Making *Sunshine*: A First Geometric Sculpture

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Abstract

The author recently completed her first large metal sculpture. *Sunshine* (figure 1), a five-foot diameter rendering of five intersecting tetrahedra in powder coated aluminum, was inspired by Tom Hull's origami model of this polyhedron. The piece has been installed in the Copley Science Center at Randolph-Macon College, where it hangs from the ceiling in the two-story entrance hall. This paper tells the story of attempting an ambitious project with no prior experience.

Figure 1: *Sunshine*

A Crazy Idea

My office is in the Copley Science Center. For the past 19 years, every time I walked into the two-story entrance I thought, "there must be something that could be done to make this space more welcoming." Then one day I got a crazy idea. A large colorful sculpture hung from the ceiling would brighten the space and give it some character. With no prior experience working with metal I charged ahead with a proposal for an internal college grant to fund my concept.

I love polyhedra and I have a lot of experience building paper models. Since I had never made anything this big I thought it would be best if I started with a familiar shape. The compound of five intersecting tetrahedra (FIT) is a stellation of the icosahedron. It was first described by Edmund Hess in

1876 [1]. Thomas Hull designed an origami model of this structure in 1996 that is well known to origami enthusiasts [2]. I understood this structure well, yet it is sufficiently complex to reward repeated viewings. It fit well with the use of the building, which houses mathematics, chemistry, physics, computer science, and biology. It could be made of straight pieces with a few bends. Colored in bright yellows and oranges it would resemble the sun welcoming the students into the building each day. I naively thought, "This will be easy."

Reality

The first shock was how expensive it would be to build this structure. After several bids I got the price down to $1800 to buy, cut, and bend the aluminum, and $1625 to get the 30 pieces powder-coated. I had learned why large sculptures are so expensive.

Deciding exactly how to assemble the pieces was like solving a mathematics problem, with successive solutions becoming ever more simple and elegant. I was lucky to have a friend who happened to be an internationally known sculptor. Jerry Peart has created over 35 large-scale public sculptures and his work is displayed in many cities in the US and Asia. Jerry convinced me that no matter how much I wanted to learn to weld, I would be assembling this piece with screws and washers. That turned out to be a very wise decision.

The final design was very simple. The ratio of length to width for Hull's FIT modules is 6 to 1. I decided to give myself a little wiggle room, since aluminum is not as forgiving as paper, and made the aluminum pieces 60" by 9.5". Each piece was cut into a 120-degree point at each end (see figure 2). The pieces were then bent lengthwise at 70 degrees, a close approximation to the dihedral angle for the faces of a tetrahedron, which is 70.53 degrees. The pieces would overlap at the ends to make 60-degree points that would then be screwed together after drilling holes in the aluminum.

I had one major communication problem with the metal fabricator. When you ask a machinist to bend a 70-degree angle that means starting with a piece of metal and bending it 70 degrees from flat. The resulting angle is 110 degrees. But luckily that misunderstanding was cleared up before any big pieces were made.

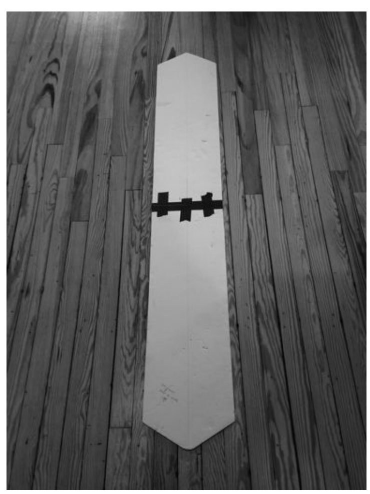

Figure 2: *The template for the 30 pieces*

Assembly

At this point I was pretty nervous about this whole project. Would I actually be able to assemble a FIT out of five foot pieces of 1/8" thick aluminum? I decided that I should temporarily assemble the 30 pieces before investing in the powder coating. It took several days, lots of Band-Aids, and some frayed nerves to get the 60 holes drilled and the FIT assembled, but it fit together (see figure 3). We used a rubber mallet a few times to bang pieces into place before we developed a technique of flexing the metal to make each piece slightly flatter, allowing it to slide into place without too much force.

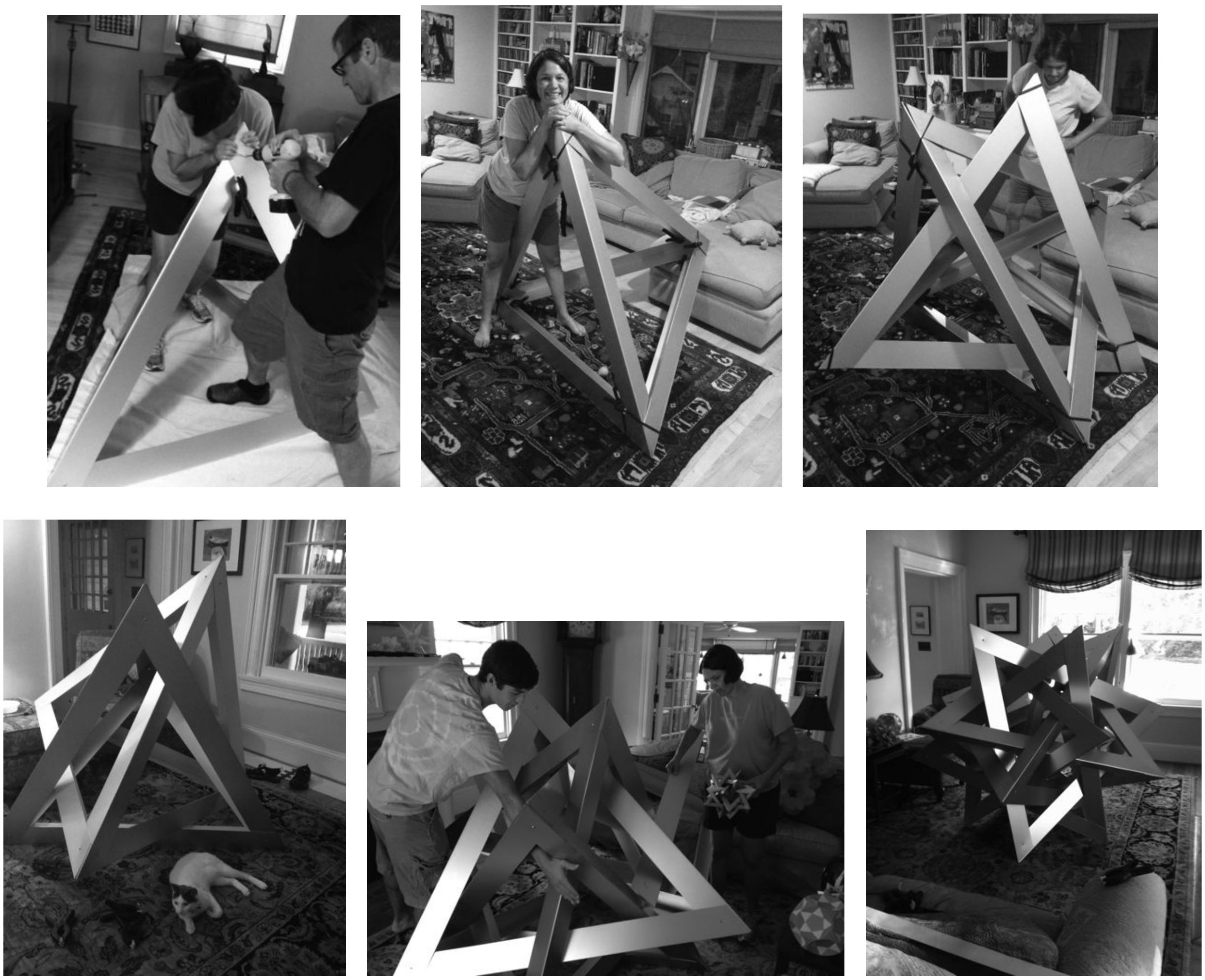

Figure 3: *First assembly*

Next, we disassembled the pieces and labeled them so we could reassemble them after the powder coating in the same configuration. There are 20 points on this structure, four for each of the five tetrahedra, and three pieces come together at each point. We labeled each piece with a Sharpie pen with two numbers: one number between 1 and 20 for the point and a second number from one to three that told us how the three pieces at that point went together. All the numbers were hidden once the piece was assembled since the pieces overlap and the numbers were written on the inside of a piece if it was on top at a connection and on the outside if the piece was on the bottom. After covering all the numbers with masking tape they were sent to be powder coated with the hope that the numbers would still be visible once they were colored.

For the final assembly I borrowed George Hart's barn raising idea and convened my math department colleagues and their families (see figure 4). We were able to do the final assembly in one day. With some protective blue masking tape on the folded edges and our flexing method we made only a few scratches on the powder coating. The final structure weighs only 100 pounds and was professionally installed so we are confident it will safely hang for many years.

Figure 4: *Final assembly*

References

[1] E. Hess, "Ueber die zugleich gleicheckigen und gleichflachen Polyeder", *Schriften der Gesellschaft zur Beforderung der gesammten Naturwissenschaften zu Marburg*, 11:1, (1876).

[2] T. Hull, *Project Origami: Activities for Exploring Mathematics*, 2nd Ed., A K Peters/CRC Press, (2012).