

Modelling and Animating Action Modular Origami

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Abstract

This paper describes how 38 animations were created for *Action Modular Origami to intrigue and delight: How to fold paper into geometrical sculptures that move, spin and change shape* (Tarquin Publications, forthcoming). A number of approaches were considered such as 3D modelling and raytracing applications like POV-Ray and Blender. However, dynamic geometry software was chosen as it was accessible and suitable for the target audience i.e. teachers and learners.

Making an action origami model in dynamic geometry software is a practical and motivating use of mathematical concepts, terminology and definitions e.g. coordinates, transformations, vectors, etc. It also can use computing concepts like variables, loops, conditional statements, Boolean logic, data representation of colour, etc. Problem-solving skills and creativity can be developed. Some models can be challenging, so intermediate targets may be appropriate e.g. allow overlapping units without animation, then prevent overlapping, then add animation.

The contents of the book are organised in five chapters. Selections are made for this paper to show the different techniques used. All animations are viewable at foldworks.net/action-modular-origami

Sliders are flat models made to expand and contract, forming different shapes (figure 1). These are 2-dimensional models that exploit rotational symmetry.



Figure 1: Sliders: Pinwheel-Ring-Pinwheel by Robert Neale

Flexagons and Rotating Rings are models that fold to expose previously hidden faces. *Rotating Rings* (figure 2) can be turned inside out in special ways. These need to use the third dimension and reflection.

Magic Wallet Series models use the two-way hinge from a famous magic trick to make flexagons, rotating rings (figure 3) and other action models. These use conditional visibility so that different keyframes show when needed.



Figure 2: Flexagons and Rotating Rings: Twelve-piece Carousel



Figure 3: Magic Wallet Series: Fluxicube

Spinners and Wheels are models that you blow to spin, or turn on a flat surface. These modules are extruded using translation (figure 4).



Figure 4: Spinners and Wheels: Octa Slider 3D

3D Shapeshifters smoothly transform from one 3D shape to another (figures 5 and 6). A number of different techniques are used.

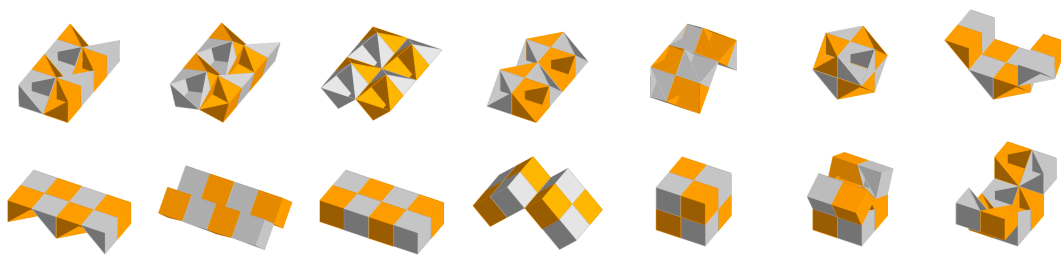


Figure 5: 3D Shapeshifters: Flexicuboctahedron

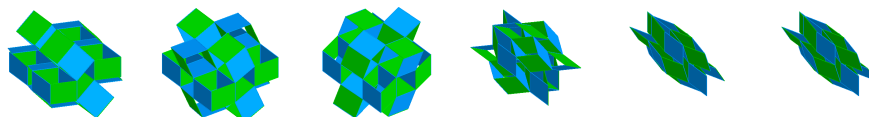


Figure 6: 3D Shapeshifters: Petrie-Coxeter Honeycomb