The Essential Module for a Mathematical Whole
by Sophie Usherwood
Hanover High School
Dr. Jeannine Mosely

The sun beamed down upon an angular white landscape. Surrounded by thirty towering pieces of white material, the Creator admired the creases that formed swooping mountains and valleys in the landscape. A difficult quest lay in store for the Creator: connecting these majestic pieces together to create a continuous world. Yet the suspense, the unknown magic she would use to confront the struggle of uniting the pieces, kindled a boundless passion in her eyes. After much maneuvering, the last piece finally clicked into place, and she christened her creation "The Partial Compound of Five Cubes."

In this way Dr. Mosely recounts her memory of folding an oversized origami project on a summer's day. She explains, "I do origami because I am driven to do it. That's how you know you are an artist. You make things because you can't not make them." The method Dr. Mosely used was called modular origami - folding multiple identical units, called modules, and connecting them. A request from V'Ann Cornelius to fold one of her original designs for the Mingei International Museum in San Diego led her to revolutionize this technique. The design that she folded was a giant white version of five intersecting cubes. The exhilarating process was fueled by the difficulty of working with such large pieces of paper, which acted as if they had a life of their own. Even the moisture content of the air could cause the paper to buckle over due to its weight.

Dr. Mosely's love of origami stems directly from math, a deep connection that is mostly unseen by the world. She exclaims, "everything you do in origami is related to math, but most people who fold origami don't realize it." In order to fold many of her original origami tessellations - origami patterns that can repeat forever - that employ curved creases, she uses a program called Mathematica to solve equations and plot a curve, which she scores onto the paper many times. Whether it is the obvious connection with geometry or more arcane relationships, like with matrix algebra, combinatorics, graph theory, statistical mechanics, differential geometry, and topology, origami is inherently intertwined with math.

Dr. Mosely grew up in Illinois, in suburban Chicago and later in Champaign, with two sisters, a brother, and a mother who was a homemaker. Her father was a lawyer, and when he gave her a Martin Gardner book, she discovered a marvelous origami project called a hexaflexagon. Figuring out how many sides the hexaflexagon had by "flexing" through the layers was an accessible way to introduce the beauty of problem solving to young Jeannine. Driven by this exposure to problem solving as a child, Dr. Mosely pursued a bachelor of mathematics from the University of Illinois and a PhD in electrical engineering from the Massachusetts Institute of Technology.

Shortly after finishing her education, Dr. Mosely had an epiphany about a 150 year old traditional origami cube design: "I realized you could link the cubes together, and build any arbitrary structure you want." The arbitrary structure that Dr. Mosely chose to replicate was the Menger Sponge. To make a Menger Sponge, one mentally divides a cube into twenty seven smaller cubes and removes the center cube together with the center cubes in each of the faces. Then this same process is applied to the remaining twenty cubes, repeating until infinity. When Dr. Mosely undertook the challenge of creating this structure, she asked over two hundred people to help fold the sixty-six thousand units from business cards, creating a

common bond amongst them. The individual modules, sculpted by people's hands, interlaced in the final product. It was almost as if people's hands were permanently intertwined in a mutual endeavor to add beauty to the world.

The finished Menger Sponge stood a majestic five feet high and weighed one hundred sixty pounds, sporting entrancing holes. Each smaller cube had the same holes and structure as the larger cube, mirroring the previous recursion. The situation perfectly matched what Dr. Mosely said: "When you make origami you know it's going to be beautiful; it's about bringing something new and unexpected into the world." Dr. Mosely's achievement was heralded in the *New York Times,* the *Los Angeles Times*, and the *Boston Globe*. She was contacted by museums all over the United States, and it was exhibited in the Fuller Craft Museum in Brockton, MA as well as in a Los Angeles gallery called "Machine Project." This origami Menger Sponge has exposed the public to a brilliant new idea: community enrichment through mathematical origami. For her services that have spread joy through origami, Dr. Mosely received the OrigamiUSA Award for Excellence in Teaching.

Dr. Mosely also worked for many years writing geometric modeling software for computer aided design. The software she worked on was used by people at Boeing, General Electric, and Ford to design better airplanes and automobiles. She found that this unique job enriched her origami skills, which also relied on maneuvering three dimensional objects. She exclaimed, "My interest in geometry inspired by origami led me to write CAD Software, and opened the door to that career."

Every crease leaves a permanent mark in the paper, due to the memory of the material; in the same way, Dr. Mosely's work in studying STEM at prestigious institutions and teaching people origami has left its mark upon society. Through Dr. Mosely's innovative and adventurous origami projects, including the Menger Sponge and her curved crease tessellations, Dr. Mosely has inspired young women to think creatively. Her various accolades in mathematics and in origami have established her as a person willing to lead, help, teach, and serve. As she says, "We [women] have to keep standing and yelling 'Here we are! Look at us, we're doing great work!'" Her imprint upon the world is like a crease that has intersected with the creases of all of the thousands of hard-working women in math. Dr. Mosely has helped create a new world where women, like one origami module, are an irreplaceable component in the field of mathematics, the assembled origami masterpiece.

Bio:

Sophie Usherwood is a junior at Hanover High School in Hanover, New Hampshire. She is an avid origami designer and folder. In addition, she has a passion for teaching origami to children and seniors, and she was one of two winners in the nation to receive an OrigamiUSA Scholarship. Sophie has worked at the Thayer Engineering School at Dartmouth College studying origami applied to engineering. She is one of three flutists for the New England Conservatory Preparatory School's Youth Philharmonic Orchestra in Boston, one of the world's premier youth orchestras. Sophie also plays the piano, and she enjoys playing Chopin's Etudes. She has won regional writing awards from Scholastic Art and Writing, and has had her poetry published in her local newspaper seven times.