

## RECREATIONS WITH PAPER

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### INTRODUCTION

- ⇒ The subject was originally to do with magic and paperfolding, but the scope has broadened to include a variety of tricks and puzzles that use paper or involve folding and/or cutting. Not necessarily origami.
- ⇒ Overlap between magic and paperfolding. Many magicians are interested in origami and puzzles (including paper stunts and puzzles) and origami people often like magic. But most people are much more heavily into one of the two. My interests are fairly strong in both areas.
- ⇒ In both magic and origami, enthusiasts are initially interested in learning new tricks/models and find old tricks and traditional models too simple, but later will often develop an interest in history, origins, theory etc.
- ⇒ My recent interest in magic history stems from the availability of old magic books online (e.g. Google). Started with search for information about *Hocus Pocus Junior* (1634) and found many old magic books in various languages. I was interested in what tricks they contained (origins of modern tricks). Some of the tricks were doubly interesting because they used paper.
- ⇒ Magic overlaps with paperfolding (including origami and napkin folding) but also with the world of puzzles, recreational mathematics and popular science. Each of these is a vast field in its own right. Also I am not a historian, puzzle expert or mathematician, so this is not an exhaustive study. “Jack of all trades, master of none”. (“Er versteht von allem etwas, ist jedoch nirgends Meister.”)
- ⇒ My recent interest in the history of paperfolding stems from awareness of the work of Joan Sallas and his study of old paperfolding books (coinciding with my discovery of old magic books). I am also translating his book on napkin folding.
- ⇒ My focus is on the use of paper and in particular paperfolding in magic literature and books on recreational mathematics and puzzles.

### EARLY MAGIC BOOKS

- ⇒ Performances of magic tricks are described by classical authors (e.g. Cups and Balls).
- ⇒ But the first recorded tricks were mainly arithmetical (Alcuin, 9<sup>th</sup> century; divination of number thought of).
- ⇒ Mathematical puzzles and card tricks (earliest examples from 15<sup>th</sup> century Italy).
- ⇒ Middle Ages: Books of Secrets, crude tricks, household hints, special inks, alchemy, scientific curiosities, “natural magic”.
- ⇒ Most tricks were copied directly (or translated) and appear in identical form in many books.
- ⇒ In the 18<sup>th</sup> and 19<sup>th</sup> centuries science developed into a more serious area of study. Magic also became a separate (and more artistic) discipline.
- ⇒ Serious magic books really began in the 19<sup>th</sup> century. Very few early tricks with paper, and most of them are stunts rather than proper tricks.

### SOME EARLY TRICKS INVOLVING PAPER

#### The Discoverie of Witchcraft (1584)

by Reginald Scot (barrister)

- ⇒ An exposé of medieval witchcraft with a small magic section (Book 13, Chapter xxvi). Long considered the first book to properly describe actual magic tricks as opposed to crude stunts. (Recent research has revealed other earlier books.)
- ⇒ The material from Scot was heavily plagiarized for many years and much of it is still found in magic books today.
- ⇒ **To transforme anie one small thing into anie other forme by folding of paper**  
Two tricks: the first seems to be the same as the modern trick with handkerchief and cutlery. The second is the Buddha Papers.
- ⇒ **How to make a booke, wherein you shall shew everie leafe therein to be white, blackie, blew, red, yellow, greene, etc.**  
Magic Colouring Book.

### Deliciae physico-mathematicae, oder mathematische und philosophische Erquickstunden (1636)

by Daniel Schwenter (mathematician and orientalist)

- ⇒ Based on Leurechon's *Récréations mathématiques* (1624) and also Schwenter's own collection of similar material.
- ⇒ Revised and expanded into two more volumes (1651 and 1653) by Georg Philipp Harsdörffer (napkin folding). Vol. 3 includes napkin folding.

### Volume 1 (1636)

- ⇒ **Paper cutting stunt, p. 145**
- ⇒ **Tabulae striatae, p. 271** (wooden)
- ⇒ **Topological puzzle to link three pieces of cut-out paper, p. 411** (cherries puzzle)
- ⇒ **Three strips of paper rolled together, p. 413**
- ⇒ **Letter fold, p. 521**
- ⇒ **Blow book, p. 522**
- ⇒ **Einmaul, p. 551**
- ⇒ **Topological paper stunt, p. 566**
- ⇒ **To make a strip of paper land on its edge, p. 568**
- ⇒ **To cut an apple with a strip of paper without damaging the paper, p. 568**

### Volume 3 (Harsdörffer 1653):

- ⇒ **Tablecloth folding**  
Brief mention. See *Vollständiges und von neuem vermehrtes Trincir-Buch* (1652))
- ⇒ **Falzbilder**  
With wooden slats. Pleated paper version in *Onomatologia* (1759), Johann Samuel Halle, *Zauberkräfte der Natur* (1787), *Die Hesperiden: Ein Magazin für jugendliche Unterhaltung* (ca. 1804), Gaston Tissandier, *Half Hours of Scientific Amusement* (1890) (stick strips down on card, then pleat the card), Walter Sperling, *Kuriose Spielereien* (1961))

### Sports and Pastimes (1676)

by J.M. (probably James Moxon)

### **Troublewit**

⇒ First known reference. Later in Dean 1722 (1<sup>st</sup> edition), Ozanam 1723 (French), Minguet 1733 (Spanish), Alberti 1747 (Italian), Crailsheim 1766 (German) and many others. Very popular in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Most of the early descriptions copy directly from either *Sports and Pastimes* or Ozanam.

### **Onomatologia curiosa artificiosa et magica oder ganz natürliches Zauber-lexicon (1759)**

⇒ Encyclopedic compilation from various earlier sources by multiple anonymous authors.  
⇒ Revised by Johann Christian Wiegleb (1784), but paperfolding items were not changed.  
⇒ A number of items with paper appear under the headings “Falten” and “Pappier”.

- ⇒ **Tabulae striatae** (Pleated paper version of *Falzbilder* (see *Deliciae physico-mathematicae* Vol. 1 (1636) and Vol. 3 (1653))
- ⇒ **Napkin / tablecloth folding** (*Serviettenbrechen*. Note about practising with paper.)
- ⇒ **Banger** (Primitive form; see Joseph Leeming's *Papercraft* (1949))
- ⇒ **Three strips** (Also in Porta, Schwenter, Schott, Eckartshausen)
- ⇒ **Covering a ball with paper** (Not very clear)
- ⇒ **Topological puzzle to link three pieces of cut-out paper** (Cherries puzzle; also in Pacioli, Schwenter, Schott)
- ⇒ **To make a strip of paper land on its edge** (Also in Schwenter, Poppe, Crailsheim)

### **Falten**

- ⇒ Description of *tabulae striatae*, or pleated pieces of paper which can be made to show two or three different images, depending on the manner of pleating (simple pleating for two images, box pleating for three images). The images are cut into strips and the strips are pasted onto the pleats so that the first image can be seen from one angle and the second image can be seen from another angle.
- ⇒ Description of the art of napkin and tablecloth folding, although it is pointed out that the explanations which appear in culinary texts (*Trenchierbücher*) are not easy to follow and the art is better learned from practical experience and from paper models (*Modelle von Papier*).

### **Pappier**

- ⇒ A primitive form of the Banger: Fold a sheet of paper in half and then in half again; grasp the middle two layers and make a sharp throwing motion with the hand. The paper should open and make a loud bang.
- ⇒ Topological puzzle with three pieces of paper, as illustrated in Plate X. This is basically the well known "Two Cherries" puzzle (how to release two buttons or balls from a piece of string and piece of card).
- ⇒ Three paper strips rolled together: see *Zum Kurzweil vorgelegte Aufgaben*.
- ⇒ How to throw a strip of paper onto the table so that it lands on its edge. The solution is to fold the paper first.

## **PAPER TOYS AND POPULAR SCIENCE IN THE 19<sup>th</sup> AND 20<sup>th</sup> CENTURIES**

- ⇒ Many 19th century books on amusements for children included simple paper toys and stunts involving paper, especially in the latter half of the century.

- ⇒ Puzzles started to become popular (Hoffmann's *Puzzles Old and New* (1893), Henry Ernest Dudeney, Sam Loyd). Paper folding puzzles.
- ⇒ Same stunts often rehashed and still appear in modern books as magic tricks for children, e.g. cherries puzzle. Direct copying of material, e.g. *Cassell's, Home Book* and *Grande encyclopédie*. It is interesting to find books with new items not found elsewhere.
- ⇒ In popular science books paper was often used to demonstrate principles of geometry and physics. Sometimes presented as magic tricks.
- ⇒ A major area of interest is the use of paper for educational purposes, e.g. Fröbel. Many books on paper folding and cutting as exercises in "hand and eye training".
- ⇒ Serious books for magicians started to become more common. Around 1920 there were a few devoted entirely to paper magic (*Houdini's Paper Magic*; Will Blyth's *Paper Magic* and *More Paper Magic*). These are good compilations of many of the paper tricks and stunts known at the time.
- ⇒ Actual paperfolding in Houdini's book: Flapping Bird, Frog, Box (with cuts), Samurai Hat, Puzzle Purse, Troublewit, type of modular kusudama made from six Puzzle Purses (glued)
- ⇒ Gift Box with cuts found in many books. Dates back at least to *The Book of Hours of Catherine of Cleves* (1440); <http://www.loggiaserena.com/Resume/Documentation/PaperFoldingDoc.pdf> and <http://www.manor.frodelius.com/Classes/APerfectlyPeriodPaperBox.pdf>
- ⇒ Many more simple traditional folds in the Will Blyth books
- ⇒ Later compilations (e.g. Murray & Rigney, Leeming).
- ⇒ Nowadays there are many to choose from, though the tricks are usually always the same and go right back to Scot (1584). A good recent compilation (expensive and hard to find) is Martin Gardner's *Encyclopedia of Impromptu Magic* (1978).

## **SELECTED AREAS OF INTEREST INVOLVING PAPER AND FOLDING**

### **Troublewit**

- ⇒ Included in many magic books from 1676 (*Sports and Pastimes*) up to present day. Mainly French and English books, but also German, Spanish and Portuguese.
- ⇒ Possibly developed from napkin folding. Similar techniques.
- ⇒ First detailed descriptions in Dean (1722) and Ozanam (1694, revised in 1723 by Martin Grandin (Professor of Philosophy at the University of Navarre) with the addition of a section on magic tricks, including Troublewit).
- ⇒ Mostly the instructions were vague and did not really explain or show the various figures. Usually copied verbatim from Dean or Ozanam.
- ⇒ Especially popular around the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Quality of instructions improved (e.g. Mieg, Bullivant). Stanyon, Caroly, Trewey.
- ⇒ Andrew Pinard's research and book. <http://troublewit.net/>

### **Chapeaugraphy**

- ⇒ Folded circle of felt used to make various hats. Trewey. Not often seen nowadays, though still found in some magic books.

### **Puzzles**

- ⇒ Hoffmann's *Puzzles Old and New* (1893). "Hoffmann's original book was effectively a catalogue of most of the mechanical puzzles available in Victorian London in the 1890s together with their solutions, plus many excellent new and classical puzzle posers." (<http://puzzlemuseum.com/library/hoffm/hoff-bk.htm>)
- ⇒ A few puzzles with paper (e.g. dissections, cutting problems). Dudeney et al.

## Paper cutting and tearing

- ⇒ Circular designs, row designs (e.g. Eric Hawkesworth, various magic books)
- ⇒ Some magic acts have been based entirely on paper tearing and cutting (e.g. hats (Gene Anderson), Captain's Shirt, Ship's Wheel).

## Mathematics / Geometry

- ⇒ Geometrical dissection puzzles often found in puzzle books. Date back to Ancient Greece, e.g. Archimedes' Ostomachion or Stomachion (old form of Tangram; square divided into 14 pieces; 536 ways to make a square). Some have modern origami versions, e.g. Henry Ernest Dudeney's Haberdasher's Puzzle (*The Canterbury Puzzles* (1907)). (Haberdasher = Kurzwarenhändler (UK), Herrenausstatter (US))
- ⇒ Möbius strip. Discovered by Listing (1858) a few months before it was discovered by Möbius. Magicians made a trick of it (Afghan Bands). Paper or fabric; several variations, e.g. 3 links (James Nelson, *Sphinx*, December 1926)
- ⇒ Polygonal knots. First Western description of Pentagonal and Hexagonal Knots in *Sfera astronomica* by Urbano d'Aviso (1690) (date and authorship controversial). Pentagonal knot also known in Japan. Later studied by mathematicians. Magic trick version (dissolving knot).
- ⇒ Flexagons (Arthur Stone et al. (1939)). Many different types. Well documented. "In geometry, flexagons are flat models, usually constructed by folding strips of paper, that can be *flexed* or folded in certain ways to reveal faces besides the two that were originally on the back and front." (Wikipedia)
- ⇒ Serious study of the mathematics of folding (Lang, Maekawa, Demaine et al. "Geometric Folding Algorithms: Linkages, Origami, Polyhedra" by Erik Demaine and Joseph O'Rourke).

## Popular science

- ⇒ Gaston Tissandier (1890 - first publication of Flapping Bird according to Gardner)
- ⇒ Tom Tit (Arthur Good) (1890s)
- ⇒ *Kolumbus-Eier* (1899) (also other editions, including 1976 by Edi Lanners)
- ⇒ Martin Gardner (Scientific American, books, magic books with paperfolding)

## Paper folding in education

- ⇒ Fröbel
- ⇒ "Paper-Folding and Cutting" was an important part of the Fröbel-style education system that became popular in the late 19<sup>th</sup> and early 20<sup>th</sup> centuries. Many books on simple paper folding exercises and how to construct things from paper and card.

Every scheme for art education must necessarily embrace the study of geometric plane figures and their mechanical construction. The prescribed methods for this construction have been difficult, complicated, consuming much time, and, if learned at all, were easily forgotten. Children would easily follow a dictation which would result in an octagon, hexagon, pentagon, etc., but were unable to repeat it independently the following day. After various unsuccessful attempts to simplify the method of drawing these figures, my attention was called to paper folding and cutting. (...) After much thought and study, I discovered the principle underlying such construction of all regular plane geometric figures. It is simple, and within the comprehension of very young children.

A simple method of making regular plane geometric figures from a square, a circle, or any regular or irregular geometric plane figure, by means of folding in such a manner that one clip of the scissors will give the desired result.

The principle upon which this folding is made is the division of the 360° of the circle, or imaginary circle, contained within the enclosing plane figure into as many parts as

there are sides or angles to the figure. The paper may be square, circular, or of any regular or irregular shape.

from *Paper Folding and Cutting* (1892) by Katherine Ball

General hints:

Do not fold the paper in the air, but lay it on a desk or table or any solid surface.

Fold from the body, not towards it.

Press the folded paper evenly with the thumb and forefinger.

In cutting take long, deep incisions, and not short jerky ones.

from *How to Teach Paper-Folding and Cutting* (1892) by MacLeod

### **Fold and one cut**

- ⇒ Betsy Ross Star. According to the (probably apocryphal) story, Betsy Ross was supposed to have made a 5-pointed star by folding and cutting (one cut) in 1776. George Washington had proposed 6-pointed stars for the American flag, but Betsy Ross said it was easier to make 5-pointed stars and used the fold-and-cut method to prove it. The "Pattern for Stars" artifact is a folded piece of paper with a partial cut, supposed to have been found in an old safe in 1922. See *Two Conundrums Concerning the Betsy Ross Five-Pointed Star* by Tubis and Mills (<http://www.ushistory.org/betsy/more/two-conundrums.htm>) and *Old Glory – The Flag of Our Country* (1894) by Albert Elias Maltby (<http://archive.org/details/oldgloryflagofou00malt>).
- ⇒ The 5-pointed (Betsy Ross) star is found with variations in many old puzzle books (e.g. Dudeney's *Amusements in Mathematics* (1917) – from a circle) and Fröbel-influenced educational books from the late 19<sup>th</sup> and early 20<sup>th</sup> centuries.
- ⇒ Principle also used by magicians. Gerald Loe *Paper Capers* (1955).
- ⇒ Important technical point: A "fold and one-cut procedure" in this paper is defined as one that involves *only* folding (i.e., no use of markings on the paper, protractor, angle template, etc.) and a single cut determined by previously made crease marks. This definition is *more* restrictive than the one associated with the modern fold and one-cut procedures [e.g., Demaine and Demaine (2004); Demaine and O'Rourke (2007)]. These procedures show how to fold a piece of paper on which an arbitrary number of general polygon structures *are inscribed*, so that all of the polygon lines overlay one another (and that consequently a single cut will result in the production of all of the individual inscribed polygons). (<http://www.ushistory.org/betsy/more/two-conundrums.htm>)
- ⇒ Modern "Fold and One Cut" procedures (Erik Demaine). According to Demaine the first known reference is *Wakoku Chiyekurabe* (Mathematical Contests), by Kan Chu Sen, published in 1721. "Pure" origami tries to avoid cuts. But the fold-and-cut approach is also interesting, especially if neat folding sequences can be found, though often you just have to collapse the paper into the creases (cf. crease patterns).
- ⇒ My version of Demaine's Jack O'Lantern with folding sequence.

### **PRESENT-DAY MAGIC WITH PAPER AND ORIGAMI**

- ⇒ Many magicians like origami and combine it with magic. Harbin, Rohm, Elias, Neale, Martin Gardner, Jon Tremaine, Steve Biddle.
- ⇒ Nowadays there are a number of excellent tricks involving folding techniques (e.g. T&R newspaper, banknote tricks) and even actual origami models, but they are widely scattered in different specialist books.

#### Origami with magic theme

⇒ Robert Neale (Bunny Bill, Bunny One Cut)

⇒ Fred Rohm (It's Magic)

⇒ Laurie Bisman (3D Rabbit in a Hat)

#### Magic with an origami theme

⇒ Dissolving pentagonal knot

⇒ Frog Prince

⇒ Coin in Water Bomb

⇒ Bar and Bolt

⇒ Row design where separate figures join (David Harkey)

⇒ Row design with inverted figure (Bob Ostin)

#### **CONCLUSION**

⇒ No real “conclusion” to be drawn.

⇒ We have looked at the evolution of the use of paper, from being a medium for the performance of simple stunts to more sophisticated feats (proper magic tricks), and its use as a means for demonstrating mathematical and scientific principles (sometimes disguised as tricks).

⇒ Most of the tricks and stunts rely on the special properties of paper, in particular the fact that it can be folded and cut.

⇒ Focus has been on European sources (no attempt to study oriental sources). But we can see that paper (and napkins) and folding techniques were being used for recreational purposes in Europe long before the introduction of origami.

⇒ Many different areas to be explored.

## **BIBLIOGRAPHY / FURTHER READING**

### **Giambattista della Porta**

*Magiae naturalis / Natural Magick* (1558)

### **Reginald Scot**

*Discoverie of Witchcraft* (1584)

### **Daniel Schwenter**

*Deliciae physico-mathematicae, oder mathematische und philosophische Erquickstunden* (1636)

### **Georg Philipp Harsdörffer**

*Deliciae physico-mathematicae, oder mathematische und philosophische Erquickstunden*  
Vol. 2 (1651) and Vol. 3 (1653)  
*Vollständiges und von neuem vermehrtes Trincir-Buch* (1657)

### **Gaspar Schott**

*Joco-seriorum naturae et artis* (1664)

### **Henry Dean**

*The Whole Art of Legerdemain, or, Hocus Pocus in Perfection* (1722)

### **Jacques Ozanam**

*Récréations mathématiques et physiques* (1694; revised edition 1723)

### **Albrecht Ernst Friedrich von Crailsheim**

*Die zehenmal hundert und eine Kunst* (1762)

### **Johann Samuel Halle**

*Zauberkräfte der Natur* (1787)

### **Johann Christian Wiegleb**

*Onomatologia curiosa artificiosa et magica oder ganz natürliches Zauber-Lexicon* (1759/1784)

### **Johann Heinrich Moritz von Poppe**

*Der magische Jugendfreund* Vol. 3 (1817)

### **Gaston Tissandier**

*La science pratique* (1889)

### **Tom Tit (Arthur Good)**

*La science amusante, Séries 1-3* (1890-1893)  
*Joujoux en papier* (Arthur Good, 1924) (*Le papier du père Mathieu*)

### **Katherine Ball**

*Paper Folding and Cutting* (1892)

Online at <http://chestofbooks.com/crafts/children/Paper-Folding-Cutting/index.html>

### **Will Blyth**

*Paper Magic* (1920)

*More Paper Magic* (1923)

### **Walter B. Gibson**

*Houdini's Paper Magic* (1922)

### **Paul Engelhardt and Adolf Lillack**

*Papiergestaltung* (1926)

**William D. Murray and Francis J. Rigney**

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*Fun with Paper Folding and Origami* (1988)

**R.M. Abraham**

*Winter Night's Entertainment* (1932)  
*Diversions and Pastimes* (1933)

**Joseph Leeming**

*Fun with Paper* (1939)  
*Papercraft* (1949)

**Robert Harbin**

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**Francis J. Rigney**

*Cub Scout Magic* (1960)

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*Magic with Paper* (1962)

**Walter B. Gibson**

*Fell's Guide to Papercraft Tricks, Games and Puzzles* (1963)

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*Newspaper Magic* (1968)

**Laurence B. White**

*Investigating Science with Paper* (1970)  
Online at <http://www.arvindguptatoys.com/arvindgupta/paperscience.pdf>

**Eric Hawkesworth**

*A Magic Variety Show* (1973)  
*The Art of Paper Tearing* (1973)  
*Paper Cutting* (1976)  
*Pleated Paper Folding* (1975)

**Martin Gardner**

*Encyclopedia of Impromptu Magic* (1978)

**Ray Bolt**

*Magic with Origami* (British Origami Society Booklet)

**Karl Fulves**

*Self-Working Paper Magic* (1985)

**Steve and Megumi Biddle**

*Origami Magic* (2012)

Many of the older books are available online (e.g. Google Books, <http://archive.org/>).