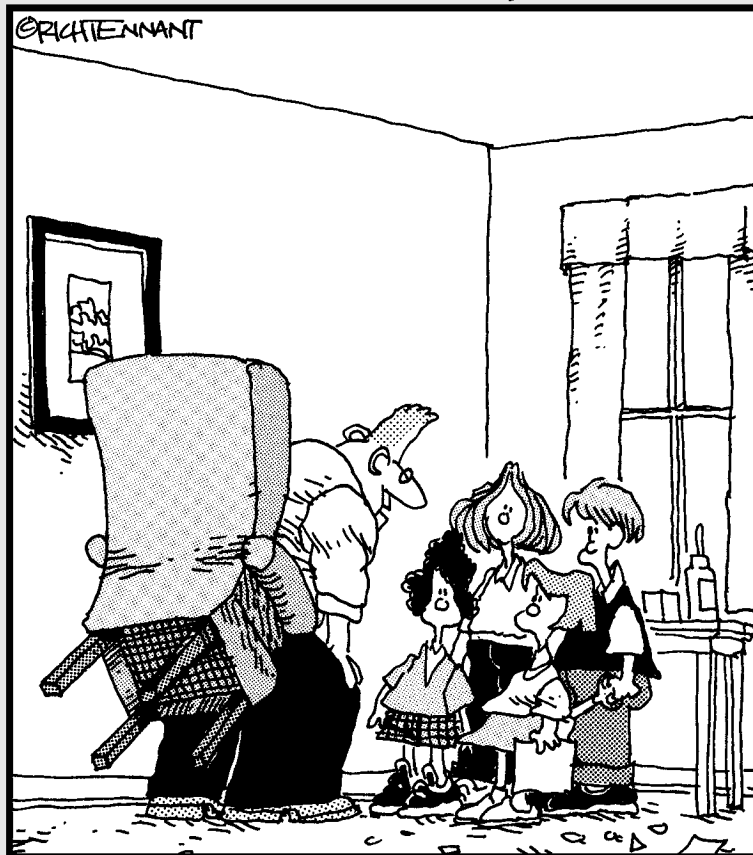
Or you can just start at the very beginning and read your way from cover to cover. No matter where you start, have a piece of paper and some scissors handy and get ready to dive right in.

Part I

Introducing the Magic of Paper Engineering

The 5th Wave

By Rich Tennant



“Okay Kids. Today we’ll be working on picking the best color of paper, creasing paper, and using a glue gun safely.”

W *In this part . . .*

elcome aboard! Here you go into the wonderful world of paper. In this part, I introduce the basics of paper engineering and outline some of the aspects that this book covers, from pop-ups and pull tabs to paper sculptures and animations. I also highlight the different types of paper you can use with your creations. I then guide you through setting up your paper-engineering workshop and stocking it with tools and materials. Finally, this part wraps up with advice on making your paper project and with some safety rules.

Chapter 1

Unfolding the Mystery of Paper Engineering

In This Chapter

- ▶ Looking at pop-ups and pull tabs
 - ▶ Going artistic with paper sculpture
 - ▶ Creating paper animations
-

Whoever came up with the idea of *construction* paper had the right idea: Paper makes a great building material — you can easily fold, bend, tear, and cut it, and sticking the parts together requires nothing more than a bit of glue. In elementary school, you may have been a bit haphazard about putting stuff together. Now that you're (somewhat) grown up, you don't have to be any less creative, but you can do a lot more with paper when you play engineer and plan ahead.

Paper engineering basically means cutting and creating shapes with paper or card. With paper engineering, you can make pop-up and moving cards, and you can create elegant and sophisticated sculptures using interesting 3D shapes. You can even make fully working machines that use only paper for their mechanisms.

This chapter gives you an overview of the main types of paper engineering that I focus on in this book. You discover how pop-ups and pull tabs are made and how they work. I take a look at paper sculpture, a way of using the paper itself as the art medium rather than just using it as the place where the art is drawn. I also introduce you to paper animations, or *automata*, which are a kind of humorous machine that shows a short animated scene made entirely out of paper. (**Note:** If you get the basics down and want to try your hand at design, I can help you out there, too — simply check out Part IV of this book.)

Including the Right Supplies in Your Workplace

Paper engineering is a relatively inexpensive hobby. You need only a few tools and materials to get started. Here's a list of the tools and materials you need to take the first steps (check out Chapter 3 for details about these items and other items you may want to add to your workspace later):

- ✓ Scissors
- ✓ Sharp craft knife
- ✓ Self-healing cutting mat

- ✓ Ruler
- ✓ White school glue (and glue spreader)
- ✓ Glue stick
- ✓ A range of different types of paper and card stock



Using colored papers and different textures can all add to the final effect. From corrugated cardboard to homemade paper, and from embossed or textured papers to foil-coated, reflective card stock — all these materials are an inspiration to the paper artist. You can combine them for a fantastic effect. For example, you can use corrugated cardboard to make the texture of a tree trunk reflecting in a pond made from blue foil-coated card. See Figure 1-1 for an example that incorporates different paper types.



Figure 1-1:
Textured paper adds interest to a relatively flat project.

Flip to Chapter 2 for more on paper and to Chapter 3 for advice on tools, materials, and setting up your workspace. Of course, tools and materials don't do much good if you don't know how to use them, so check out Chapter 4 for some info on cutting and construction techniques.

Cutting Away with Cutout Greeting Cards

When you cut a shape out of a piece of paper, sometimes you're after the piece you just cut out. And sometimes you're after the leftover scraps, wanting to let the hole do the work for

you. Artists can give you a neat, technical discussion of positive and negative space, but for the paper engineer, the important idea is this: Cutouts can make great greeting cards. See Figure 1-2 for a sample where you cut out the word “Wow!” and use a different colored paper directly behind the cutout.

Instead of adding colors or paints, *cutout cards* use holes and cuts as their main decorations. Through the holes and cuts, you can see other paper of other colors or just an interesting shadow. You can make cutout cards with a craft knife using a whole variety of different weights and colors of card. Chapter 5 gives you several opportunities to make your own cutout cards.

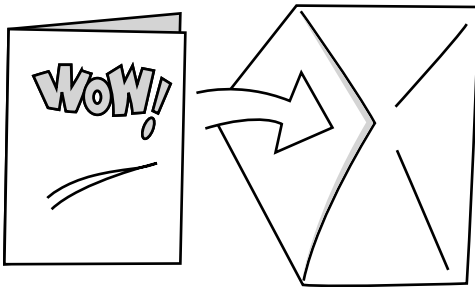


Figure 1-2:
A sample
cutout card.

Rising to the Occasion with Pop-ups

Pop-ups literally add a whole new dimension to books and greeting cards. Pop-ups use clever folds of paper to make ingenious mechanisms. When viewers open pop-up pages, anything can happen. You can open a greeting card and find that an entire 3D scene — complete with castles, knights, and a dragon — comes into view. Open another card, and a whole bunch of flowers appears like a magic trick. Even simple pop-ups can be surprisingly effective. This section gives you a quick overview of pop-ups. Check out Chapters 6 and 8 for more in-depth info.

Looking at how pop-ups pop up

With a pop-up, you open the page of the pop-up book (or card), and the character lifts into view. In the simplest pop-ups, you make the effect easily. A cutout of the character is fixed so that it sits just in front of the background. By clever use of paper tabs, the character folds flat when you close the book or card. Figure 1-3 shows an example of a simple pop-up card. The shadows cast on the background give the flat character dimension.

You can make more-complicated pop-ups by changing the way parts are folded and how the characters join together. If the fold and tabs that hold the card together are angled, then when the card opens, the character twists into position instead of just lifting straight up. Figure 1-4 shows how a character can swivel into view.

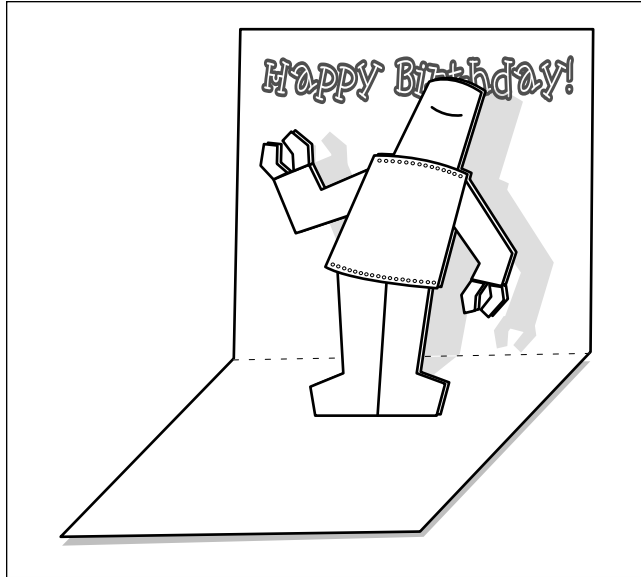


Figure 1-3:
A flat character in front of a backdrop appears to have depth.

Even the most complicated pop-ups work using the same small set of mechanisms. When you understand these mechanisms, you can design your own amazing paper inventions.

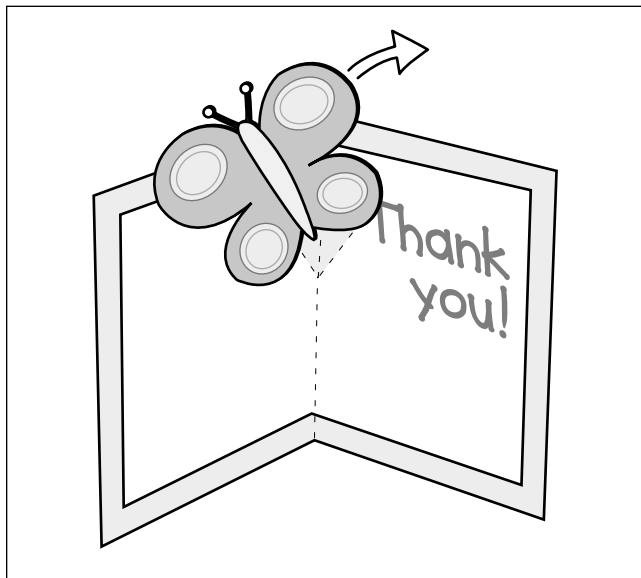


Figure 1-4:
The parts of a pop-up can burst out from the edge of the card.

Eyeing the different pop-up methods

Pop-ups come in all shapes and sizes. They use a variety of different mechanisms to do their popping. From the coffee-table books to greeting cards, each pop-up may use a single mechanism or a whole range of linked mechanisms. Read on to find out more about the types of pop-ups just waiting for your discovery:

✔ **Parallel pop-ups:** You may well have made the simplest type of parallel pop-up when you were at school. Usually, parallel pop-ups open only halfway so that the book or card is opened to 90 degrees. In front of the background of the card is one or more layers of pictures that are parallel to it. Figure 1-5 shows a typical parallel pop-up.

From this simple starting point, you can change and add to parallel pop-ups to make quite sophisticated pictures with very interesting mechanisms. With care, the movement of the picture as the card opens can really add to the project's impact.

✔ **Pop-out pop-ups:** The second common type of pop-up is the pop-out pop-up, which you most commonly see in books. With pop-out pop-ups, the pages open fully, and a 3D model appears miraculously in the middle of the page.

You can make fantastically complicated pop-out pop-ups that still fold flat, hiding their secrets within. Figure 1-6 shows an example from *Encyclopedia Prehistorica Dinosaurs: The Definitive Pop-Up*, by Robert Sabuda and Matthew Reinhart (Candlewick).

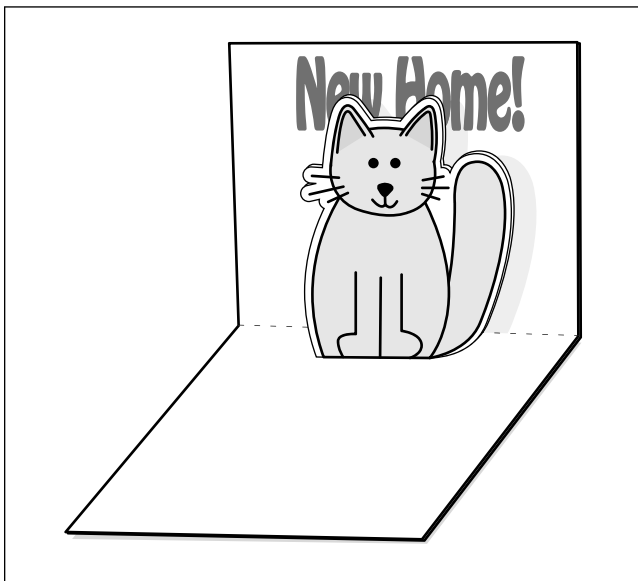


Figure 1-5:
A parallel
pop-up cat.