

Boatbuilding as a Timeless Example of Curved Folding

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Abstract

Traditional boat builders used little explicit math when creating boat hulls. All the same, their boat design methods (called “lofting”) produced curves and shapes that could be formed from flexible planar materials.

Curved paper folding (that is, bending without creasing) follows the same rules. Paper can be used to create (generalized) cones, (generalized) cylinders, and tangent developable surfaces of space curves.

These, in essence, are the surfaces that the boat lofters designed. And the hulls they built were simply combinations (unions) thereof.

Differential calculus made the modern study of developable surfaces possible. Euler and Monge both studied them. Over the past seven decades, such surfaces have received a great deal of attention. With one or two exceptions, students of paper folding have arrived at curved folding relatively recently. Boat builders, however, have been using developable surfaces for millennia.

A developable surface is one that can be flattened into a plane without stretching or tearing. It has zero Gaussian curvature everywhere, and can be created by sweeping a line through space.

Once upon a time, materials like bark and wood were used to create developable surfaces for boat hulls. Animal skins, which stretch, were not constrained to developable surfaces. In the modern era, developable surfaces have been made from lumber, plywood, aluminium and steel. Fiberglass and carbon fibre, on the other hand, like animal skins, are not constrained to developable surfaces.

We propose to (a) describe the historical boat building methods that made use of developable surfaces (e.g., lapstrake; sewn plank; stitch and glue; welded sheet metal), (b) provide examples of the pertinent principal lofting methods, within (c) the particular context of an experiment by which we have used one of these methods to construct a cabin workboat.