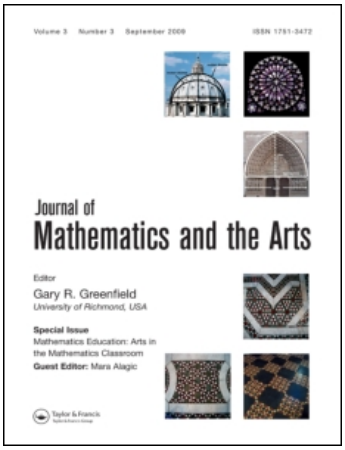

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D-Forms: surprising new 3-D forms from flat curved shapes, by John Sharp

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BOOK REVIEW

D-Forms: surprising new 3-D forms from flat curved shapes, by John Sharp, Hertfordshire, UK, Tarquin Publications, 2009, 44 pp, UK£9.95 (Hardcover), ISBN-13:978–1–8996–1887–3.

You probably know that paper folding is good for making party hats, airplanes or more complex origami shapes, ranging from cranes to beetles to elk with antlers. But what shapes can you make by gently bending paper and gluing it along its rim? – You can make *D-Forms* – a concept introduced by Tony Wills (http://www.wills-watson.co.uk/). These are elegant geometrical shapes that may remind you of some sculptures by Brancusi or some minimalist concrete furniture that you encountered in a public park. A new, easy-to-read, and very enjoyable booklet by John Sharp teaches you how to make your own D-forms by using paper, scissors and just a little bit of glue.

The most *elementary D-Forms* are made from two flat shapes with smooth perimeters that are both of equal length. First, you cut out two such shapes from the many templates given in the new booklet. Then you join the two together by working around the whole perimeter of one, fusing it with that of the other. Since they both are of equal length, the process should terminate evenly and result in a graceful closed shape (Figure 1).

The basic idea, though simple, seems to be rather novel. It is not addressed by the standard mathematics or modelling literature. Apparently, there are no known closed form solutions that will predict what 3D shape will result when simple 2D figures are joined at their perimeter into a D-Form – raising a challenge for some serious mathematical research. There are, however, computer simulation programs that can give you a preview of the shapes that might result from joining two arbitrary shapes, for instance a Java applet by Kristoffer Josefsson (http://www.math.tu-berlin.de/~josefsso/).

Fortunately, no math or computer is required to build all of the D-Forms in this book. The material properties of paper, cardboard or thin sheets of metal will automatically 'solve' the shape-forming problem as the two cut-outs are joined. The physical fusing together of the perimeters of the two cut-outs takes some getting used to, but this book shows a couple of options and gives you detailed instructions on how to proceed. When working with paper cut-outs you may use little strips of tape around the joined edges, or you can use the serrated tabs provided in the templates in this book. The latter makes cutting out the shapes a little more tedious, but then the joining process is a breeze!

This book starts out with the example of just *two identical ellipses* and demonstrates that, depending on how much you rotate them against each other before you start joining them along their rims, you can get quite different results. If they are perfectly aligned, you just get a flat double ellipse; but the more you rotate one against the other, the thicker this 'cushion' becomes, and for enough of an angle offset, you get some thick 3D shapes with cross sections that resemble a capital 'D'. These shapes may also wobble nicely back and forth when placed on a smooth flat surface.

Mathematically, these D-forms are composed of two *developable surfaces*, i.e. surfaces that can be unrolled into flat shapes. This is not too surprising if you have followed the above construction; after all, we started out from flat pieces of paper and bent them without stretching or tearing. This book also has a brief theoretical section, where it explains the difference between such developable surfaces and the more *general ruled surfaces*, such as you may find in the hyperbolic cooling towers of a power station. The latter surfaces are also composed of all straight lines; but nearby lines are skewed, leading to a doubly curved surface that cannot be unrolled without stretching. The theory section even mentions briefly *tangential developables*, but those paragraphs are probably too short for most people to give them an understanding of these intriguing shapes. Yet you should not worry; if you skip that section, you can still enjoy this book and construct all those harmonious D-Forms.

After joining ellipses of various kinds in various ways, this book goes on to cut-out shapes with sharp corners in their perimeters. This then forces some kind of crease in the other surface as it passes through this corner point. The results are such intriguing shapes as the *Squaricle* developed by Tony Wills, the original creator of D-forms, or a *crescent* made from a single piece of paper, but with two curved creases, so that

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Figure 1. D-Forms constructed from the templates in Sharp's book.

the end result is composed of three individual developable surfaces. From perimeter curves with some concave sections, this book progresses to shapes with an all concave perimeter, i.e. a hole, and shows how two such shapes can be also be joined to make *anti-D-forms*. This booklet is replete with colourful illustrations and many templates for most of these shapes. Along the way it also tells a little bit about the history of D-Forms and discusses some opportunities for applications in art, industry and in consumer products.

This booklet should provide good, educational entertainment for a couple of rainy weekends.

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