


## A USC COMMUNITY PROJECT AT THE INTERSECTION OF MATHEMATICS, ART, ENGINEERING, AND LIBRARIES

In 1926, mathematician **KARL MENGER** discovered the first three-dimensional fractal, which came to be called, in his honor, the Menger Sponge. Ninety years later Dr. Jeannine Mosely, an MIT-trained engineer, built a model of this extraordinary object using 66,000 business cards.

Now Mosely has discovered a relative of Menger's original fractal—the **MOSELY SNOWFLAKE SPONGE**. During spring semester 2012, the USC community will construct this unique mathematical form out of 49,000 business cards.

This is the first time in the history of the world, and perhaps the universe, that this wondrous fractal object will be brought into being. We invite students, faculty and all members of the USC community to join with the USC Libraries in this campus-wide celebration of mathematics, art, engineering, and the library as a place of discovery and invention.

The instructions here show how to assemble the basic building blocks of the Mosely Snowflake Sponge. 108 X-modules and 216 Y-modules are required to construct the final object. Instructional videos may be found at www.usc.edu/libraries/sponge.

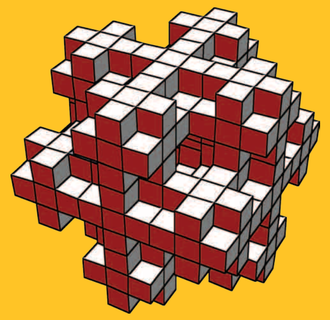
## THE DISCOVERY FELLOWSHIP OF THE USC LIBRARIES

This event is part of the USC Libraries Discovery Fellowship 2011-2012 programming, curated by Discovery Fellow **MARGARET WERTHEIM**.

Margaret Wertheim is a science writer and curator of exhibitions about the intersection of science, mathematics, and aesthetics. Wertheim is director of the **INSTITUTE FOR FIGURING** in Los Angeles.

**JEANNINE MOSELY** is a Boston-based software engineer who specializes in 3-D modeling programs. A pioneer in the field of mathematical paper folding, Mosely is the foremost expert on business card origami and is a leading researcher in the field of curved folding.

More information about the mathematics of the Menger Sponge and the history of Mosely's Business Card Sponge project can be seen in the Institute For Figuring's online exhibit: www.theiff.org/oexhibits/menger01.html

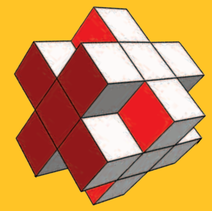


**www.usc.edu/libraries/sponge**



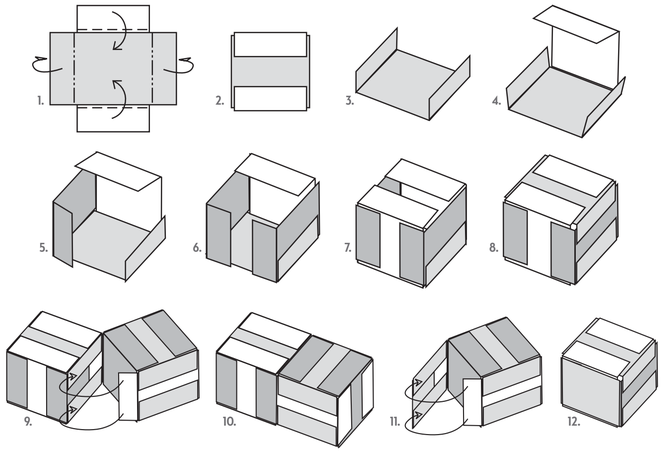
# THEMOSELYSNOWFLAKESPONGE

## CONSTRUCTION GUIDE



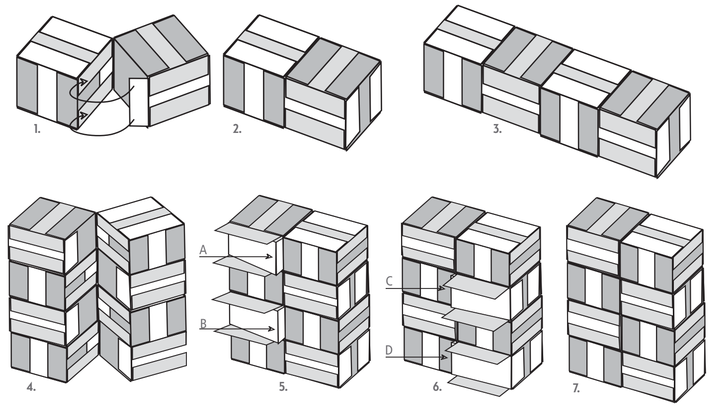
USC Libraries

# HOWTOMAKEANDPANELCARDCUBES




**1.** Place one business card across another, centered and at right angles to the first. **2.** Fold the flaps down as shown. **3.** Separate the cards. Make 6 for each cube. **4.** Assemble the cards so that all the flaps are on the outside, matching short edges to long edges. **5-8.** Adding each of the 6 cards to complete the first cube. **9-10.** Link 2 cubes together by slipping a flap from one cube under the corners of 2 flaps on an adjacent cube, then slip the matching flap from the first cube under the other 2 corners of the flaps on the second cube. **11-12.** Cover the exposed flaps with the facing cards.

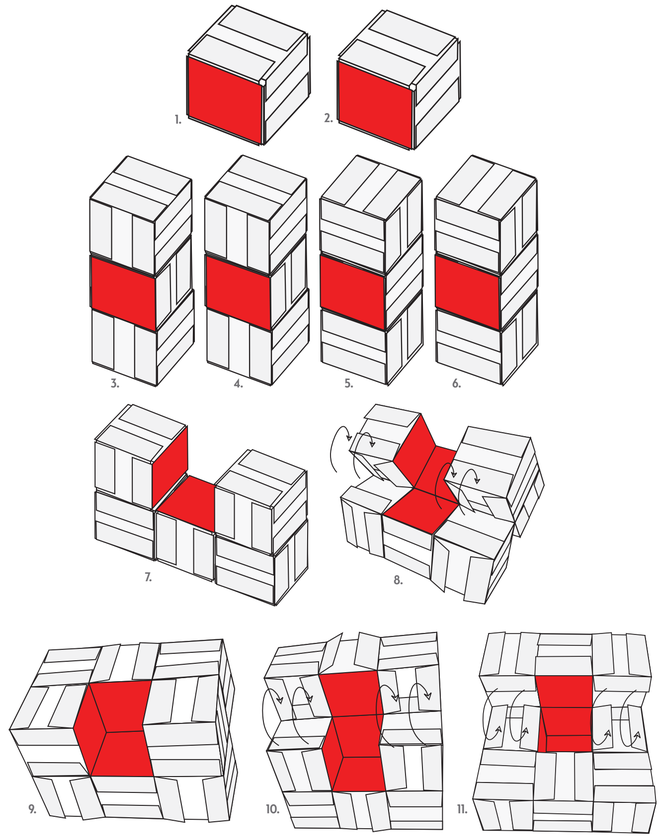
# LINKINGRODSOFCUBES



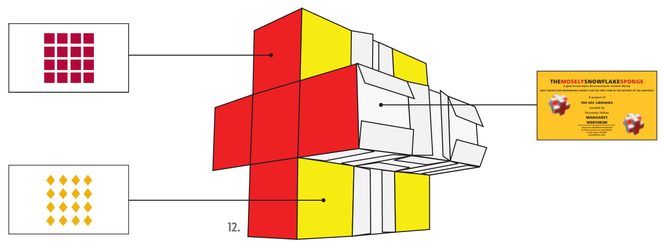

**1-2.** Linking 2 cubes. **3.** Link more in the same way to form a rod. **4.** Link the back half of 2 rods together by slipping flaps from one rod under the flaps of the neighboring rods. **5.** Pivot the two rods around the back edge to bring the front edges together. Lift flaps so that you can complete the linking on the front. Tuck flaps in at A and B. **6.** Tuck flaps in at C and D. **7.** Two linked rods. You can link together rods of any length, and you can link together many adjacent rods to form panels of any size.

# MAKINGTHEXMODULE

108 X-MODULES ARE NEEDED

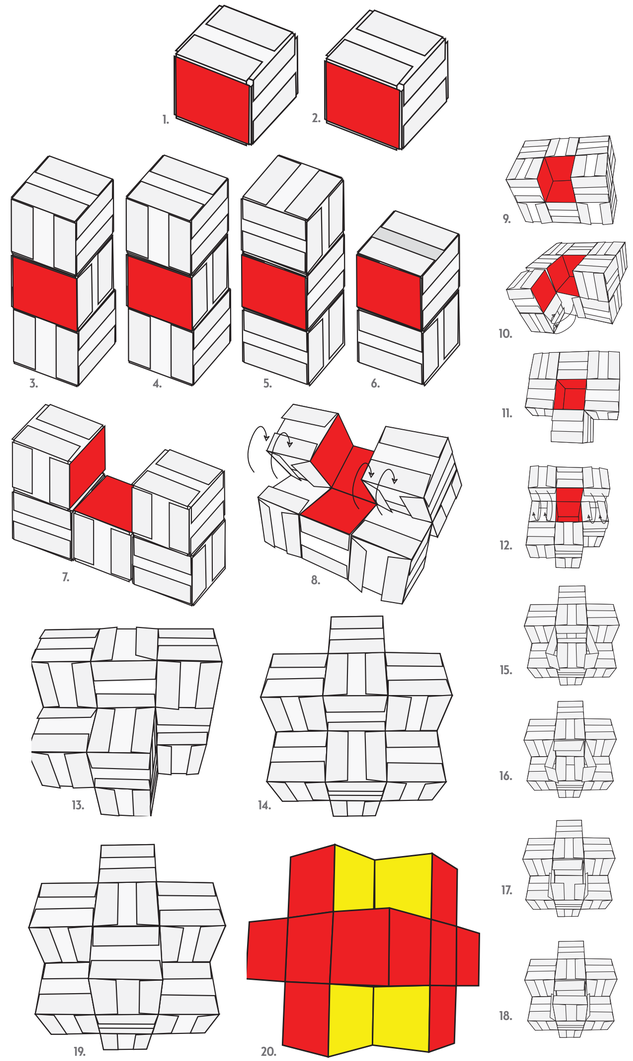



**1-2.** Panel one face of each of the 2 individual cubes **RED**. **3-6.** Make 4 rods of 3 cubes. Apply a **RED** panel card to one face of the center cube in each rod. Note the orientation of the flaps. Two of the paneled faces should have horizontal flaps, the other two should have vertical flaps. **7.** Link the 2 single cubes to one of the rods to form a U shape. All 3 of the inner faces of the U should be **RED**. **8.** Attach the U module to a rod of three cubes as shown. Swing the U and the rod together and slip the marked flaps under the neighbor's flaps as indicated by the arrows. **9.** Eight linked cubes. **10.** Add another rod of 3 cubes. **11.** Add the fourth rod of 3 cubes. Note that you are paneling the 6 faces that look inward toward a void at the center of the module. Even though they are invisible, we include these paneling cards to give extra strength to the model. **12.** Finish the module by paneling the 5 faces that form a cross shape on one end with **RED** cards. Panel in **YELLOW** the 4 faces shown below that are not on the ends, and the 4 faces that are opposite them on the back side of the module. Note that you must match the orientation of the flaps.




# MAKINGTHEYMODULE

216 Y-MODULES ARE NEEDED




**1-2.** Panel one face of each of the 2 individual cubes **RED**. **3-6.** Make 3 rods of three cubes and 1 rod of 2 cubes. Apply a **RED** panel card to one face on each rod as shown. Note the orientation of the flaps. Two of the paneled faces should have horizontal flaps, the other 2 should have vertical flaps. **7.** Link the 2 single cubes to one of the rods to form a U shape. All 3 of the inner faces of the U should be **RED**.Be careful to match the orientation of the flaps. **8.** Attach the U module to a rod of 3 cubes as shown. Swing the U and the rod together and slip the marked flaps under the neighbor's flaps as indicated by the arrows. **9.** One view of 8 linked cubes. **10.** Add the short rod of 2 cubes. This step can be tricky—please watch the video on our website. **11.** Ten linked cubes. **12.** Rotate counterclockwise 90 degrees. Add the last rod of 3 cubes. **13-14.** Thirteen linked cubes showing different views of the same. **15.** Steps 15-18 can be tricky—please watch the video. Build a cube one card at a time into this corner. Start by slipping 2 cards under the flaps as shown. **16.** Slide a third card under the flaps shown. **17.** Slide a fourth card under the first 2 cards. **18.** Slip the fifth card under the front corners of the same 2 flaps with the third card tucked under, making sure that the front flaps of the first 2 cards remain outside. **19.** Complete the cube by adding the sixth card to the top, again keeping all flaps on the outside. **20.** Finish the module by paneling the 10 faces that form a pair of crosses with **RED** cards. Panel in **YELLOW** the 6 faces in the corners between the crosses, and the 4 faces opposite them on the back side of the module.