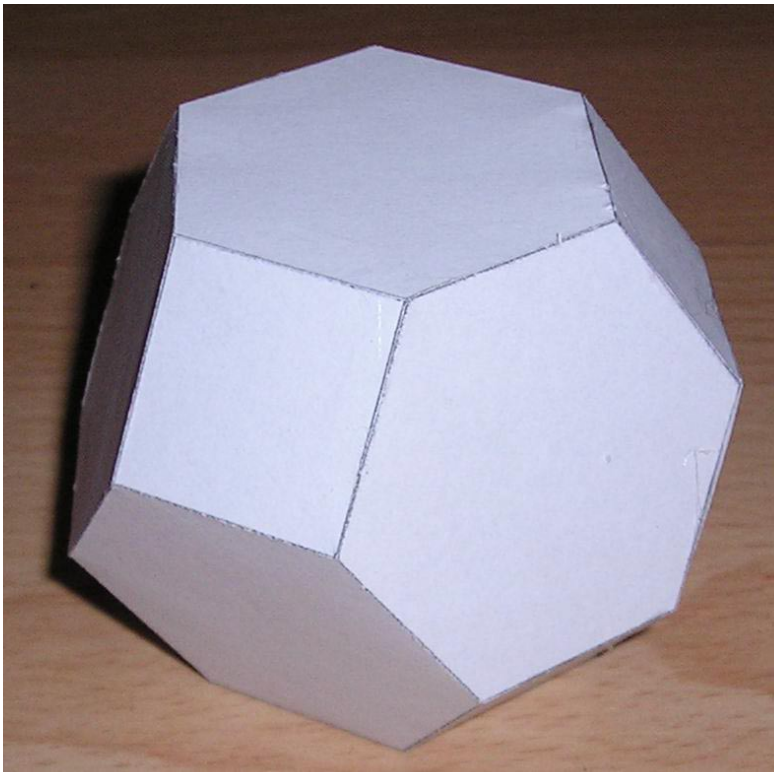
CHAPTER 12 - REGULAR SKEW POLYHEDRA: SHAPES THAT GO ON, AND ON, AND ON . . .

By now, you may have noticed that a number of solids we have made actually have cubic shapes, which is to say that if each was put into a box of the appropriate size, the top and bottom and four sides of the solid would touch the walls of the box. Another way of putting this is to observe that if you had made five or six geometric solids of a certain size and shape, they would be "stackable."

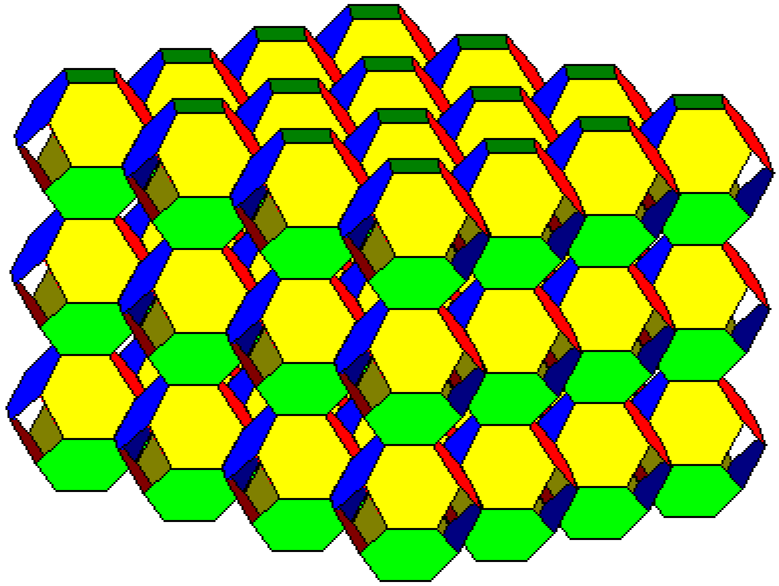
This is also true of the truncated octahedron. However, this solid has a unique property not shared by the others. If we look at it sitting on one of its square faces, we will note that it has a square top and bottom, and a square on each of four sides (although the side squares are turned). A number of these forms, stacked in this fashion, will all fit together by aligning the square faces, leaving spaces between which could otherwise be filled by other complete truncated octahedra.



Truncated Octahedron
www.korthalsaltes.com/obtuse_octahedron.html

If we were to create a number of truncated octahedra and leave the square faces open, it would be very easy to affix any two together, one atop the other, by reaching inside and applying tape across the common edges where two open squares meet. Furthermore, we could do the same with solids placed left, right, and behind. And there is no reason why we could not stack these three or four high, as long as practicality and convenience permit. In a word, this construction could go on, and on, and on . . . .

The term for such a construction is a "regular skew polyhedron," and as interesting as it is, we can make it much more exciting in a simple but dramatic way. Here's how.



Regular Skew Polyhedra (using truncated octahedral)
www.uwgb.edu/DutchS/symmetry/3dptgrp.htm

Objective:
Create three-dimensional regular skew poyhedra.

Vocabulary:
Skew
Truncated Polyhedra

Materials:
Standard white paper
Several large sheets of 22 x 29-inch white poster-board (cut in half to the more manageable dimensions of 22 x 14 1/2-inches),
A ruler
Sharp No. 2 pencils
A quality compass
A pair of scissors
Cellophane tape
An eraser
1/2-inch x 3 1/2-inch white label strips (recommended)

Steps:

1. Make eight or ten truncated octahedra as a class project--all to the very same size--but leave the square faces off. See **Chapter 9**. If you make a small, desktop version, the

net given in the section on Archimedean Solids will work perfectly just by eliminating the squares. But squares will be needed too--in fact, in even larger numbers. For the small version, lay out four squares in a row, score, cut out and tape to make a “floppy” open-ended cube. More of these can be made as you need them.

2. Affix one of these open-ended cubes to one of the open square faces of the first truncated octahedron, and tape in place along the inside where the common edges meet. Set the model up on this “foot.” Do the same to another truncated octahedron, so that now you have two models with “feet.” Install an open-ended cube to the side face of one of these models, and it will be seen that this same cube can be connected to the other model. You can, in effect, continue adding solids to each other in this way on all sides, installing open cubes between them by their common square-faced openings. **Figure 12.1** clearly illustrates the process and the finished product.

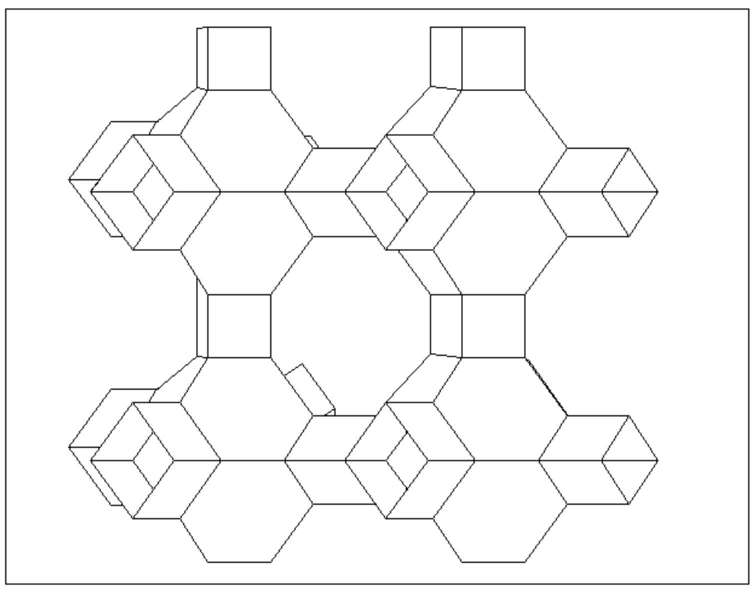


Figure 12.1

3. Another form, shown in **Figure 12.2**, may be made entirely of squares. But there is a surprise in store for you here. This model works best if made of individually cut squares. Begin by making six strips of four squares in a row, taping them along their common edges. These joints should be “loose” so that they flex easily. Loop the ends over to form six open-ended or hollow cubes. Place four of these hollow cubes side by side in a row, and tape the common edges. Now, pick up the two end sections, and bring them together so that their shared edges may be joined. They will be quite floppy, which may require you to tape in one or two stabilizers (a couple of straight-edges works quite well, set in opposing directions).

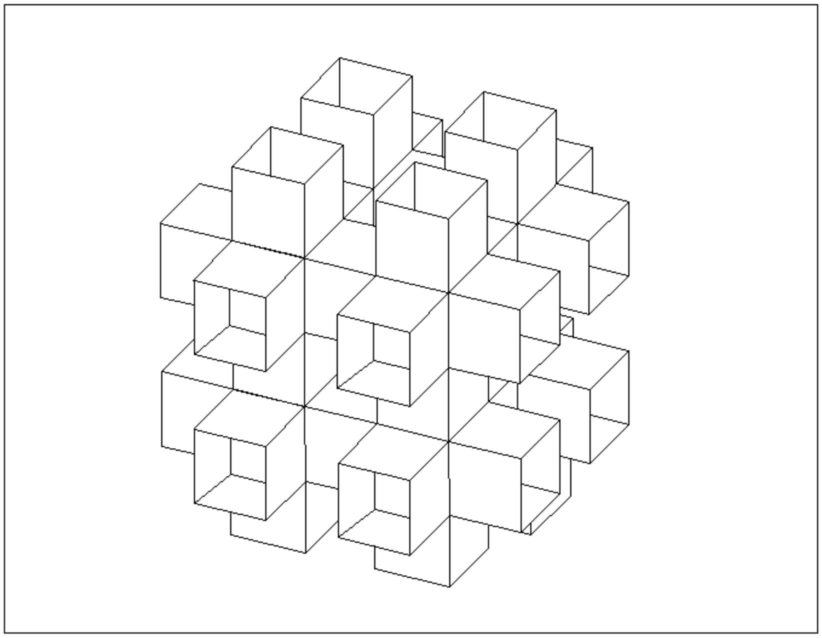


Figure 12.2

4. With some skill, you can tape in another hollow cube on each side. As you will learn, the structure is quite unstable, and unless braced internally, will collapse flat! (For all of this, it is not a true “collapsoid.”) In fact, that in itself is an attractive feature of this form, and I encourage you to make just one for that purpose alone.

5. An interesting way to display this construction is to suspend it from four strings, one set into the mid-point of each face of the top loop of squares, or at the corners. The four lengths of string can come together as one about five or six inches above the model. A square will be needed inside the top to stabilize the form, but when placed on a flat surface, the model will collapse flat—to the delight of your observers. But be warned: when it collapses, it is often very difficult to return it to its original shape.

6. The Rhombicuboctahedron will submit to this process by leaving the appropriate square faces open and connecting multiples of this solid by loops of four squares between. See **Figure 12.3**.

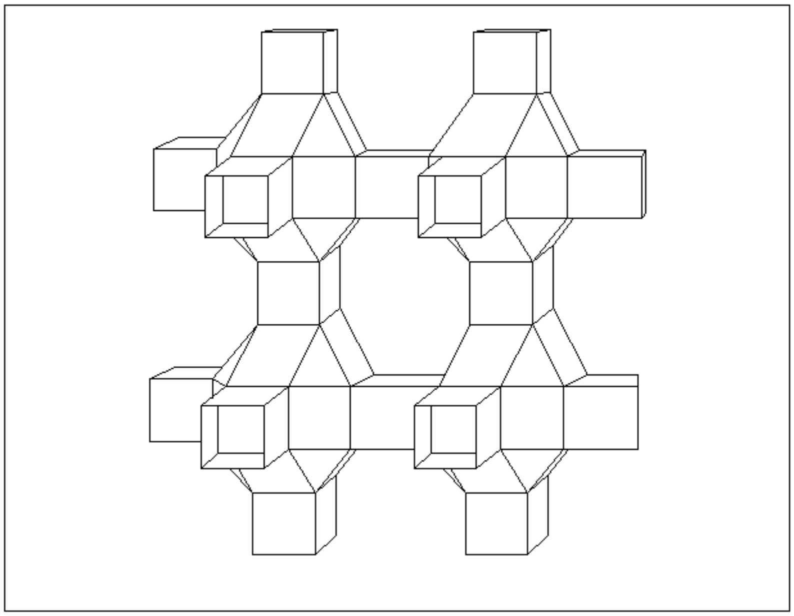


Figure 12.3

7. The rhombitruncated cuboctahedron produces an even more interesting skewed polyhedron by leaving all the octagonal faces open, and connecting a number of such solids with loops of eight squares between them. See **Figure 12.4**.

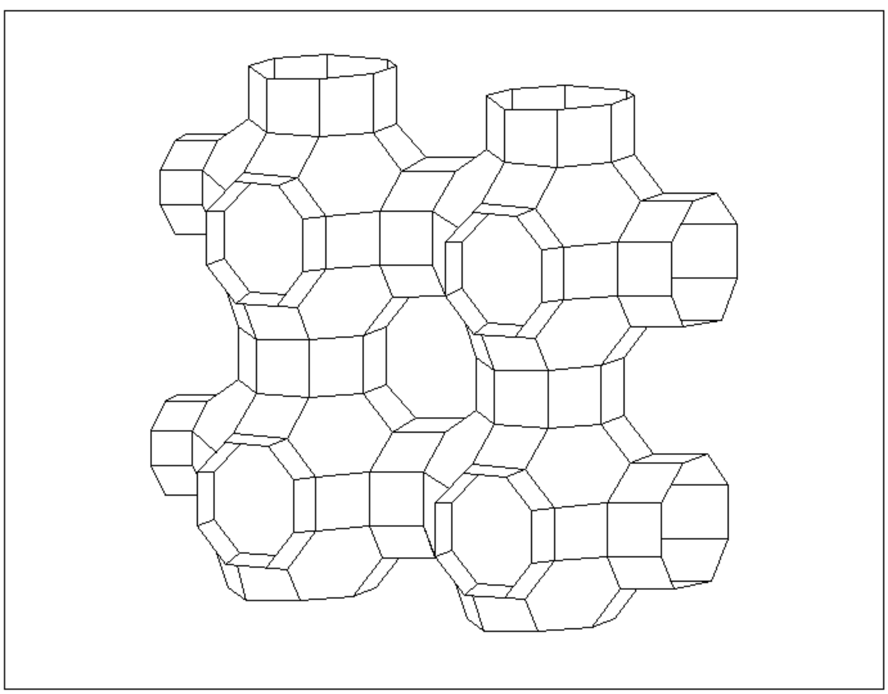


Figure 12.4

8. Other regular skew polyhedra are possible but these constructions are the most interesting. For the most dramatic effect, it is recommended that the unit of your choice be built at least three cells high, three wide, and three or four cells deep. For this purpose, the rhombitruncated cuboctahedron is ideal. In fact, with a great deal of caution, students (if they are not too big) can crawl around inside! Any damages can easily be repaired with new pieces of cardboard and a few lengths of tape. And here's a final parting thought: you could actually fill a room—wall to wall and floor to ceiling—with a massive skew-polyhedron model! When such a model is on display at school fairs or for visiting parents, students can invite adult visitors to join them in building and adding additional cells to the structure.