Using D-Forms to Create a Calder Type Mobile

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Abstract

D-Forms have been the subject of papers at previous Bridges Conferences, but not as a workshop. They are created by joining the edges of two flat surfaces that have the same length of perimeter. A related problem is to create a baseball or tennis ball by joining the edges of two pieces of leather. This workshop will consider some relationships between these concepts and display the variations in a mobile of the type invented by the artist Alexander Calder.

Concepts

The concept of D-Forms was invented by the London designer Tony Wills [1]. They were also discussed by John Sharp [2]. D-Forms are three dimensional forms created by joining the edges of two flat surfaces that have the same length of perimeter. The flat surfaces should be made of material that does not stretch or shear. Though the concept was expanded to surfaces composed of three pieces [3], we will not include these in this workshop.

Joining two pieces of material edge to edge is not a new idea. The difference is that in D-Forms the shapes being joined *define* the surface. In making baseballs, tennis balls or certain soccer balls [7], a dumbell shape is applied. In these cases, a deformable material like leather is used to provide surface curvature across the sphere. Thompson [4] has described the design of a baseball with mathematical enhancements. In this workshop, we present some of the connections between the two phenomena, and we propose to join forces with our audience to construct a mobile that represents these connections, and some of the variables that play into them. In doing so, we plan to create an addition to the art exhibit for the Bridges 2008 conference, in the form of mobiles of the type invented by the artist Alexander Calder.

Practical aspects

Before the conference, we will create a series of templates consisting of two types of shapes, all of which will have the same perimeter:

- a range of ellipses of varying eccentricity, going from circular to highly eccentric
- a range of Cassinian ovals [8] which are dumbell shaped and have different indentations

Workshop participants are invited to generate the D-forms by tracing them onto card or stiff paper, cutting them out and joining them. Many variables are involved and we expect to see a crossing over between mathematics and art; we expect participants to explore the possibilities and choose the most aesthetically pleasing results to build the Calder mobile. For example:

- Progressively change the relative orientation of the two pieces, using two ellipses of equal, mid-range eccentricity,

- Progressively change the eccentricity of one of the ellipses, from circle to really eccentric whilst using a constant mid-range eccentricity for the other ellipse; this option has many variables, including the relative angle between the major axes,
- Repeating these possibilities with Cassinian ovals where the variation in the indented curve is analogous to the eccentricity of an ellipse,
- Using one Cassinian oval and one ellipse; investigating what happens with similar (ovals close to an ellipse) or disparate (highly indented ovals and nearly circular ellipses) pieces.

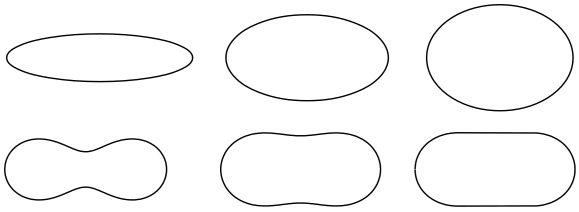

Figure 1: *Ellipse and Cassini-oval templates*

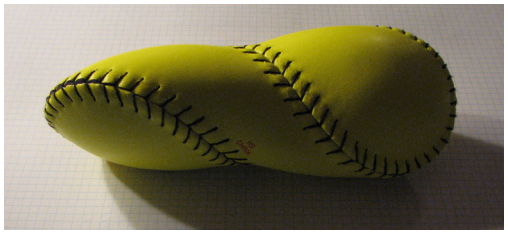

Figure 2: *Re-sewn Baseball pieces*

Though Tony Wills [1] frequently says that you can never create an ugly D-Form, our workshop allows the question to be posed as to the aesthetic merit of some of the variables we explore. Their combination into a mobile also questions the beauty of their juxtaposition. As an introduction to the workshop, we will present examples of re-sewn baseball pieces, and sewn, padded fabric models.

D-Forms is a very good teaching aid, particularly on understanding curvature. In looking for ways to display the results, we will use additional mathematics guided by [6] which uses Calder mobiles.

References

[1] Tony Wills (2006), 3D Forms from Two 2D Sheets. In Reza Sarhangi, John Sharp (Eds.), *Bridges: Mathematical Connections between Art, Music and Science*, pp. 503-510.

[2] John Sharp (2005), D-Forms and Developable Surfaces. In Reza Sarhangi, Robert V Moody Eds.), *Bridges: Mathematical Connections between Art, Music and Science*, pp. 503-510.

[3] Özgür Gönen, Ergun Akleman and Vinod Srinivasan (2007), Modelling D-Forms. In Reza Sarhangi, Javier Barallo.(Eds.), *Bridges: Mathematical Connections between Art, Music and Science*, pp. 209-216.

[4] Richard B. Thompson (1998), Designing a Baseball Cover. In *The College Mathematics Journal*, 29(1), pp. 48-61.

[5] John Sharp (2008), *D-Forms: Surprising New 3D Forms from Flat Curved Shapes*. Tarquin

[6] David Muller, Robib A. Ward (2007), Algebra and Art? Middle school students discover algebra in Calder mobiles, *Mathematics in School*. 36(3) pp 15-21

[7] There is a good description of the new soccer ball at www.soccerballworld.com/teamgeist.htm

[8] For the mathematics of Cassinian ovals, see www.mathworld.wolfram.com/CassiniOvals.html