Math 168 Weekly assignment #10 Due Mon, Nov 26, by class

About rigid unit space frameworks

There is just one focus for this assignment. In class on Monday, Nov 26, we are going to build three-dimensional structures from rigid struts connected by completely flexible joints. There are a couple of different possible building systems for such a build, one or more of which will be available for you to choose from on that date. (For a sense of scale, you should expect the individual struts available to measure somewhere between 25 cm and 1 meter long.) As with the cubes, boxtahedra, polyhedra, etc., your assignment is to design and model what you might build, and then as usual, you and a partner will choose one of your two designs to execute during class.

Rules and Guidelines

1) Your design must not lie in a plane; i.e. it must be truly three-dimensional.

2) Your design must be a space framework realizing some edge-weighted network with all weights equal to 1 (in other words, all struts of the same length).

3) Your design must be rigid.

4) Your design must contain between 7 and 225 edges.

5) It may not be a regular octahedron or regular icosahedron or contain exactly one regular tetrahedron or one regular octahedron or one regular icosahedron as a subframework.

6) If your framework contains edges that intersect (at points other than vertices), you should investigate further. If the intersection points only lie on two edges each, and you have reasonably large (approximately a third of a strut length or more) separation between intersection points, then you can very likely actually build it – the real-world materials we use will likely have enough "give" to overcome the fact that real materials can't actually pass through each other. If you have *three* edges passing through the same point, and such points are well separated, you *may* be able to pull the thing together. If you have *more than three* edges passing through any point, or if you have several intersection points that need to be close to each other in space, it is *unlikely* that your design will actually be able to be constructed and you should choose an alternate design.

7) If you want more than one color of strut for the aesthetics of your build, I will have large-format Sharpie markers on hand (I recommend wearing gloves while using them) that you can use to color struts. I cannot guarantee there will be pre-colored struts available.

8) Thoughts on what to build: the framework of edges of an interesting polyhedron; a well-known/interesting network from network/graph theory, possibly with edges added to ensure rigidity (you may want to use a separate color for added edges); a model of a real-world network, like Boston's T system (again, you may have to add edges for rigidity), or like the network formed from (three-note) chords that differ by a single note changing by half a tone; etc.

What to Submit

1) Your software model of the framework

2) A justification that the framework is rigid. You can model it as per Weekly Assignment 9, or appeal to a rigidity theorem we cover in class, or reference a published proof of the rigidity of the framework you choose.

3) A two- or three-paragraph essay on the mathematical significance of your framework.

4) A brief build plan for your network: what sub-assemblies or junctions will you focus on first, and how will you proceed to completing the structure.