Origami-hull concept for a sailboat

Estimation of fairness and strength trough Gaussian Curvature visualization.

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Gaussian curvature (GC) is used to check the fairness of a surface. The model is shaded in colors, based on the discrete Gaussian curvature in each point. Most hulls are curved in two directions, called the principal curvatures.
Gaussian curvature is the product of these two principal curvatures. Now there are 3 possibilities here:

• **Negative Gaussian curvature**. These areas are shaded blue and have the shape of a saddle, since the curvature in one direction is positive while the curvature in the other must be negative.

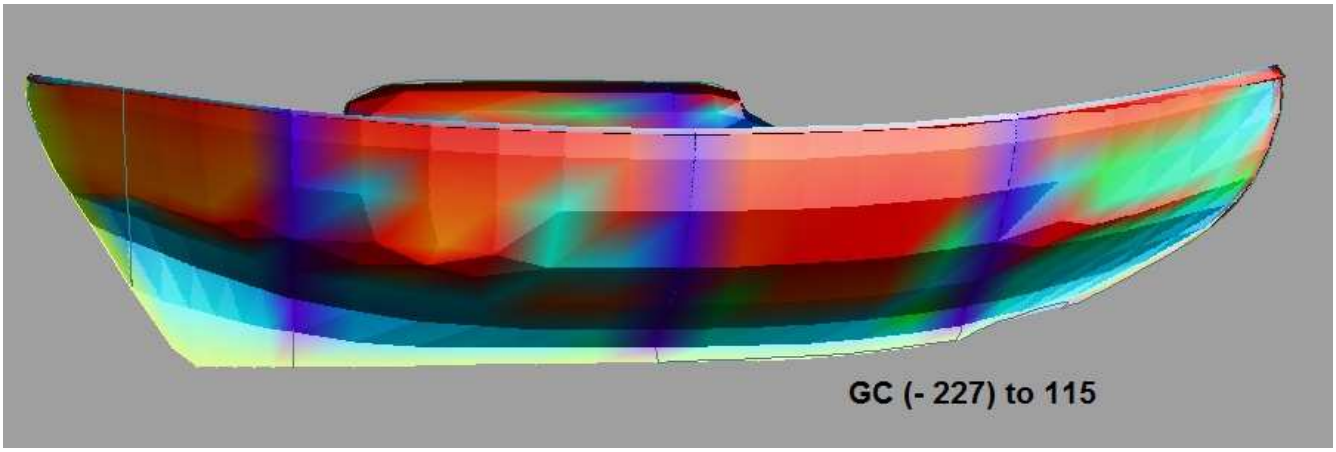
• **Zero Gaussian curvature**. At least one of the two principal curvatures is zero, so the surface is either flat or curved in only one direction. In both cases the surface is developable (This is in fact a very important property of developable surfaces). These areas are shaded green.

• **Positive Gaussian curvature**. The curvature in both directions can be positive or negative, but must have the same sign. These areas are convex or concave and shaded red.

Example 1:

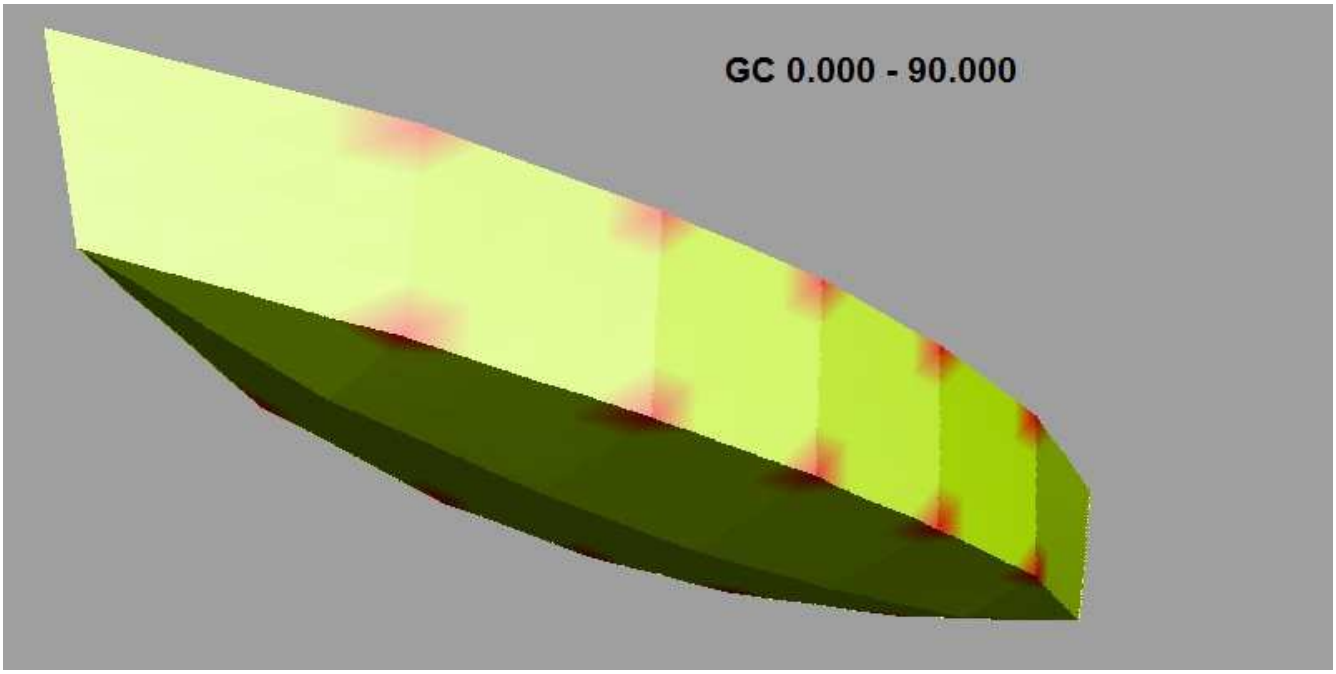
Below are several examples to give you some ideas. Numbers (GC) represent fairness of the hull, color depth (as I think) represents strength of the form (compare to flat plate).

First model I found in group's files section. I suspect, it was concept of origami hull in 3D. Good idea, but 3D model execution looks terrible in GS colors. Looks much better when rendered (see group's file section for images).



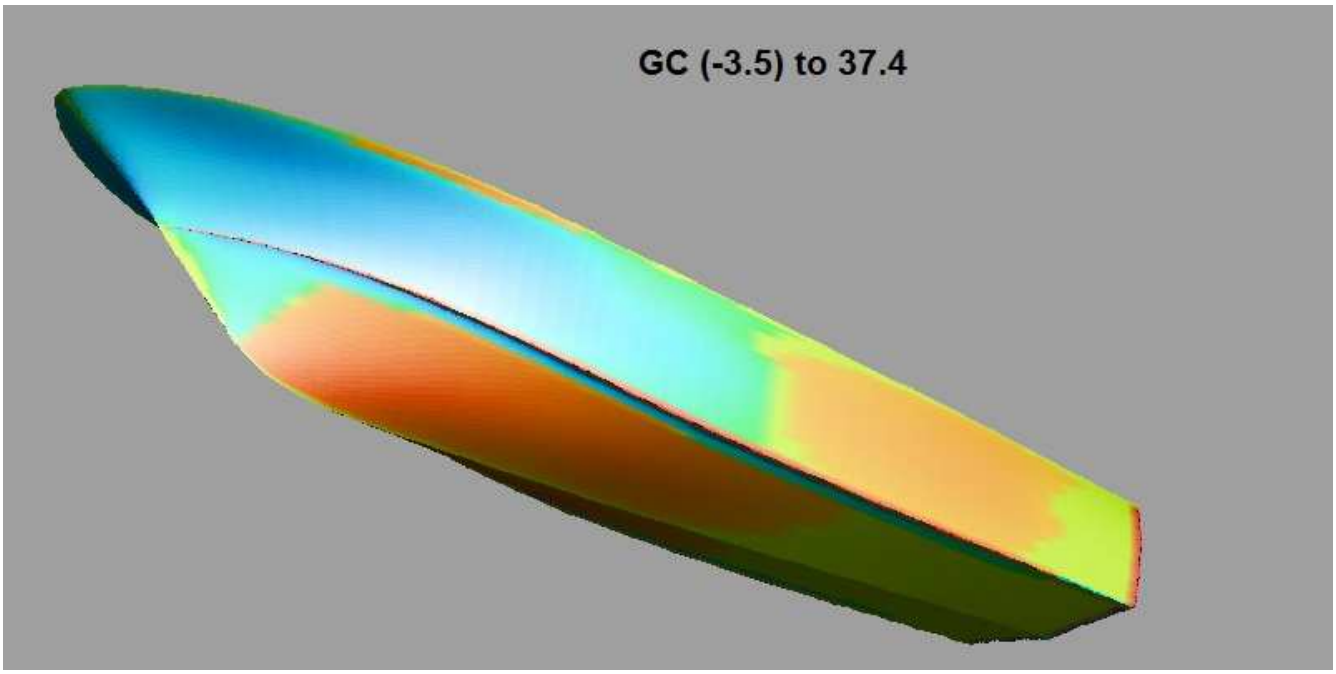
You can see lot of colors. Rapid change from one color to another shows distorted (problem) areas. The numbers have wide range from negative to positive. Three vertical deep blue lines are areas of buckle-heads' connections. The hull itself is not fair ether. It might be hard to see it in 3D, but easily visible with help of Gaussian curvatures.

Example 2:



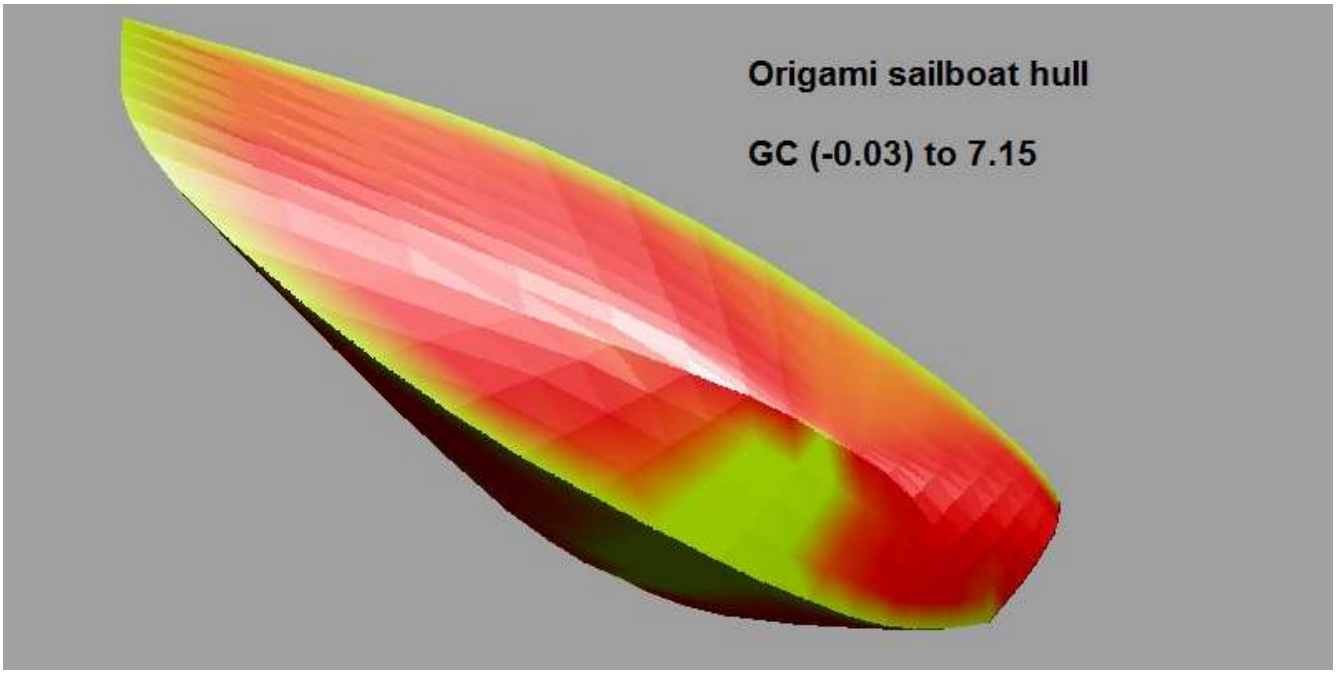
This model made from developable plates – easy to manufacture (CNC). Geometrical hull's form made from “peaces” - hard to assemble. You can see red problem areas as well. Flat plates (greenish, yellowish) need reinforcement. No negative curves.

Example 3:



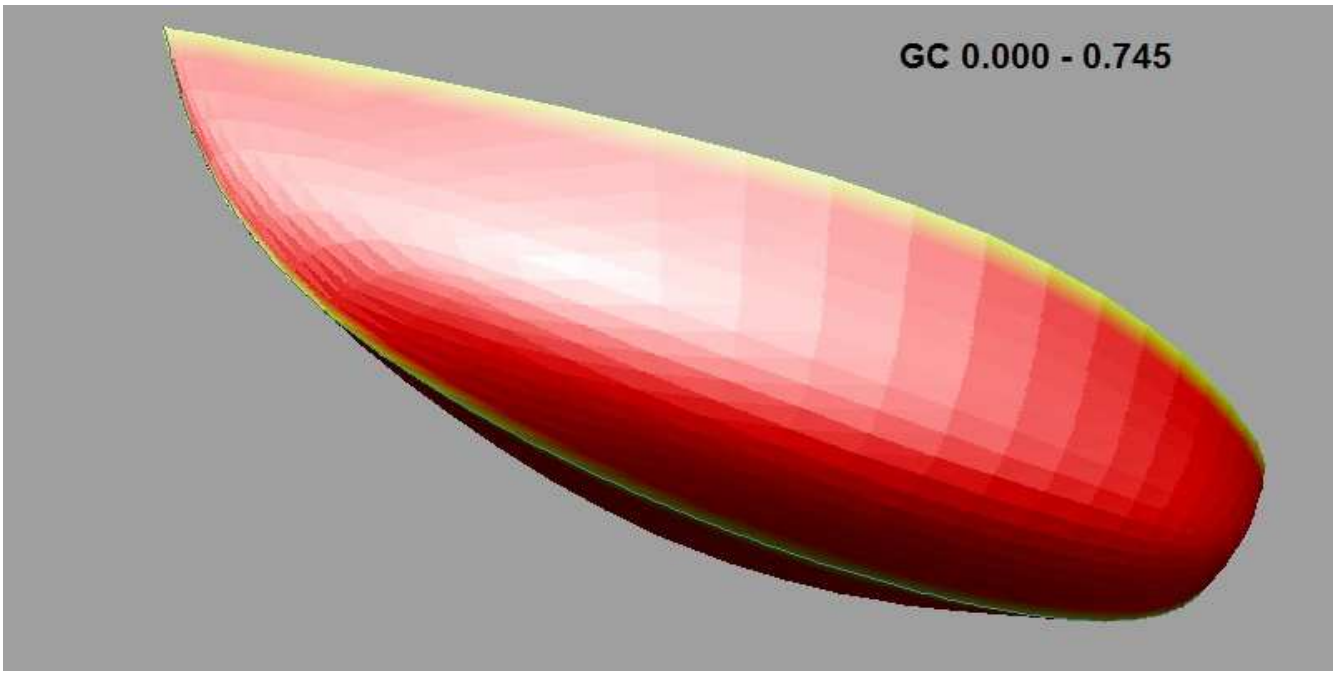
This model's hull-halves is possible to make from 2 continuous strips. It has reasonably smooth transition. More fair than model above (regardless of negative curve) – less numbers range.

Example 4:



This is reasonably good single chine sailboat hull. You can see greenish, yellowish and slightly orange areas which require reinforcement. Red areas are form's strength areas. As you can see looking at numbers, fairness of the hull is good too. This is Brent's type of the hull (not to Brent's plans) – concept ONLY.

Example 5:



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This is close to perfect thin-shell hull form which has its strength mainly from the form. Look at numbers. This hull form could be done by hydro-forming (hard to do as regular origami).