Dept. Computer Science
SUNY Stony Brook

CSE391 Special Topics:
Solid Modeling Projects

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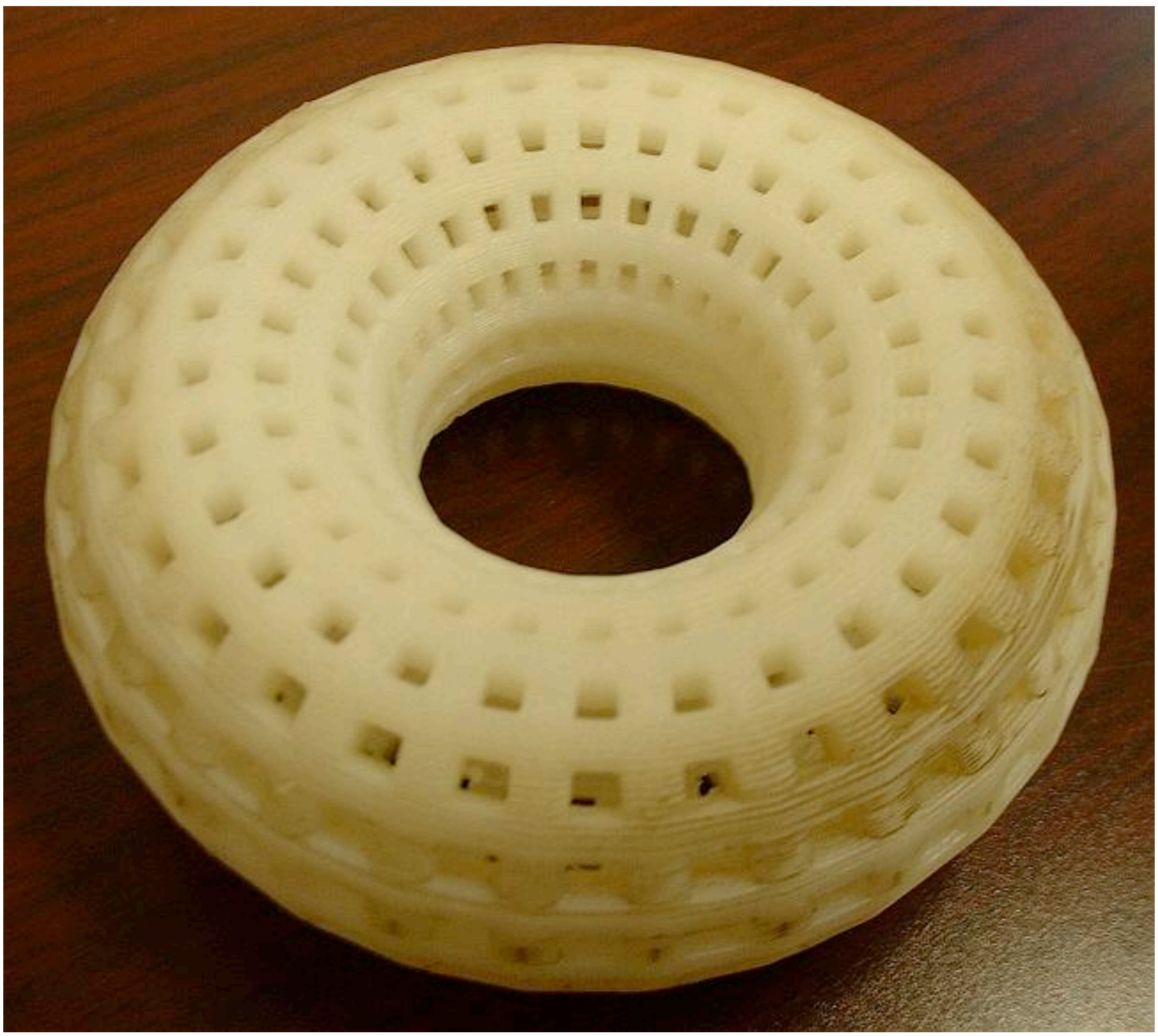
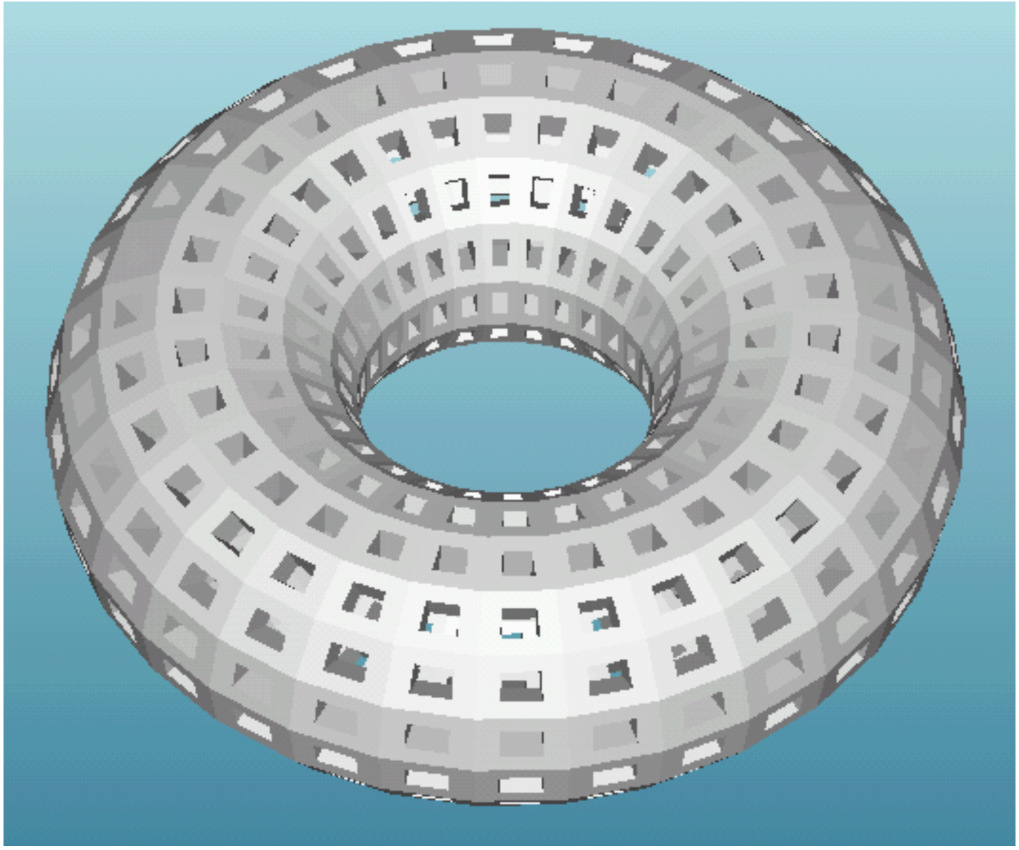
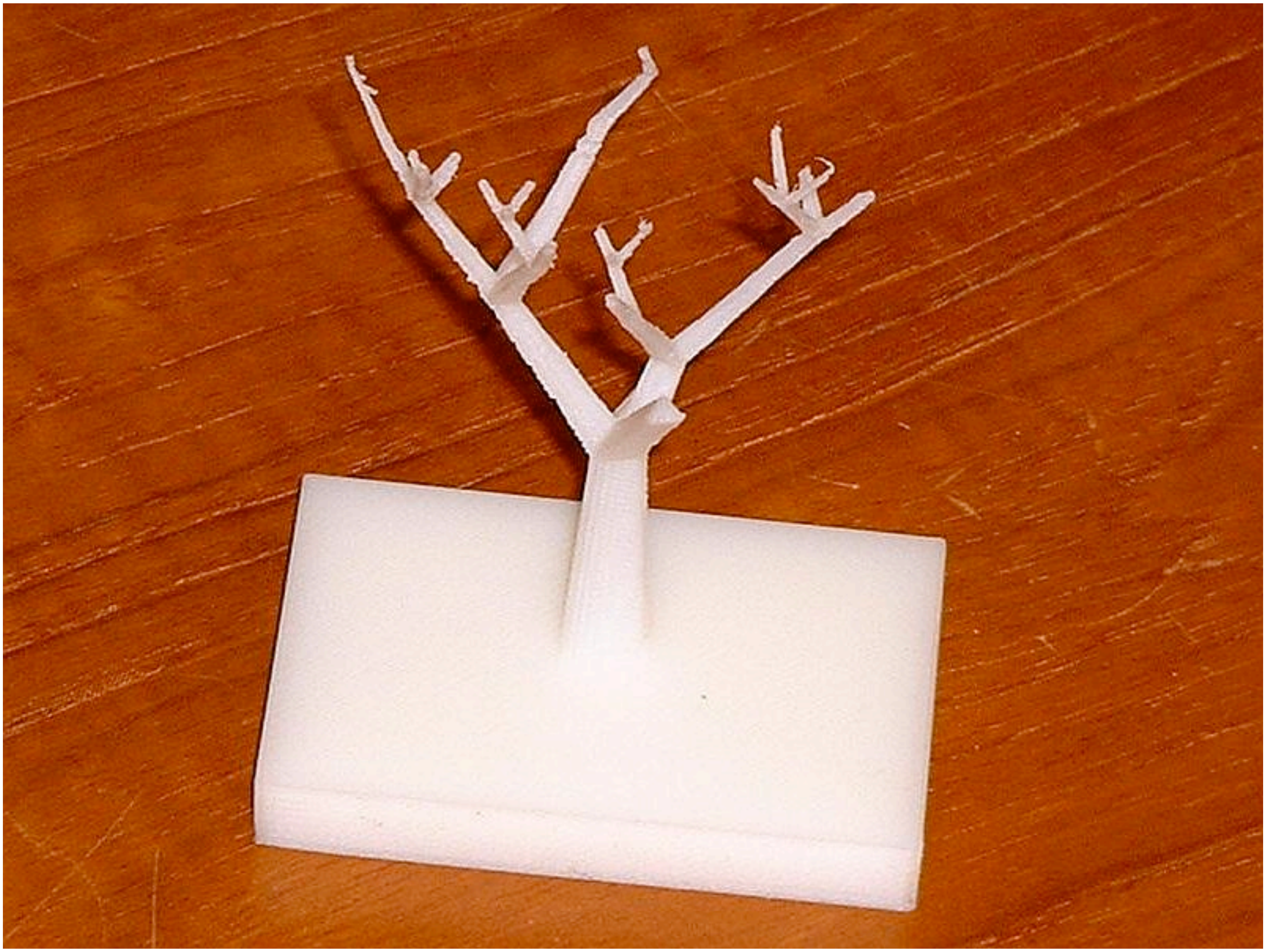
Here are some of the projects made in this class, in its trial run, Fall 2003. The software part of each project is a program which can procedurally generate an infinite variety of objects ranging from simple to complex within a family of forms. We adjust a slider on the program to select an instance of reasonable complexity for the fused-deposition modeling machine we have available. The students listed with each object are not using any existing solid modeling programs; they are writing the solid modeling programs. I am adding more photos to this page as I get the objects from the FDM machine.



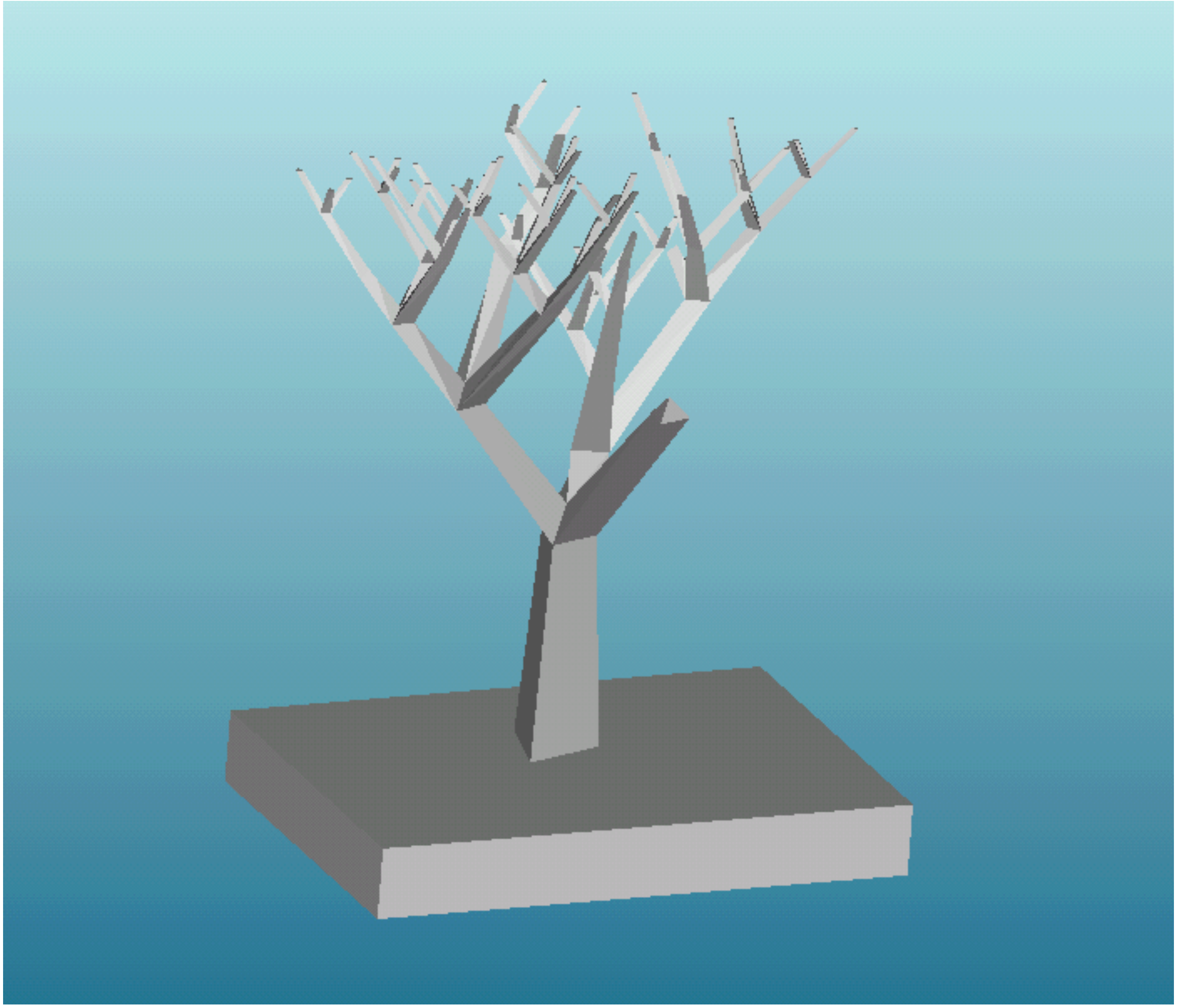
Above is a hollow torus with perforated boundary. The layers from the production process are clearly visible. This was not a project but the first significant homework assignment for everyone. Below is a screen shot of the ideal form. This particular file is the work of Ethan Closson.



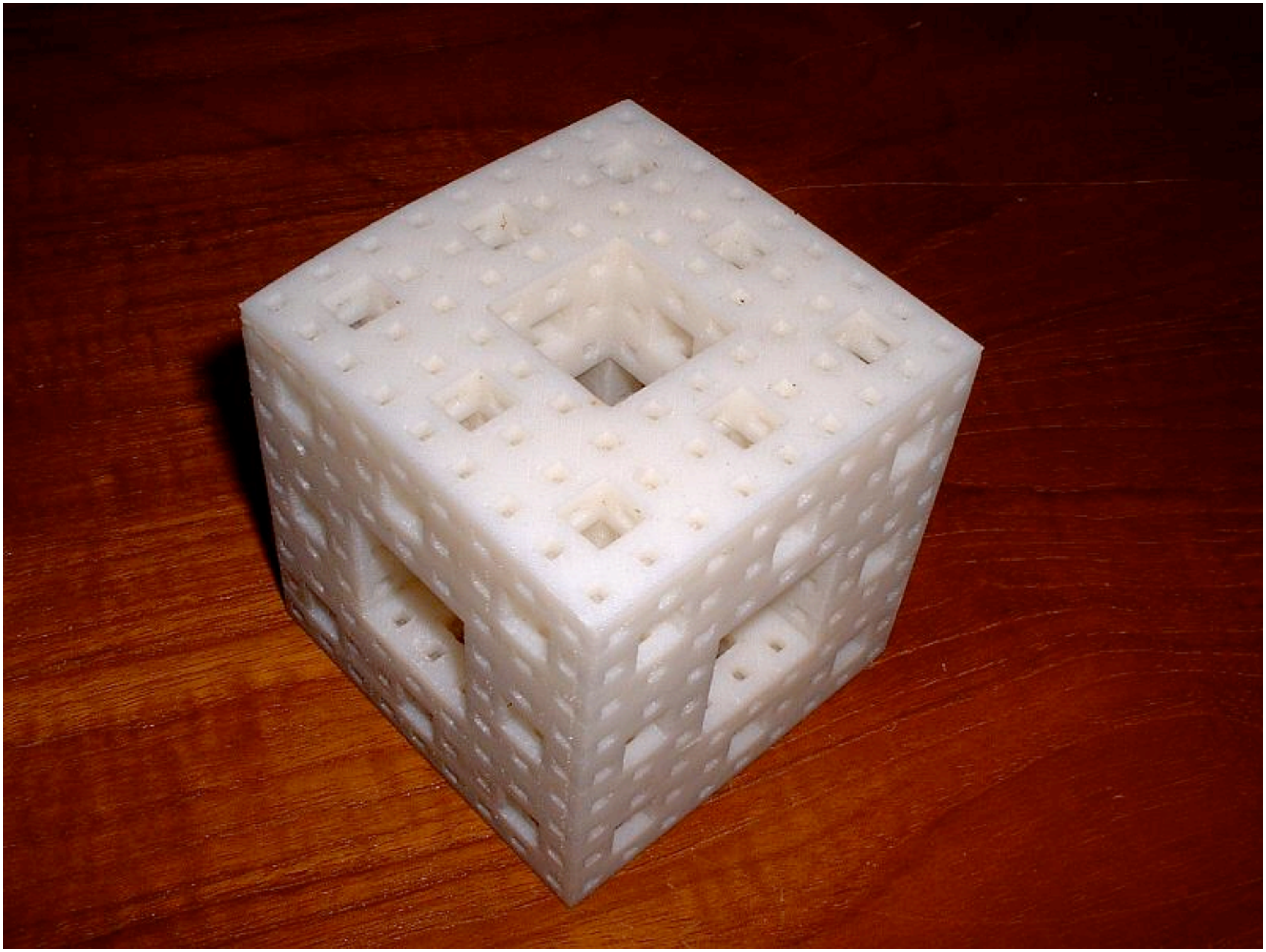
Below is a tree model, also by Ethan Closson. The branching involves some random parameters, so it is a statistically self-similar fractal.



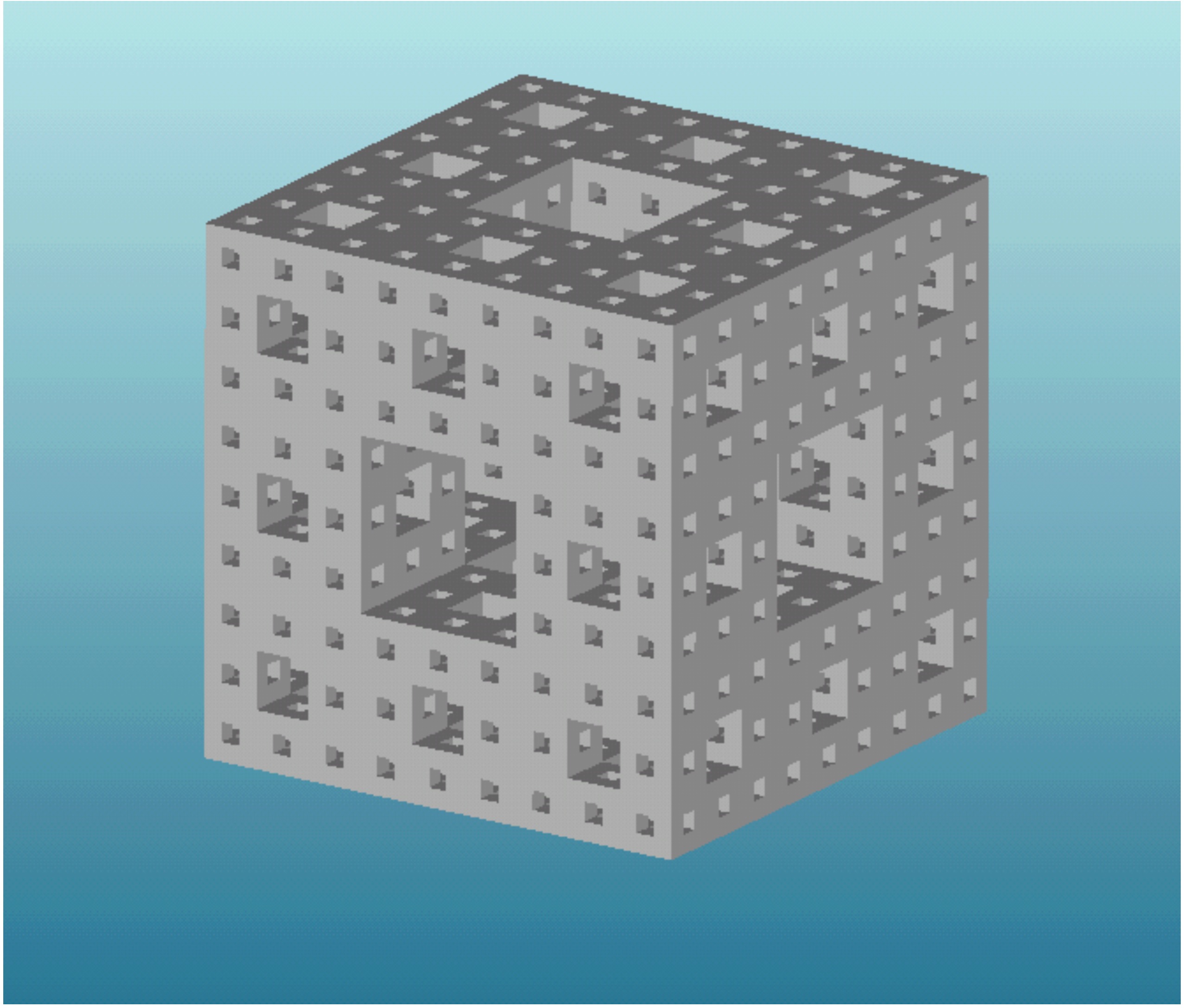
Below is a screen shot of the intended form. Its smaller branches either were too small to hold together, or were torn off as it bubbled around when the support material was being removed in the dissolving bath.

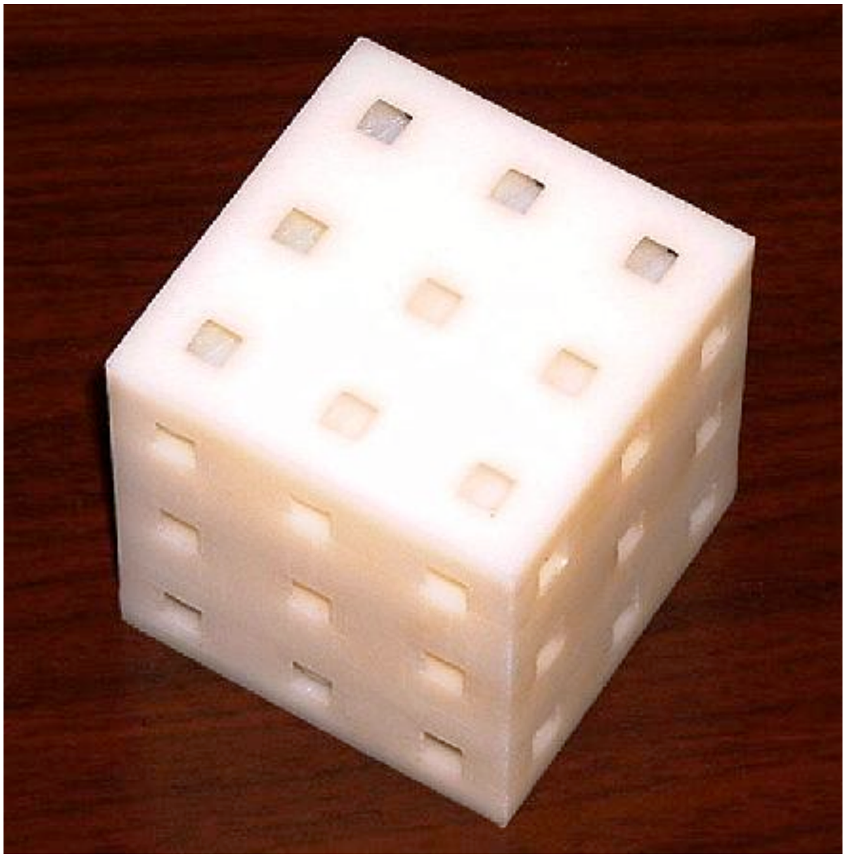


And here is a nice Menger sponge, by Thomas Lai. Though less than three inches on edge, this took the FDM machine 50 hours to fabricate; I believe its routing algorithms can be improved significantly.

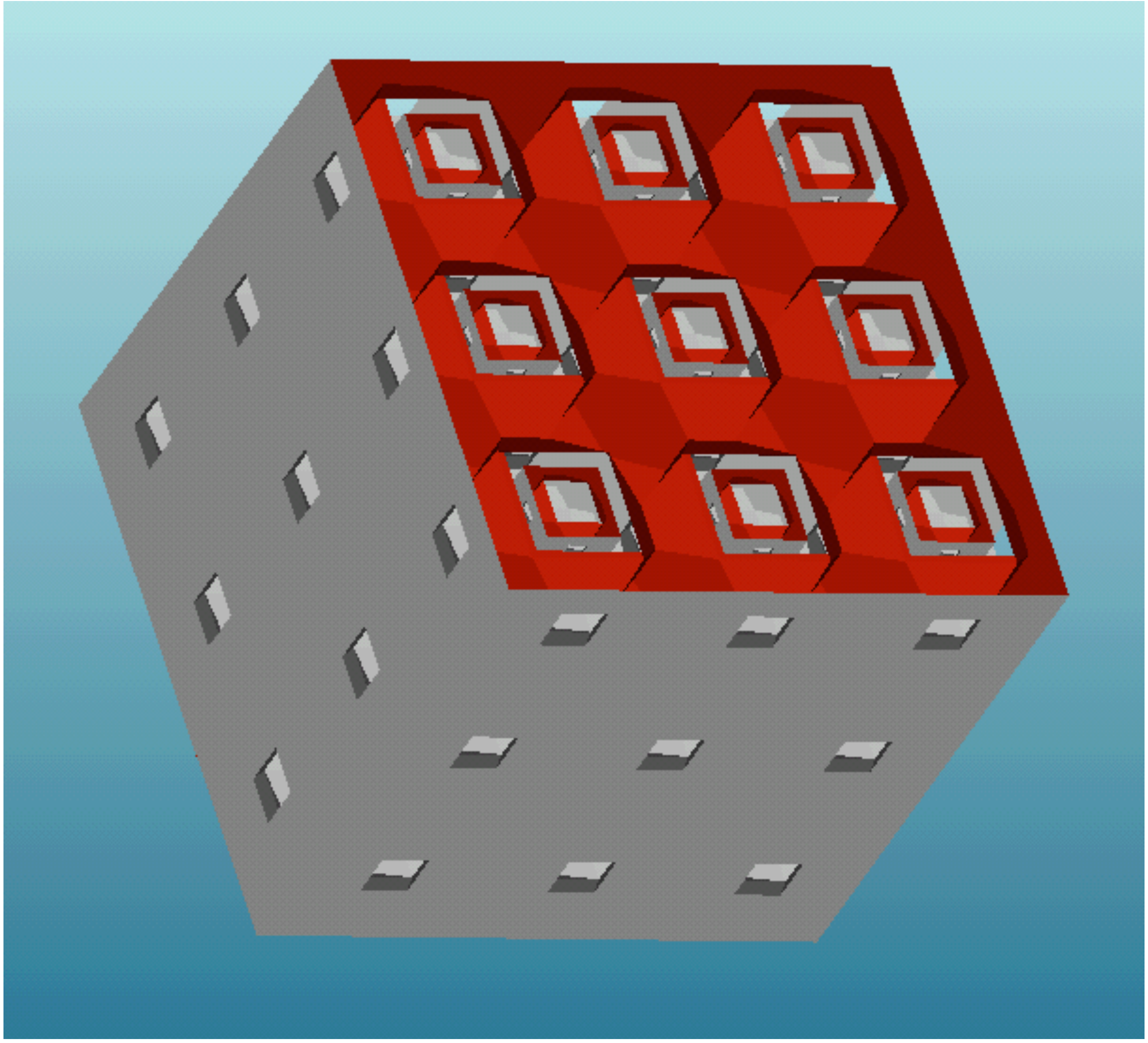


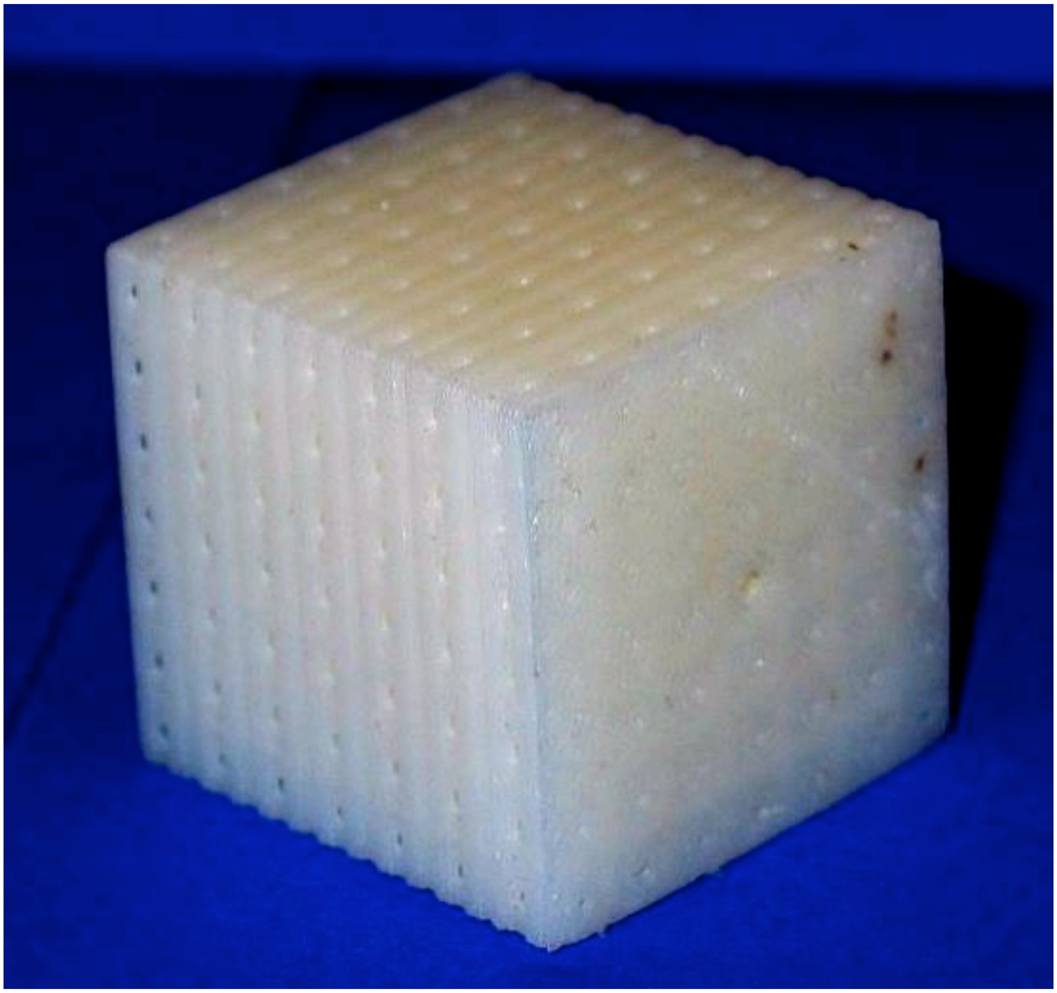
One corner is sagged in the above fabricated model, unlike its ideal form:



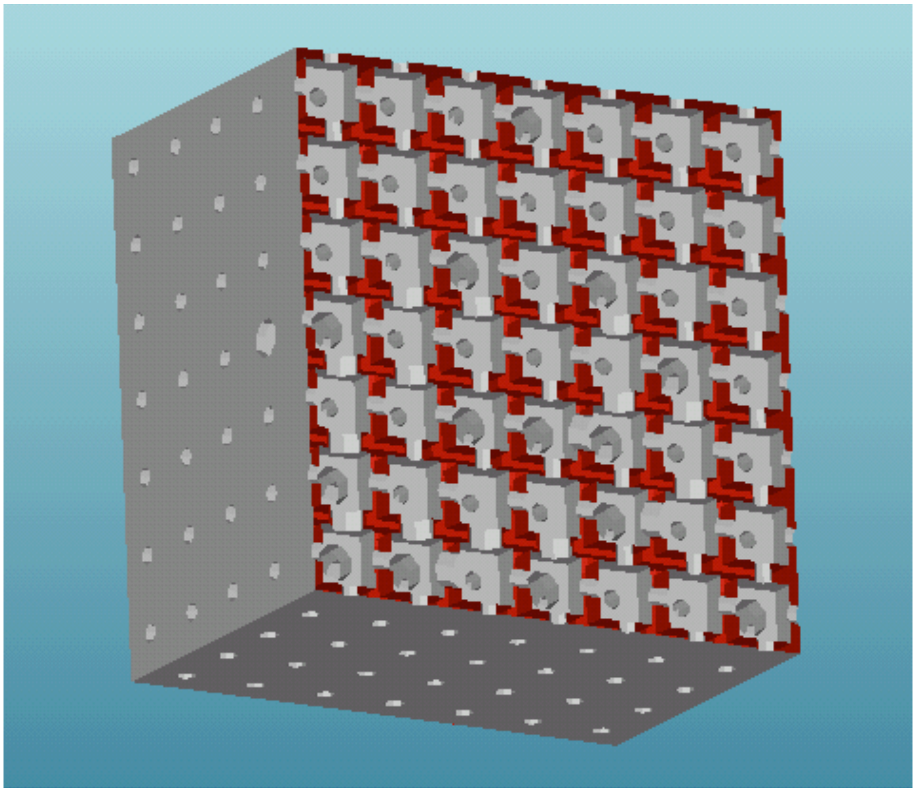


Above is a cube with 27 compartments, each of which contains a smaller hollow cube. The windows are openings into tunnels which let you see all the way through. It makes a very nice one-of-a-kind rattle. Below is a cut-away view, to show nine of the smaller cubes on the inside. This project is by Jian (Jay) Pan.

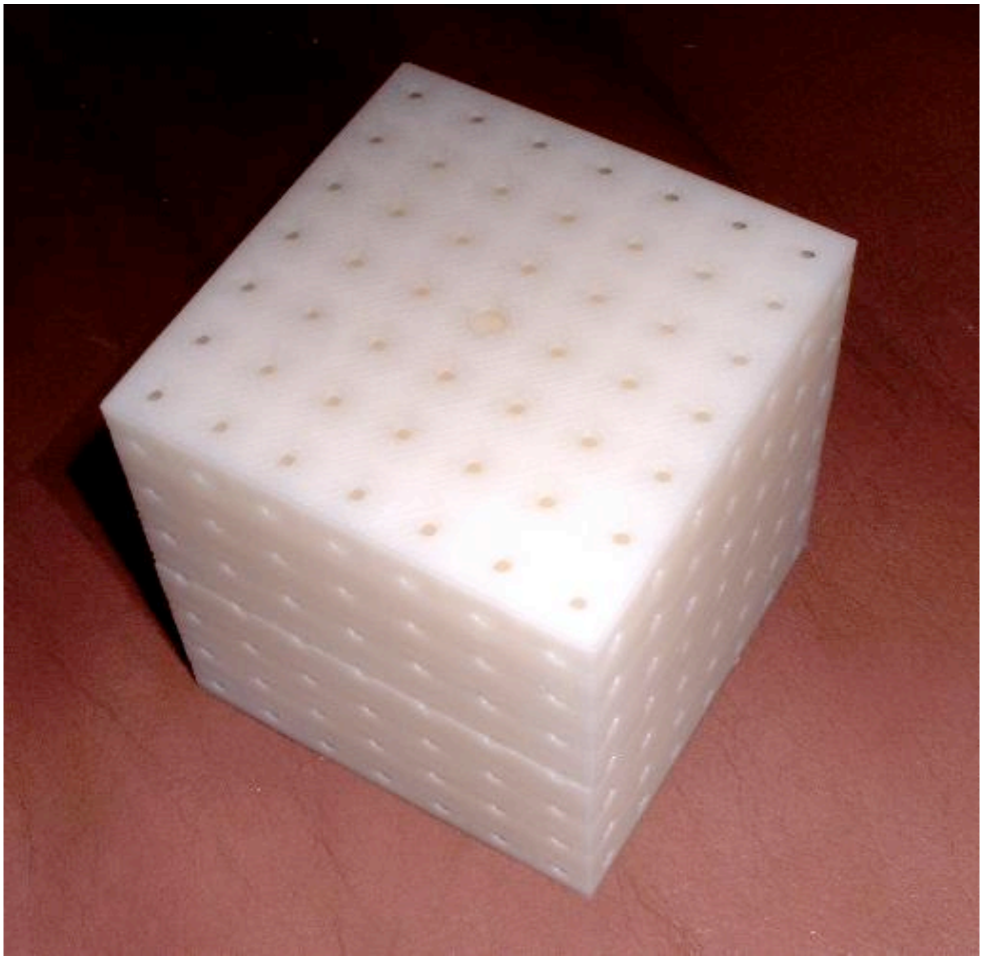




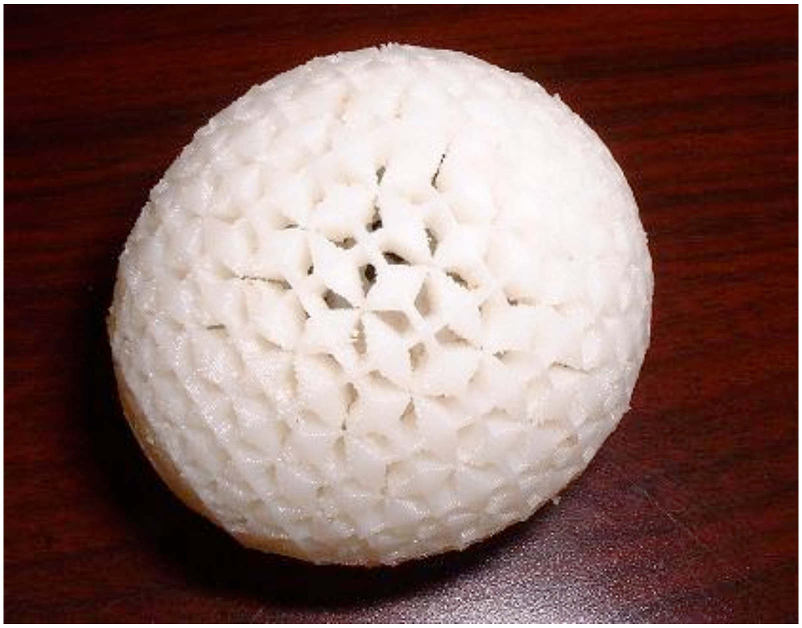
Above is a 3D maze by Michael Nachreiner. We accidentally made it too small at first---unscaled as a 1 inch cube. It is designed so a ball can go in one side, travel a winding path, and come out the other side. Below is a cut away view, near the middle of its 7-by-7-by-7 cubical structure. There are small openings in all the walls, so you can see everwhere into the interior to locate the ball. Only some of the openings are a larger size, for the ball to pass through. A path of the large openings connects the large opening at the center of one exterior wall with another large opening opposite it.



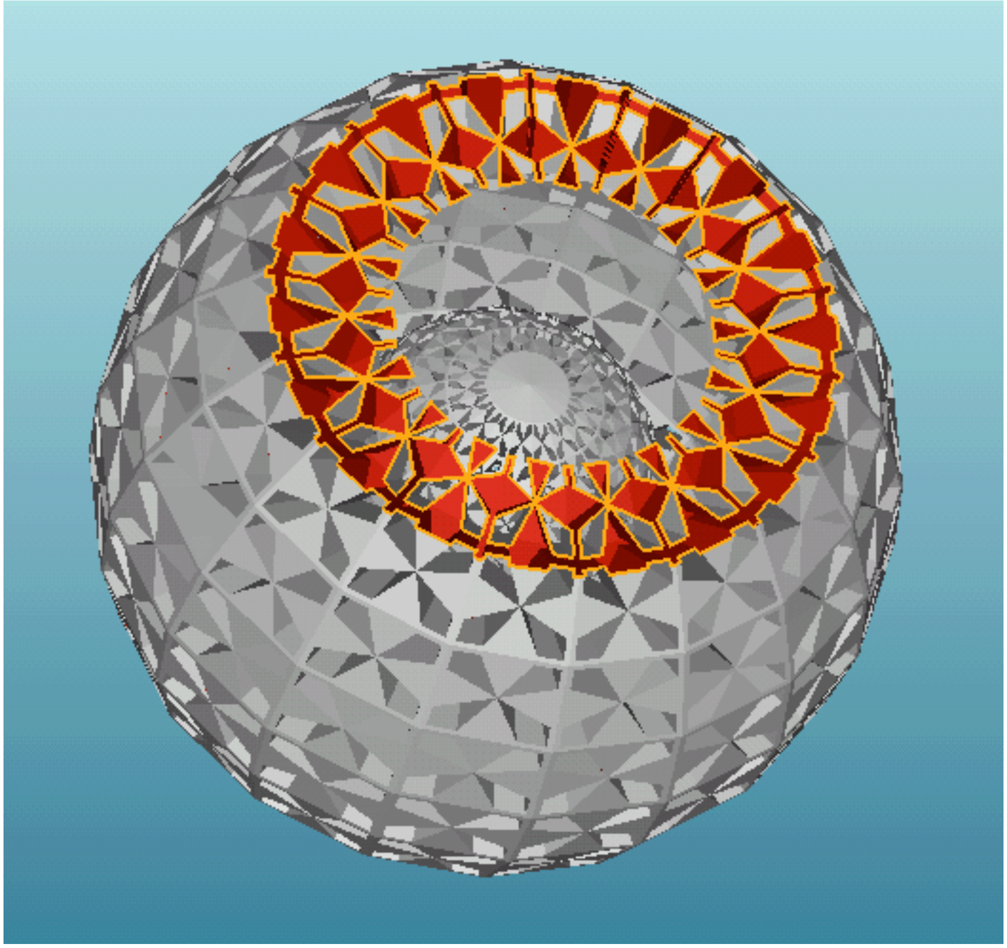
The larger version (about 2.5 inches for each edge) came out very well. A 1/8 inch ball bearing runs throuigh it nicely, but I haven't solved it end-to-end yet:



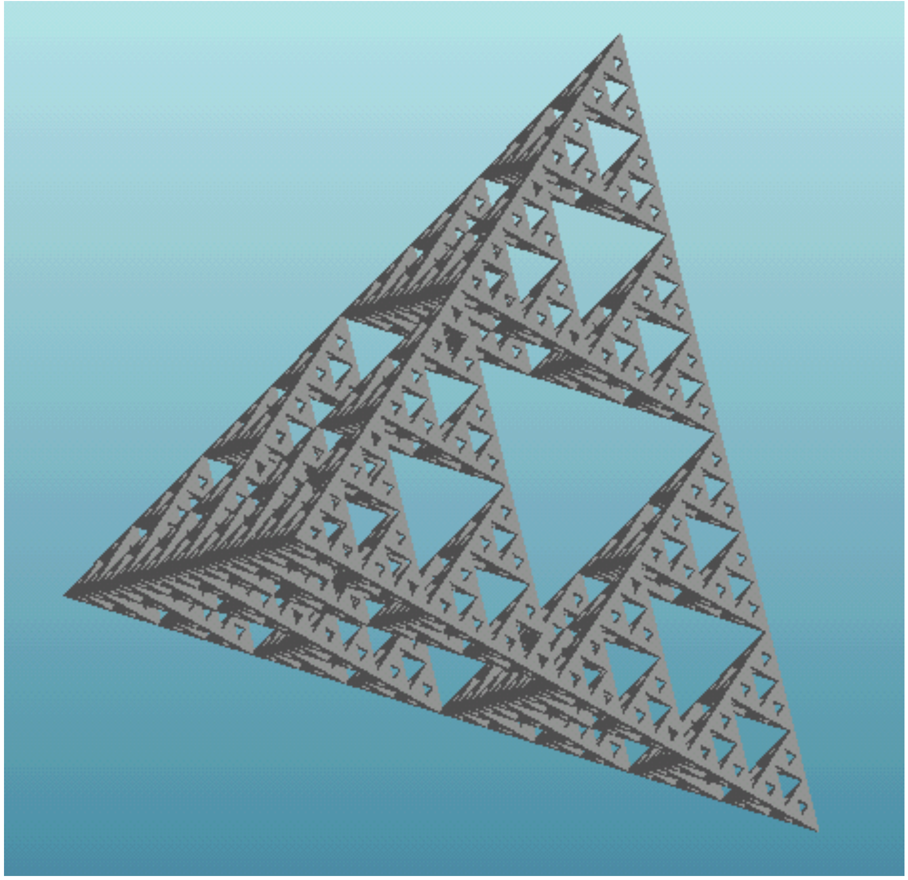
Next is a nicely ornamented hollow ball by Jian (Jay) Pan. There is a calibration error in the machine, which stretched it somewhat in the vertical direction. So it is slightly prolate, like an egg. It contains within it a similar smaller hollow ball.



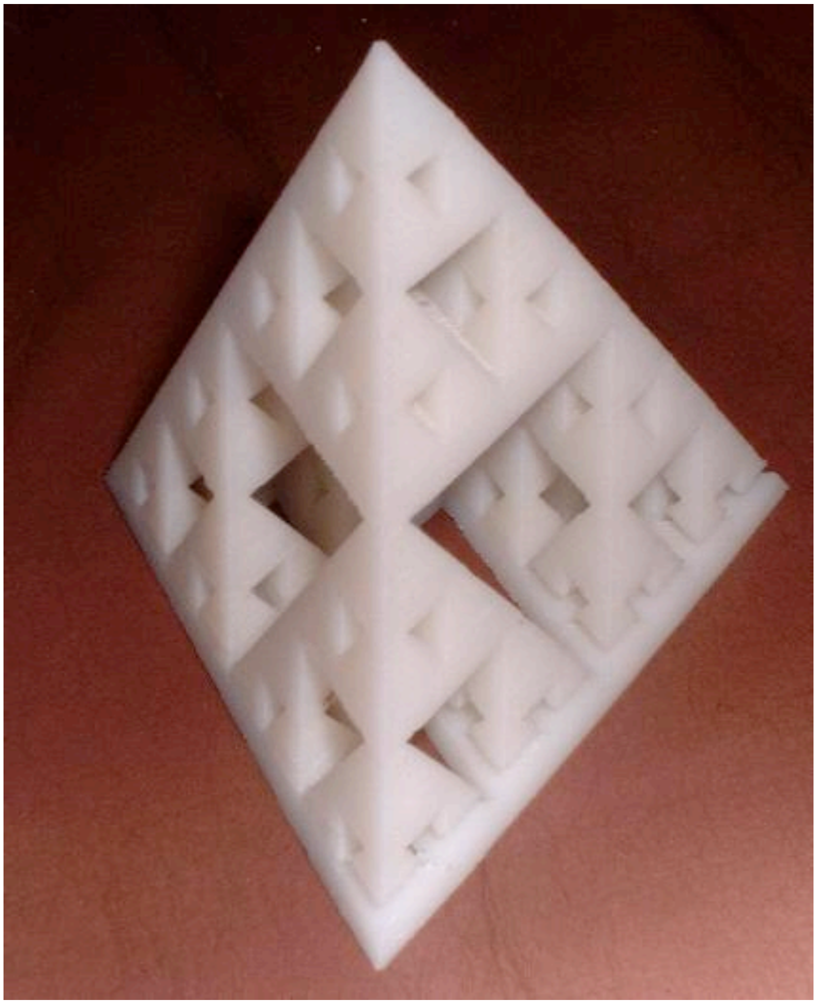
Below is a cut-away view of it, showing a cross-section, some of the inner wall, and the inner ball. This makes clear that it is designed to be spherical.



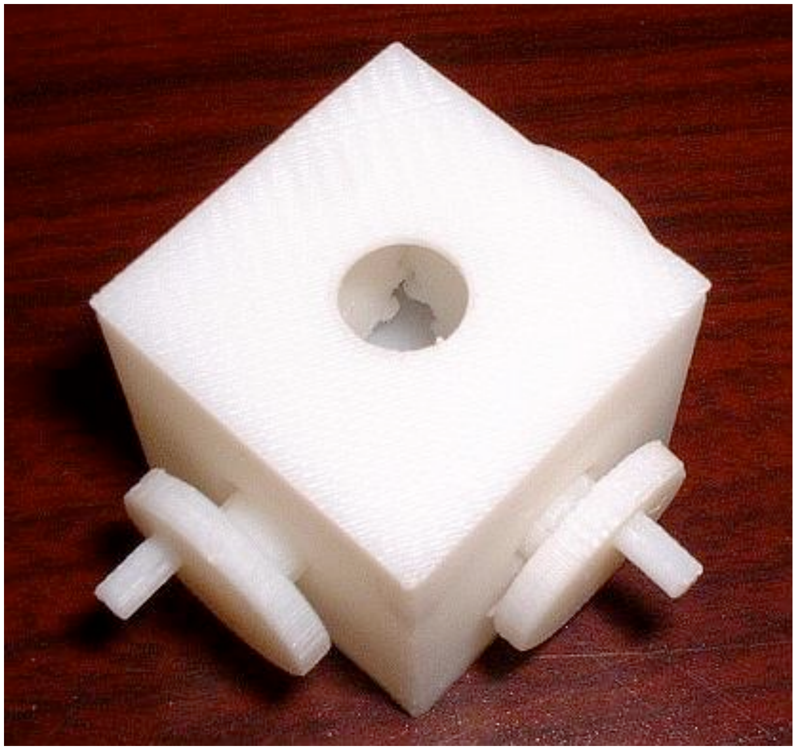
Still queued up to be built is a "Sierpinski tetrahedron". The file for this was produced from code written by Thomas Lai, using an algorithm I proposed. This took many tries. We first tried for the fifth-level version shown below. Because there are thin parts, the machine's slicing algorithm would sometimes completely miss a layer where the thin members "fall between the pixels" of a slice. If we had built it with that problem, the result would have fallen apart as if sliced. So we had to modify the parameters quite a few times.



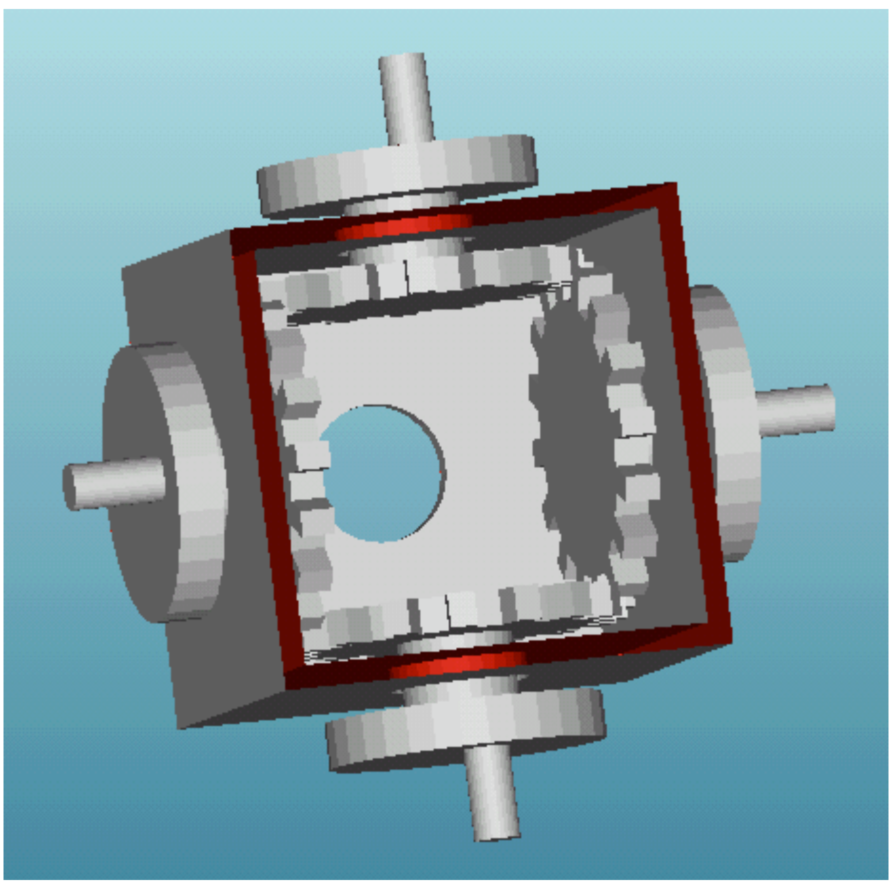
Here is a third-level version, showing some partially missing slices at the bottom. Numerical problems in the FDM machine's software causes this, but enough of the structure remains that it holds together.



This next one is a gearbox by Michael Nachreiner. It is built with four movable parts. Each exterior wheel and handle is connected to a gear on the inside. You can see two of the gears meshing through this hole in the top:



Below is a cut-away view to show the four internal gears. It is tricky to know how much clearance to leave between the parts when designing something like this. With too little clearance, the parts would fuse together, and with too much clearance the mechanism is wobbly. We erred on the side of slightly wobbly. Everything works, but the teeth can also disengage. Nonetheless, I think it is very cool!



Acknowledgments: Thank you to Prof. Imin Kao of the Mechanical Engineering department for access to the Stratasys 3000 machine we are using to fabricate these objects, and to Joo Hoon Choi for processing the files and running the FDM machine for us.