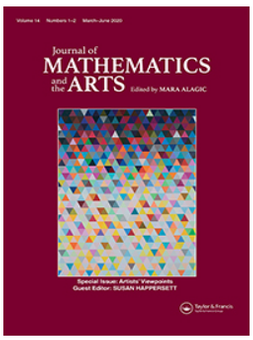

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Stixhexaknot: a symmetric cylinder arrangement of knotted glass

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Diving deep into the patterns that make up the world is a fun way to reveal new perspectives. Paintings and sculptures create an opportunity where I can freely experiment and explore the universe. Mathematics provides an infinite realm of inspiration and helps give structure to my research. Abstraction expands on reality and presents a chance to look outside of a regular pattern of seeing. Playing with art and math often leads to unexpected questions and discoveries.

For the past several years, I have been developing sculptures with symmetric arrangements of congruent cylinder packings restricted to only three and four directions. Hexastix and Tetrastix are periodic non-intersecting arrangements of cylinder packings that are of particular interest to me. Packing problems are an important class of optimization problems that have a visually rich history in mathematics. These homogeneous rod packings have been described by Conway in *The symmetries of things* (Conway, Burguel, & Goodman-Strauss, 2008) and by O'Keeffe in *The invariant cubic rod packings* (O'Keeffe, Plevert, Teshima,Watanabe, & Ogama, 2001). The structures described can be built easily with a little patience and present fairly stable configurations that naturally have some rigidity when compressed. Finite groupings of these cylinder packings can be joined in various ways to produce some interesting nets, helices, and polyhedrons. The large variety of options for the shape, configuration, and colouration of these structures provides ample space for artistic creativity.

Finding ways to classify and develop new cylinder arrangements starts with sketching patterns of intersecting hexagonal prisms on paper. After some basic symmetry is worked out, I build a small series of models using an inexpensive material, mainly toothpicks or pencils. I develop the most appealing of these models further with diagrams that symmetrically connect the ends of the rods to create knots. The models and diagrams are then used to guide the creation of larger sculptures made out of glass.

Straight, clear rods of borosilicate glass are cut to shorter segments before being organized using clamps and string to replicate the model's geometry. I use a propane and oxygen torch to melt the ends together in an orderly way. Using a flame that is over 2000 degrees

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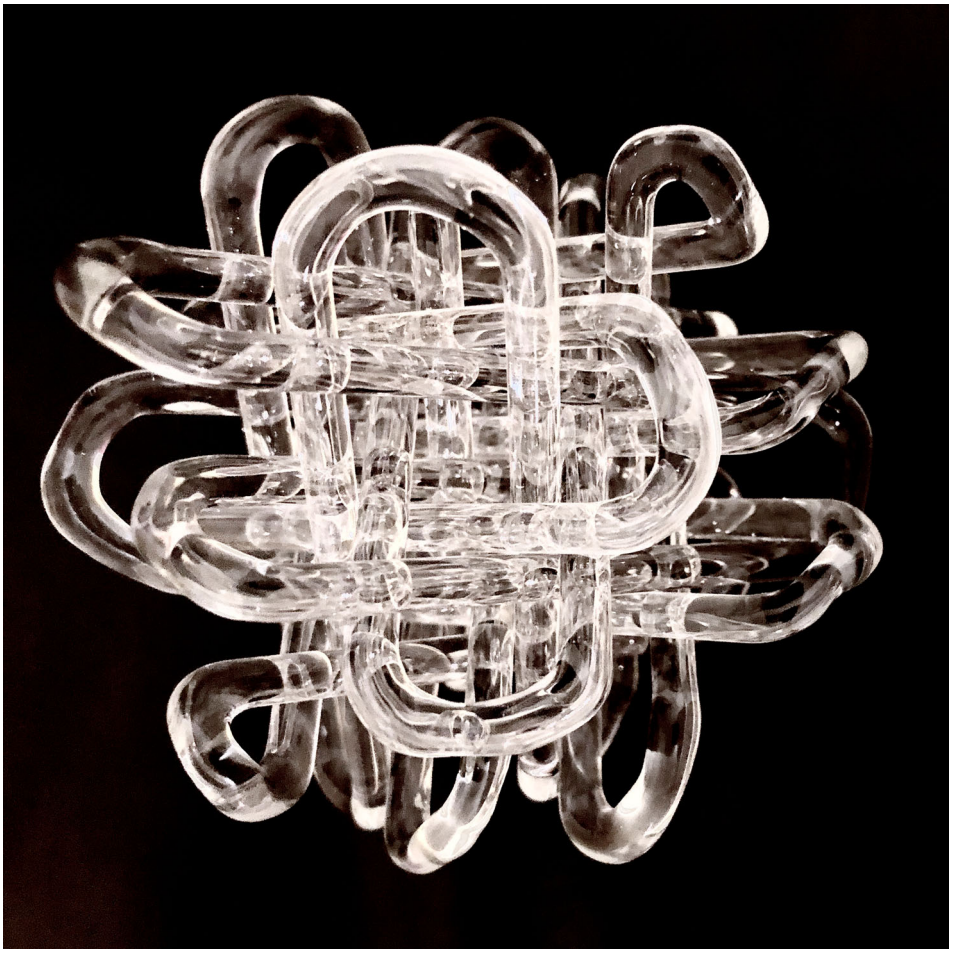

Figure 1. Stixhexaknot, 2019, flame-worked borosilicate glass, 10 × 10 × 10 cm.

Fahrenheit requires an acute attention to detail in order to avoid melting the entire structure. After I weld the ends together smoothly, making the structure a continuous embedded loop, the sculpture undergoes a final annealing cycle in a kiln at 1050 degrees Fahrenheit, where it is cooled gradually to reduce any stress or tension that may have occurred during construction (Figure 1).

Stixhexaknot shown here is based on a structure known as hexastix, but it can be classified and described as an independent arrangement. It can be obtained by removing six pieces from around the centre of a hexastix arrangement. Hexastix, when extended infinitely, takes up approximately 68% of space. The rods are welded together using tetrahedral symmetry to create a knot. The single continuous piece of glass is approximately 96 inches in length. By using transparent glass the light can dance around and illuminate the interior geometry in a striking way. Building these sculptures is a fun way of using math to explore and express beautiful and fascinating patterns (Figure 2).

Figure 2. Stixhexaknot, 2019, flame-worked borosilicate glass, 10 × 10 × 10 cm.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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