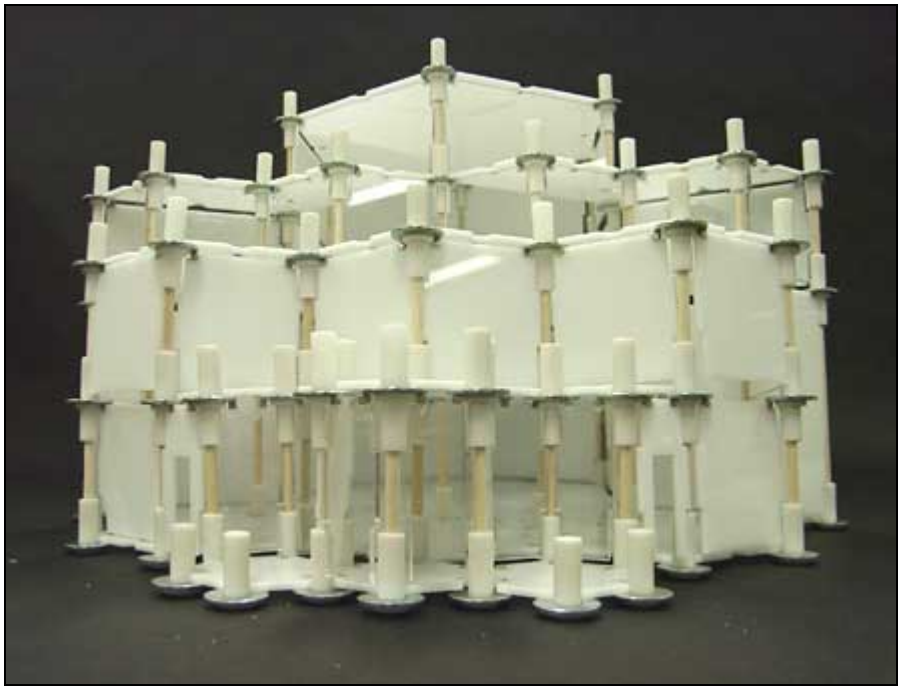
Diagram Panels

Introduction

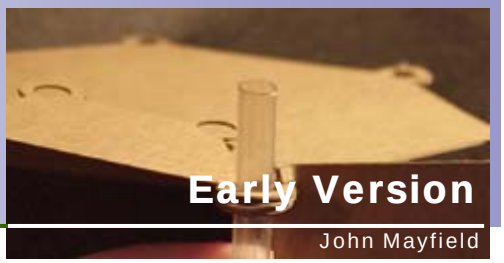
John Mayfield

The Diagram Panels set is a physical construction kit for quickly diagramming building schemes within a specified system. It uses entirely non-permanent connections (magnets rather than glue) so that it can be reused. The kit was developed as a student project for the University of Washington's Systems Studio (Spring 2004).

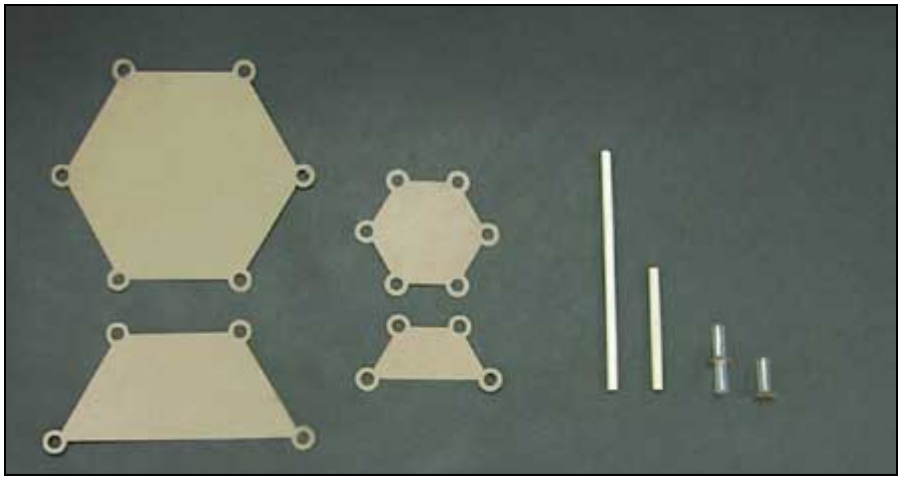


A construction kit

Diagram Panels



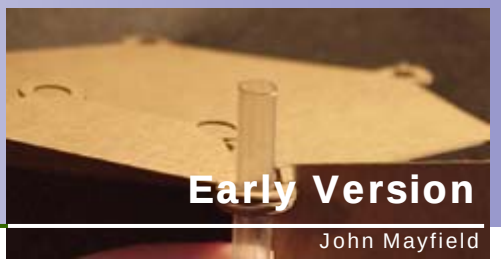
The first version of Diagram Panels was intended to create quick models of schemes for a women's halfway house. The main components were floor, ceiling and wall panels made from 1-dot chipboard, wooden dowels for columns, and connectors made of chipboard and thin plastic tubing. All were constructed to 1/4" scale.

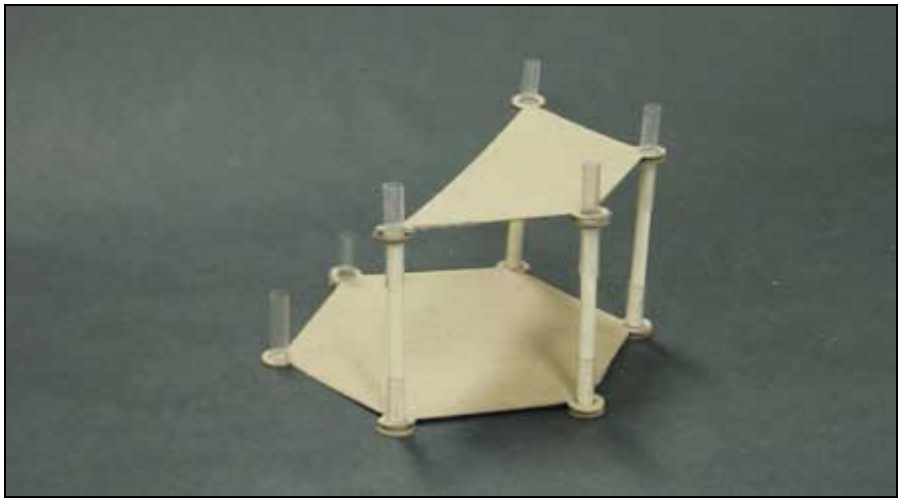


The system in which I was attempting to design allowed only for hexagonal and trapezoidal floor and ceiling panels. I found that a remarkable variety of building forms could be derived from these simple shapes. One of the main virtues of the hexagon is that when bisected across two intersections, the resulting side is twice the length of the original sides. That is to say, that the long sides of the trapezoids are exactly twice the length of the three other sides.

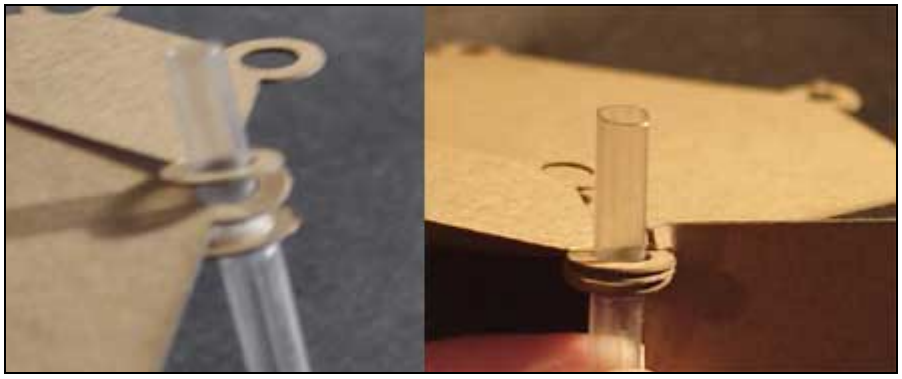
The lengths of the panel sides were all either 5 feet, 10 feet, 20 feet or 40 feet. Floor and ceiling panels had hexagonal and trapezoidal shapes with 5, 10, 20, and 40 foot sides. Wall panels also had lengths of 5, 10, 20 and 40 feet, with heights of either 10 or 20 feet.

Diagram Panels



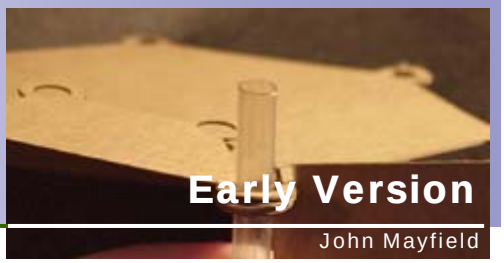


The connections were all non-permanent. A floor panel would slip over a set of base connectors, which could then each hold columns. The columns could then receive two-sided connectors, on which could go another floor and ceiling panel. The connection was such that multiple panels could meet at each connector, and overlap as they connected to it.



I found that problems arose when attempting to connect the wall panels to the ceiling panels and connectors. When designing the kit, I had assumed the thickness of 1-dot chipboard to be negligible, but I quickly found that a few overlapping ceiling connections, combined with the thickness of the connector could make attaching wall panels difficult, or even impossible.

Diagram Panels

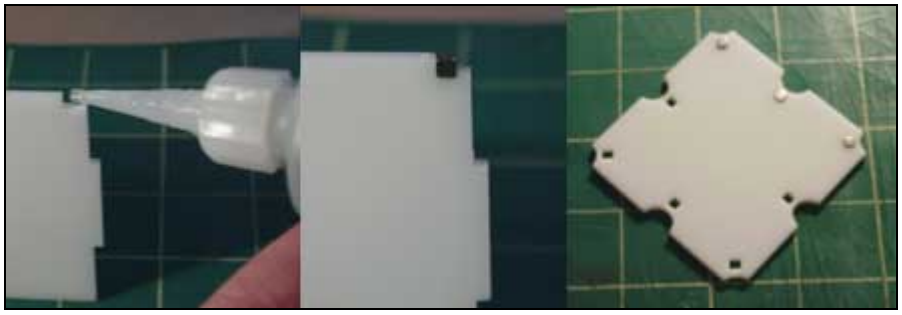


Another problem with the first version of the kit was the variety of wall panels. I designed these in an effort to provide for every possible wall panel condition. Many dimensions had as many as six or eight wall character variations. With eight dimensional variations, that meant I had to mass-produce 64 unique wall panels. Far too many to be practical.

Diagram Panels

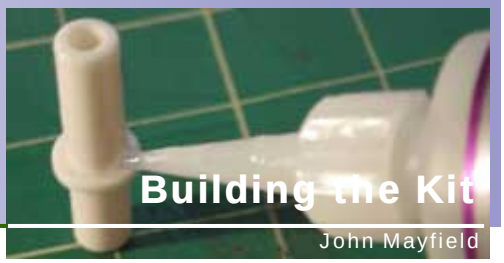
The version of the kit that I used as my final project shares many similarities with the early version of the kit. The two main differences are the materials used, and the nature of the connections.

The floor, ceiling, and wall panels were made from 1/8” thick plexiglass. The panels were laser cut from 18” x 36” sheets to create the exact shapes needed. The cutting took roughly 30 hours.



1/8” Nickel-plated neodymium magnets, which would serve as the basis of all connections were then glued in place using cyanoacrylates (crazy glue). Keeping the magnets all properly aligned was something of a challenge, but I was able to determine the direction of each magnet’s poles by setting them each on a larger magnet prior to gluing them in place.

Diagram Panels

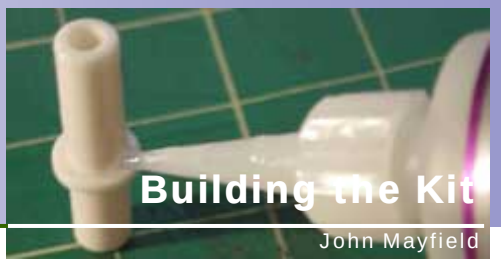


The connectors were the most challenging piece to create, due to their unusual shape and requirements. They are basically just hollow cylinders, but with a metal washer around the outside, supported by a small plastic ring. Additionally, the hole of the cylinder had to be a very specific diameter to accommodate the dowels that would serve as columns, and had to have a stopper at mid-height to prevent the columns from slipping through.

Though I did investigate rapid prototyping (three dimensional printing in layers of plastic), the time and cost involved proved to be prohibitive. Instead, I was able to find a manufactured part which was close to what was required. It would require some modification, but could be made to work: the bi-fold door guide.

So, I drove around to four of the Home Depots in the greater Seattle area, and at each one, bought nearly all their packages of bi-fold door guides. I left one package at each store in case someone was absolutely desperate for a door guide, but still ended up with about 160 of the little nylon things.

Diagram Panels



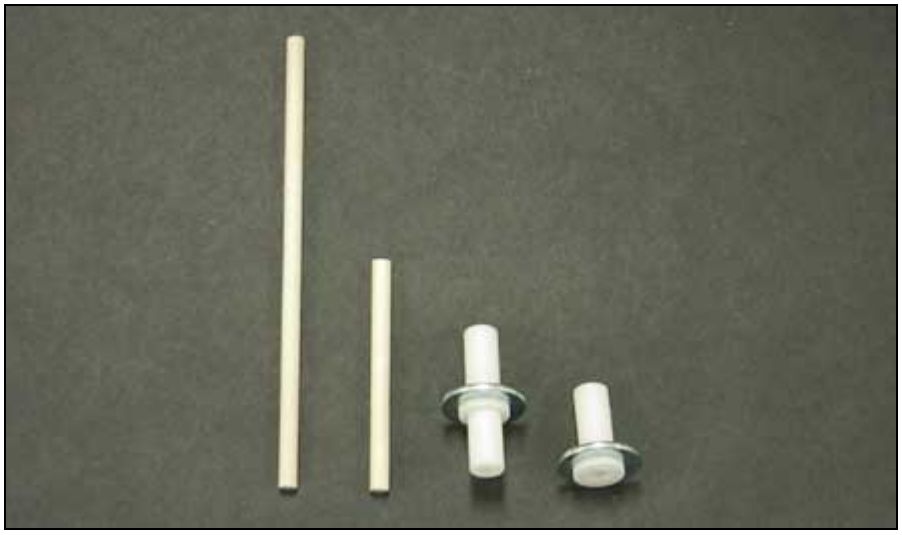
As I said, though, the door guides were close, but not perfect. The three main problems with them being that the diameter of the inner hole would not work well with any standard dowel size, that there was an inner plug but it was not centered, and that there were ridges along the outside of one end.

I drilled through the hole of each guide, both to widen it, and to get rid of the misplaced plug. I then shaved off the offending ridges, and added a new plug of clear acrylic, held at the correct height by a nail board.

Each washer was then glued into place, and 1/3 of the connectors were cut in half to serve as base connectors. Finally my kit was complete.

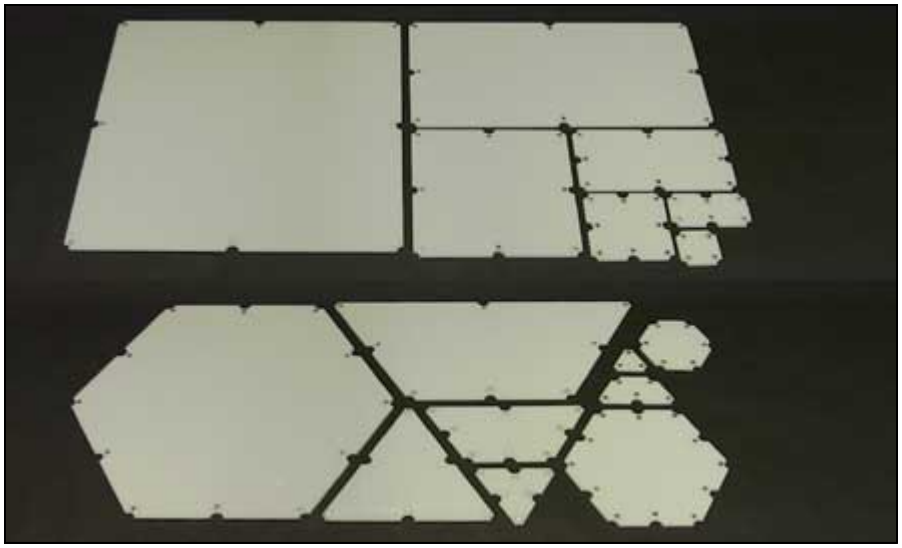
Diagram Panels

The pieces of the kit are in many ways similar to the pieces of the early version. There are floor and ceiling panels, wall panels, columns, base connectors and double-sided connectors. All are constructed to 1/4" scale.



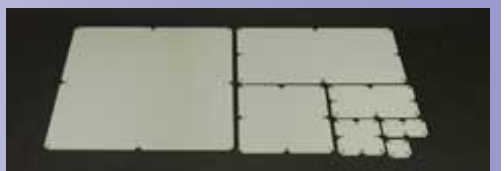
The four main connective pieces are the 20' dowel, the 10' dowel, the double sided connector and the base connector. In the completed set there were approximately 100 of each length of dowel, 110 double sided connectors, and 50 base connectors.

Diagram Panels



Floor and ceiling panels came in two main types: 90-degree and 60-degree. The 90-degree panels are either squares or 2:1 rectangles with dimensions of 5, 10, 20 and 40 feet. The 60-degree panels are made up of hexagons, trapezoids, and triangles, also having side dimensions of 5, 10, 20 and 40 feet. Each side with a length of 10 feet or more is further subdivided by a connector at it's center. This allows for more flexible connections between pieces of different dimensions.

Numbers of floor and ceiling pieces were determined by what I judged would be useful dimensions, and by material requirements. Generally there are only a few of each larger piece, somewhere around 10 of each middle-sized piece, and perhaps 5 or 6 of each of the tiny pieces.



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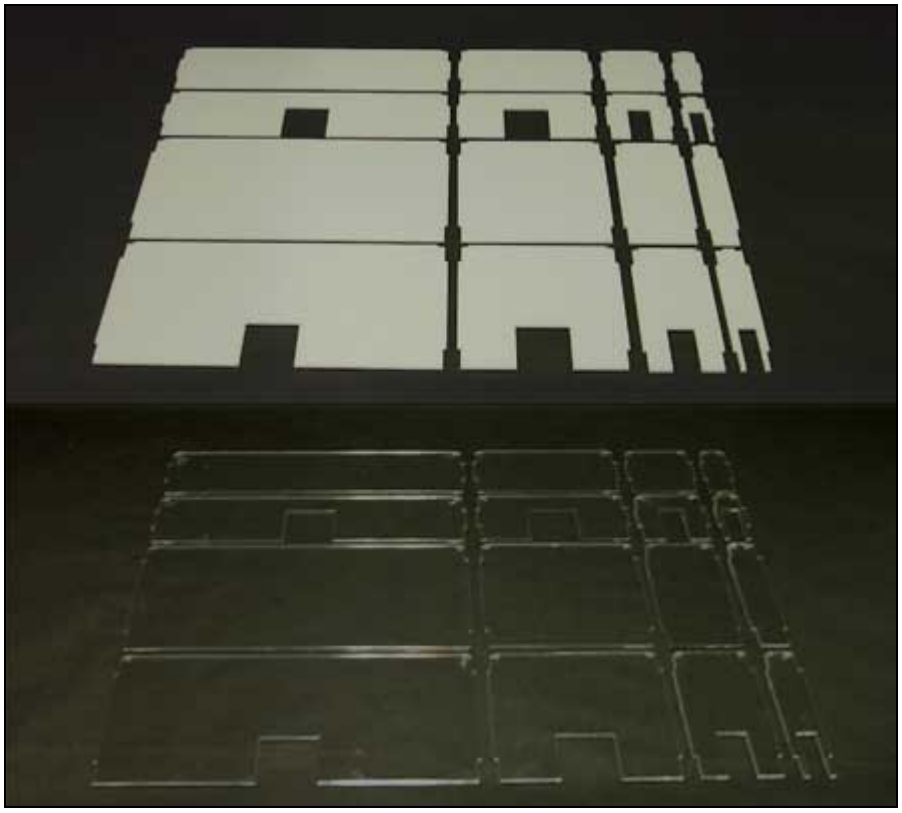
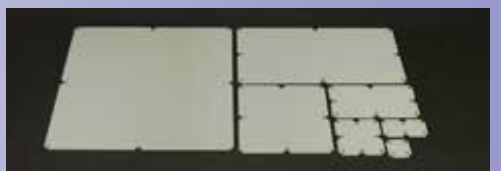


Wall panels come in eight dimensions. Lengths of 5, 10, 20 and 40 feet, to match the walls, and heights of 10 and 20 feet to match the columns. Each dimension comes in four varieties created by two simple variations: transparent or opaque and with a door or without. I judged that the two most important qualities of a wall, for diagramming purposes were whether it could be seen through, and whether it could be moved through. As seen in the early version of the kit, more variety creates production problems.

Similar to the floor and ceiling panels, the numbers created were determined by what dimensions I thought would be most useful. Thus there are a relatively large number of 20'x10' panels (8-15 of each variation) but only two transparent 20' high 5' wide panels with doors.



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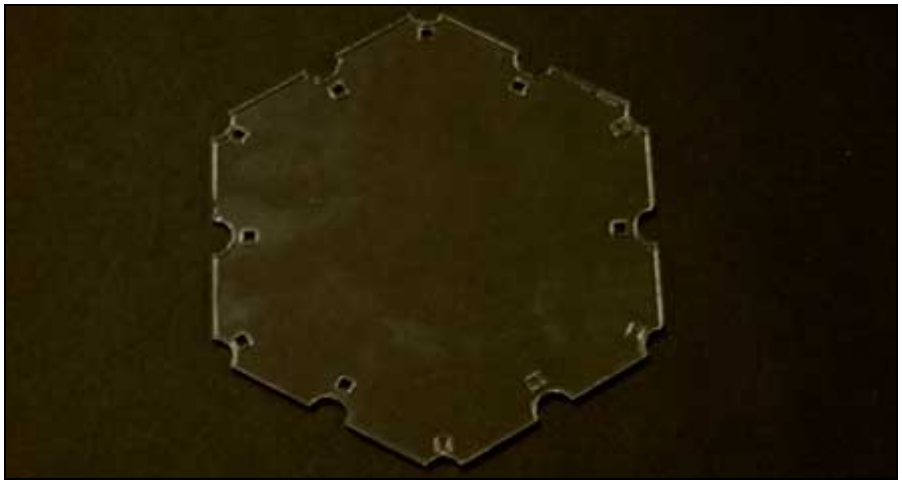
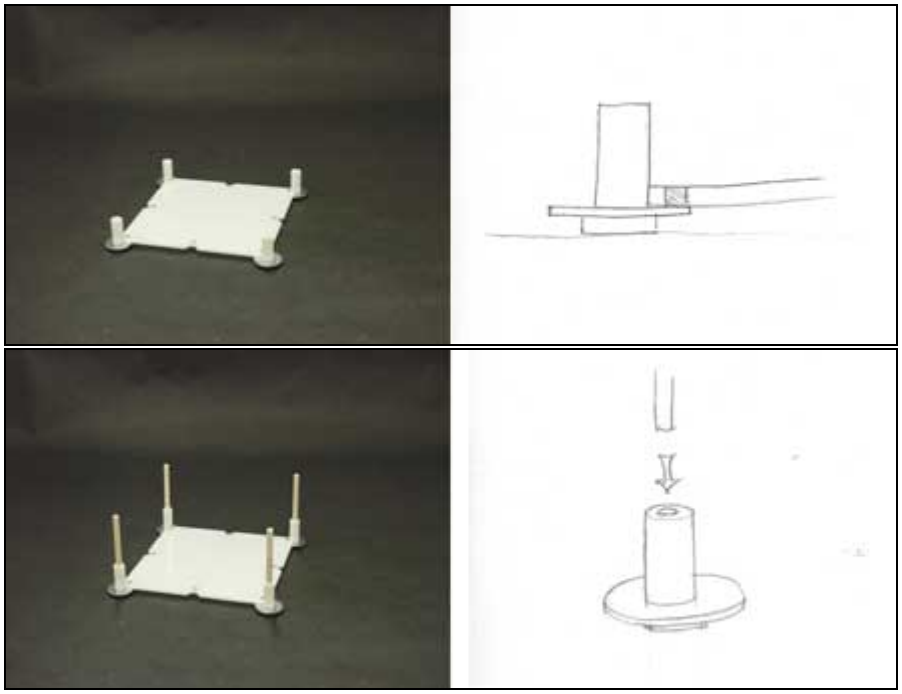


One of the panel types that didn't quite make the final cut is the transparent floor and ceiling panel. I had intended them to be used to represent skylights and the like.

Diagram Panels

Usually, the first step in using the kit is to give some thought to what you want to build and how. You might want to lay out the basic plan using only floor panels. This can help you figure out exactly where things will go and how the dimensions will match up. If you don't know enough about how the kit works to plan ahead yet, follow these instructions and we'll have you building in no time.



Begin by attaching base connectors to a floor panel. The base connectors should be on the ground with their cylindrical ends pointed upward. The floor panel then attaches magnetically to the connectors by simply resting each corner (or side connection) on top of the metal washer.

Once that is done, you can insert a dowel into the hole of each base connector.

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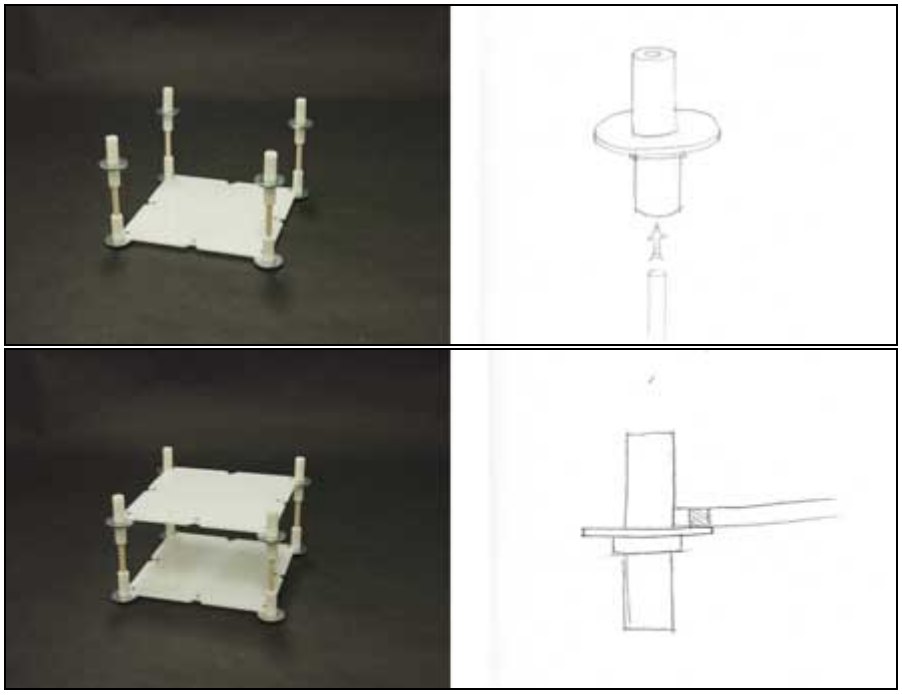
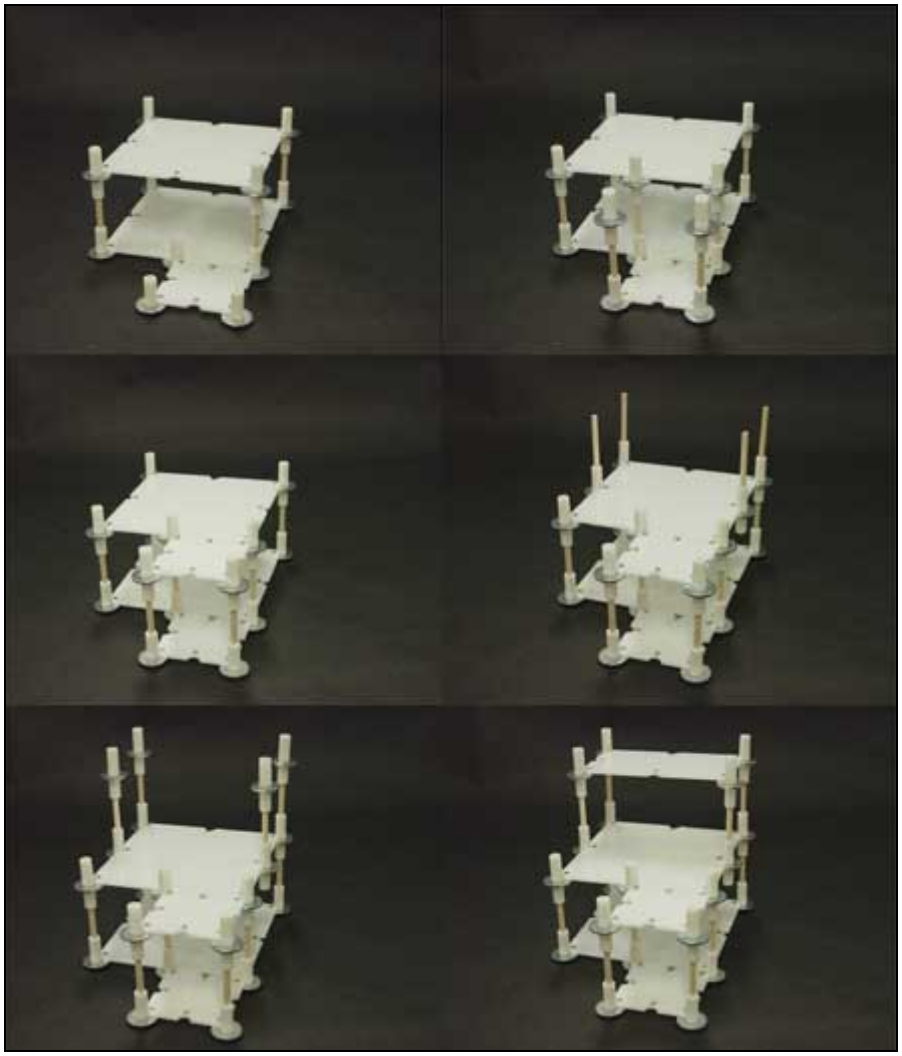


The dowels are then topped with double sided connectors. Be sure to orient the double sided connectors such that the washer is above the plastic ring.

Then, similar to how you attached the floor panel to the base connectors, you can attach another panel (this time acting as a ceiling) to the double sided connectors.

Diagram Panels



Further framing is just an expansion on the same principles.

Note that the double sided connectors which hold up the top platform's front columns do not need to be supported by columns themselves. The strength of the magnets will hold them to the underside of the middle platform. There are many other tricks like this which can be employed to create more interesting and flexible structures.

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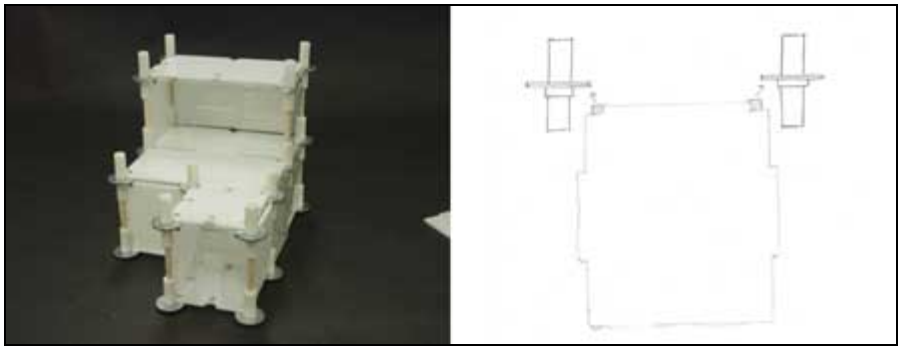
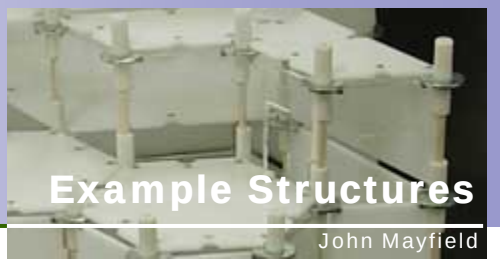


Adding wall panels is simply a matter of attaching their corner magnets to the undersides of two washers. The panels will then swing naturally into place.

A construction kit

Diagram Panels



Example Structures

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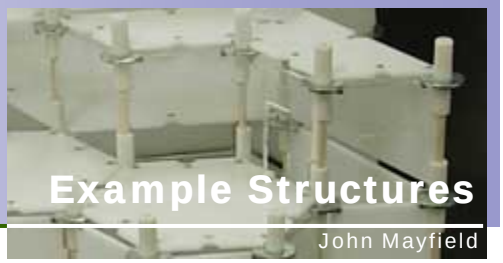
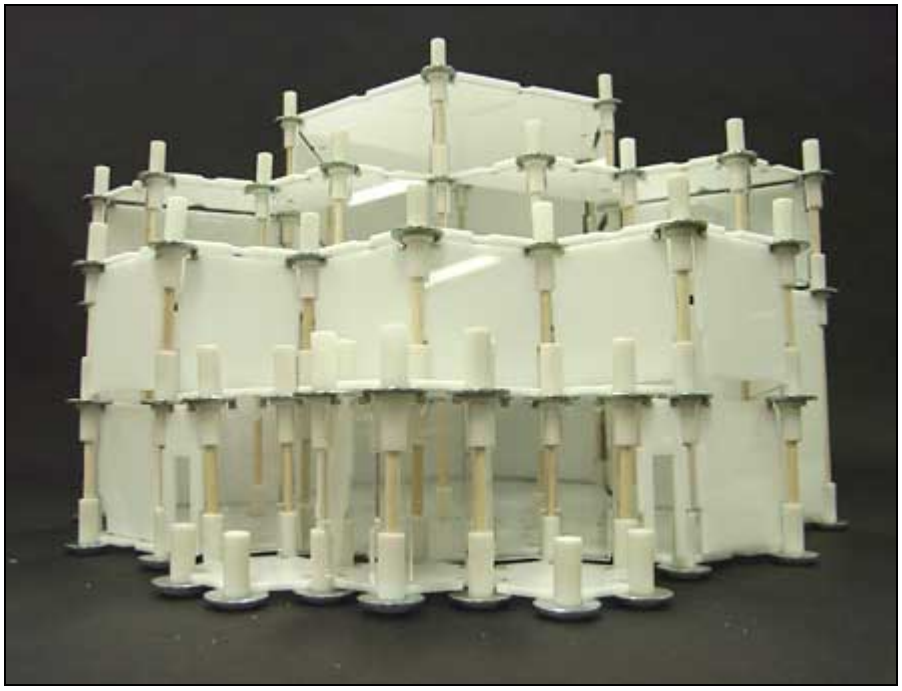
A construction kit

Diagram Panels





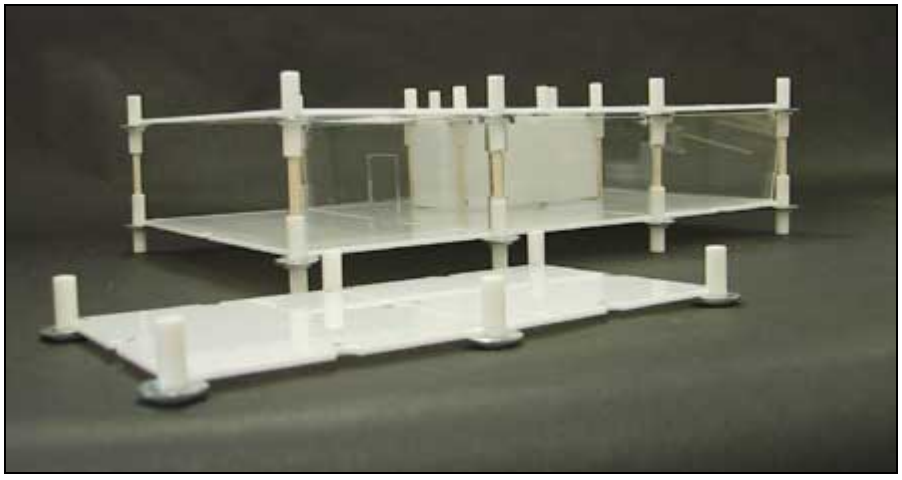


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Diagram Panels

Example Structures

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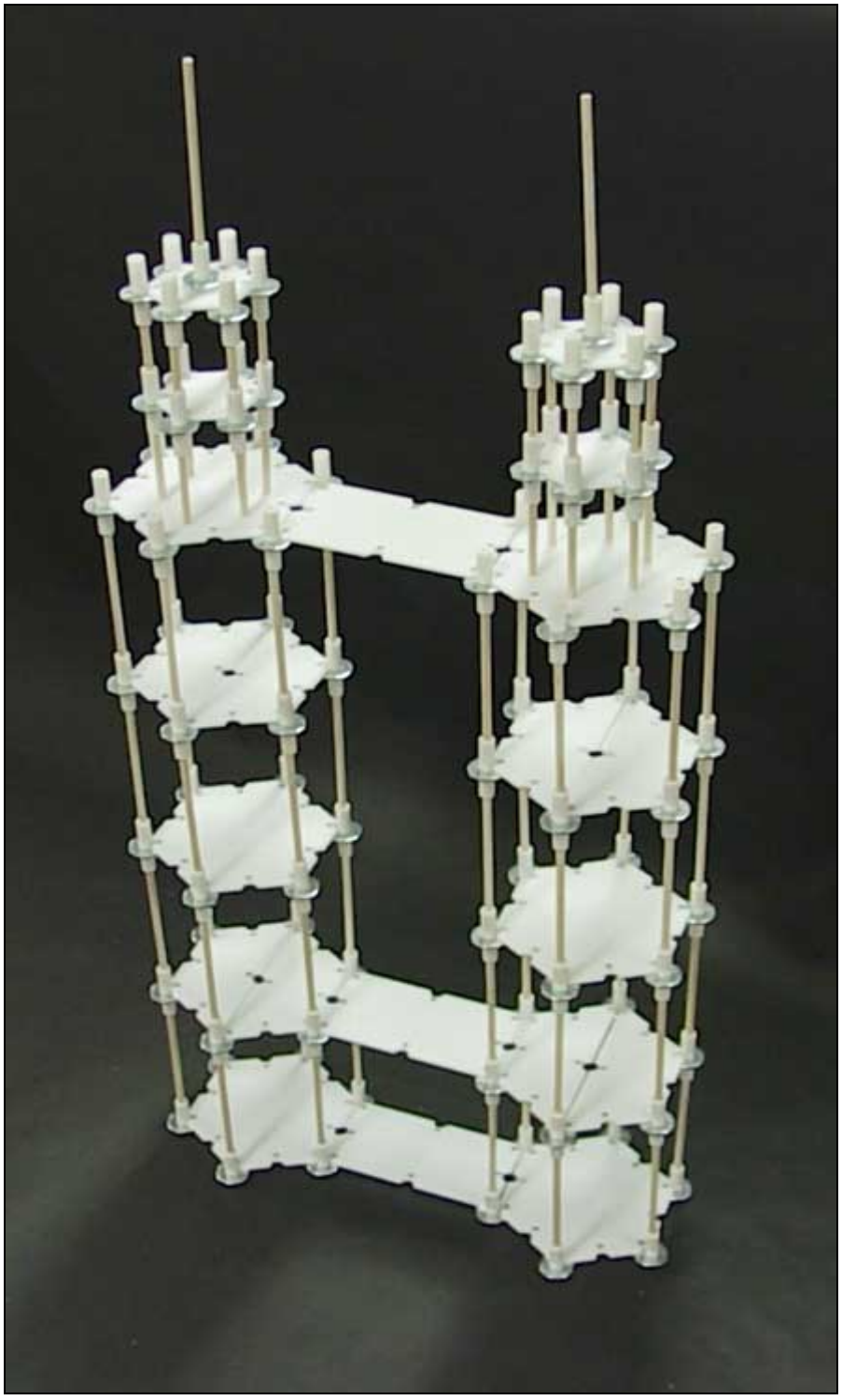
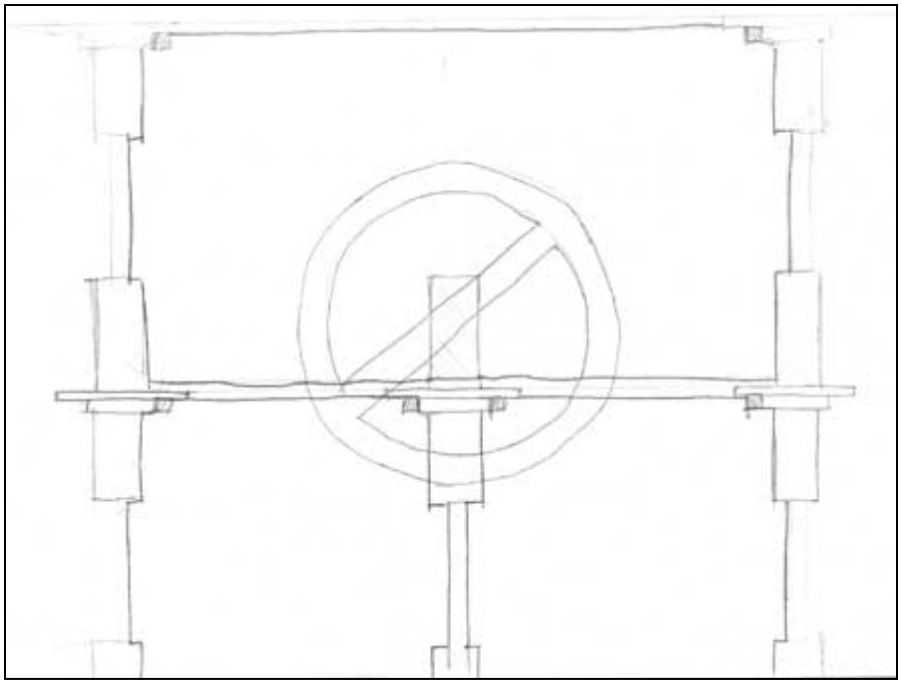


Diagram Panels

Though there is a lot that the Diagram Panels kit can do, there are a few things that it can't. The two major deficiencies are wall panel related, due in part to the fact that the wall panels did not work well enough in the early version to be thoroughly tested.



The first problem is that it is not possible to position a longer panel above two smaller panels. The middle connector required to hang the smaller panels will stick up into the space of the larger panel.

This can be avoided somewhat by using an inverted base connector in place of the normal double-sided connector, but this solution is far from ideal.

Interestingly enough, this is not a problem in the reverse. It causes no problems to position a longer wall panel below two smaller wall panels, as long as the middle connector is hung from a floor panel rather than supported by a column. This is because connectors are only required at the top corners of wall panels, and not the bottom.

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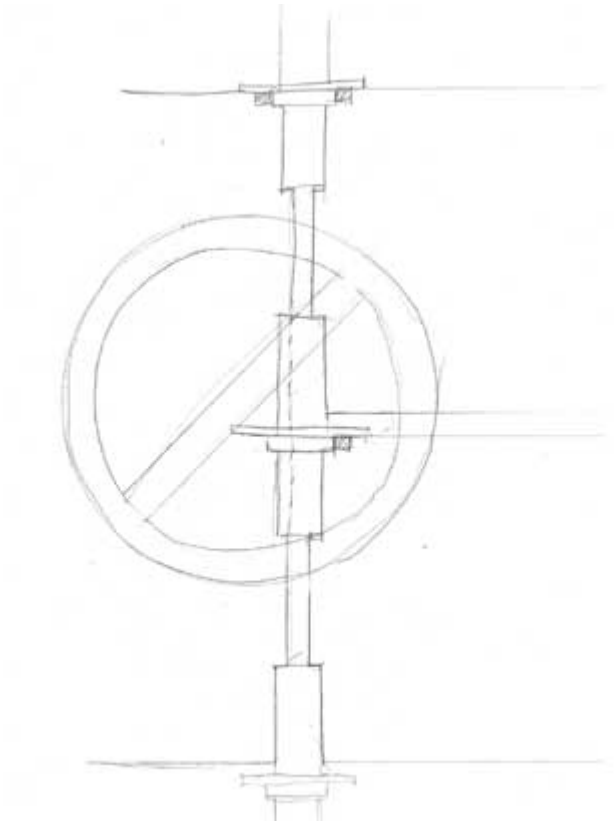

A similar problem arises when attempting to position a 20’ tall wall panel next to two 10’ wall panels. The connector required to hold the corner of the lower 10’ panel interferes with the 20’ panel.

It is sometimes possible to do away with the offending connector entirely by either resting the lower 10’ wall panel on top of a floor panel, or by attaching it’s corner magnet to the corner magnet of a floor panel in between the two 10’ wall panels. Again, this is not an ideal solution.