

# The Continuously Convoluting Carousel

## A Jacob's Ladder carousel book

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*Please note: this is an outline and tips to follow during the presentation, not complete instructions.*

### INTRODUCTION TO THE STRUCTURE

Two examples of the structure I am binding today

- *News Cycle* edition with Sarah Smith
- Larger multi-color demonstration model

Nope, it's not a flexagon!

This structure moves similarly - a ring blooming out from the center - to the family of structures called flexagons or kaleidocycles, but has some key differences.

#### FLEXAGONS

- 2-dimensional: a string of hinged polygons (triangles or squares) joined in a ring, usually folded from a single sheet of paper. The polygons do not change shape during manipulation.
- 3-dimensional: a string of hinged polyhedra (usually tetrahedra) joined in a ring, also usually folded from a single sheet of paper. The polyhedra also do not change shape during manipulation.

#### CCC

- A series of board pairs linked by Jacob's Ladder pseudo-hinges, joined in a ring. (Another way to say this is **two Jacob's Ladders interlaced at 90 degrees.**)
- Each pair of boards alternates between a closed state and two different open states, flexing its contained pages.

How I came to this structure.

Goal: Make a book that opens in multiple perpendicular directions.

Not a dos-a-dos, but fully interlaced alternating pages.

First try: two opening directions perpendicular, problematic binding

There are foldings for multiple perpendicular page arrangement, but how to bind?

Jacob's Ladder hinge

Provide temporarily bound edges, using straps that create pseudo-hinges.

The page panels were at first only a mechanism to prevent hinge hyperextension

Carousel is most stable configuration to keep all temporary hinges on a given edge.

An early example: an interactive mobile

Varying the basic elements - Jacob's hinges with no folded panels; folded panels with no Jacob's hinges

# BINDING A CCC: BASIC PROCESS OUTLINE

## THE SIMPLIFIED VERSION

Good for getting a sense of the structure, and prototyping content.

Key features

- Bare boards
- Pages tipped in after assembly
- All straps adhered around edges
- No paste-downs
- No magnet closure - permanently opened

A. Cutting materials for a 5-sided carousel

10 square boards (H x W)

10 center straps (H - 1/2 in, W + 1/2 in)

20 edge straps (<1/4 in, W+1/2 in)

20 page panels (H - 1/2 in, [Wx1.2]+1/2 in)

B. Preparing materials

Fold pages, trim corners

C. Assembling binding

### 1. Center straps

Place center straps between board pairs; fold margins over edges and adhere.

### 2. Edge straps

Place edge straps between board pairs; fold margins over edges opposite of center strap, and adhere.

**NOTE: Steps 1,2 can be completed in conjunction for each board pair, or Step 1 can be completed on all boards before moving on to Step 2 on all boards. Binder's preference. *This is not the case for the advanced version!***

### 3. Pages

Adhere pages between board pairs by tipping margins to board and facing center strap.

## THE ADVANCED VERSION

Key features

- Covered boards
- Page pairs and center straps in a single folded piece - the “page assembly”
- Page assembly adhered inside board edges
- Paste-downs
- Magnet closure

Content: imposition and printing

A page assembly is constructed of two page panels adhered to a center strap - “pieced”, OR pairs of pages are printed recto and verso on a single sheet with a center strap incorporated between them.

A. Cutting materials for a 5-sided carousel

Same basic dimensions as simplified version above, except:

- Cut 13 boards, 4 of which are half-thickness and make up 2 cover boards
- Cut centered magnet holes in 2 of the half-thickness boards
- Cut covering material for 11 board edges and 2 full boards

Paste downs: time consuming and fussy, not essential, but give better finished look.

$H, W = \text{board dimensions} - \frac{3}{32} \text{ in}$

## B. Preparing Materials

Cover board edges: 9 boards + 2 half-thickness boards with magnet holes

Overall-cover 2 half-thickness end boards and back-fill

Crease and fold pages

## C. Assembling The Binding

### 1. Pages

If piecing page assemblies, adhere page pairs to each center strap.

Adhere all page assemblies between board pairs. (These margins may adhere inside board edge.)

Must be well centered to make room for edge straps. Use a jig!

### 2. Straps (recto)

Adhere one end of each edge strap to board rectos, opposing center straps. The second end hangs free. Be sure not to adhere over other moving parts.

(Narrow strap ends must wrap around board edge.)

### 3. Straps (verso) + Paste downs

Prepare magnet hole by overall-adhering first paste-down

Working from front to back adhere free strap ends and paste downs. Again, be sure not to adhere over any other moving parts.

### CAUTION

Assembly order is critical at this stage! Paste downs cannot be inserted under adhered straps, and strap ends cannot be inserted under adhered paste downs. This is the fiddly bit. Make sure you're rested and ready before diving in.

### Tips for success:

- Proceed through the book one board face at a time, from the front to the back of the book.
- For any given opening between board pairs, first pull the loose straps out of the way.
- Before adhering a verso paste down, make sure a set of strap ends is adhered to that board face (except for the very first board).
- When adhering straps, pull them snug, but only enough to take up slack. Too tight creates problems in functionality later.
- All paste downs except for the ends can be drummed on at the two exposed edges. Apply adhesive to edges that run with the grain to minimize expansion.
- Once both paste downs of a given opening are adhered, replace the loose straps and move on.

### 4. Covers + magnets

Orient magnets so that poles are facing the same direction. Place the magnet in the hole, and overall-adhere the end board.

## VARIATIONS

Fewer sides are also fun: 4, 3, 2; square, triangle, flat.

The boards don't need to be solid.

Who needs straps? Let's sew it!

Funky rectangles.

Something for the future: triangular unit with 3-way Jacob's hinge

## References for several sources and people I've mentioned

olfactorypress.com

Books, prints, and drawings by Sarah M. Smith, creator of illustrations for *News Cycle*.

yibinliang.com @liang.yi.bin

Yi Bin Liang - artist, bookbinder, and fabricator. Creator of watercolors for *Water Cycle*.

pattisonpaperworks.com

@pattisonpaperworks

Todd Pattison, conservator and contributing bookbinder for *News Cycle* edition.

Jacob's Ladder Book Structure: a modular approach. Bound and Lettered, Spring 2012.

[http://www.karenhanmer.com/reviews/documents/jacob%27s\\_ladder.pdf](http://www.karenhanmer.com/reviews/documents/jacob%27s_ladder.pdf)

Karen Hanmer's instructions for a Jacob's Ladder book.

Single degree of freedom everting ring linkages with nonorientable topology. Johannes Schönke, Eliot Fried.

Proceedings of the National Academy of Sciences Jan 2019, 116 (1) 90-95; DOI:10.1073/pnas.1809796115

<https://www.pnas.org/content/116/1/90>

A fascinating, mathematics-heavy article that delves into Mobius kaleidocycles.

kjmagnetics.com

A good source for neodymium magnets of many shapes and sizes.

"Jacob's Ladder", Scientific American, Vol. 61, No. 15 (October 1889)

Six-fold dos-a-dos binding. National Library of Sweden flickr photostream

<https://www.flickr.com/photos/25300312@N08/albums/72157625022630035/with/4998209938/>

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Full instructional document coming soon!

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