Preliminary Construction Guide

for the

Educational Model Set

Contact:
Richard Murphy
PolyBuilder Systems
9508 Wellington Circle
Windsor, CA 95492

707 529 6470
rmurphy@polylinx.com
www.polylinx.com

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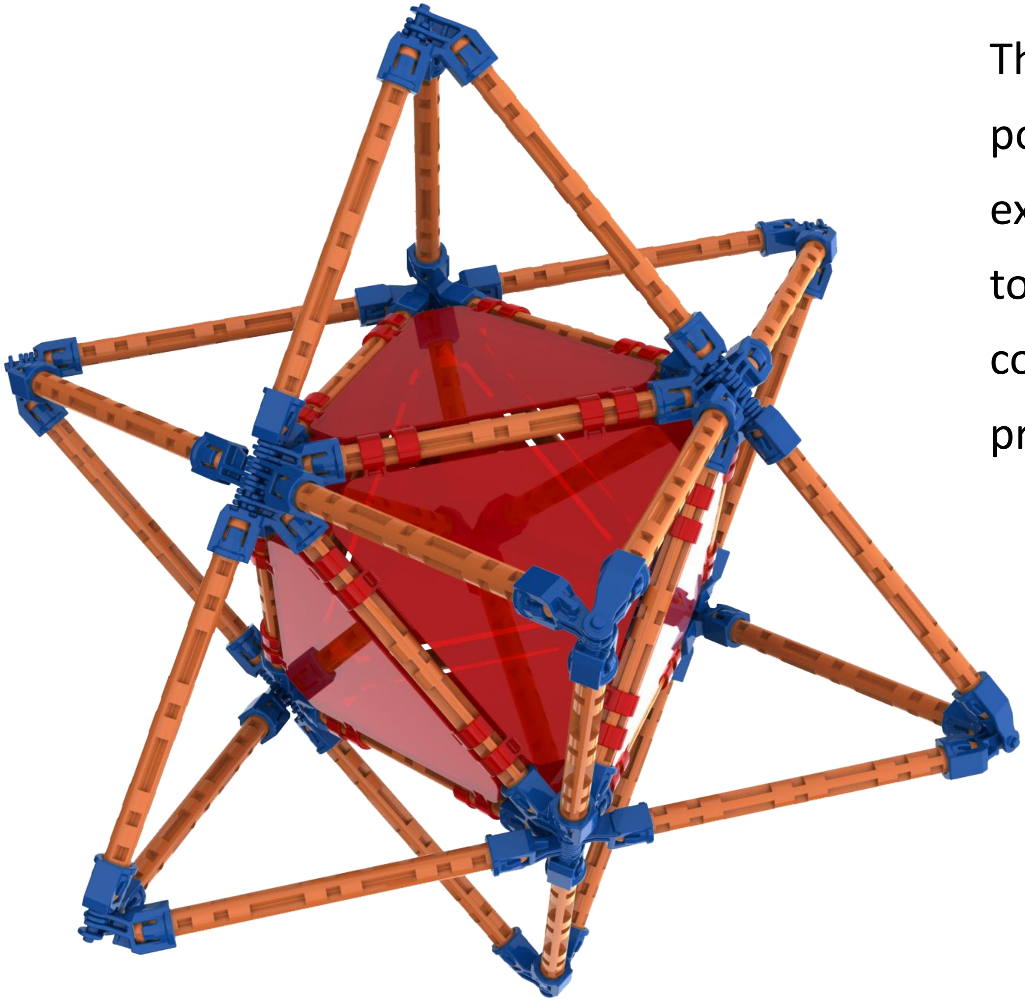
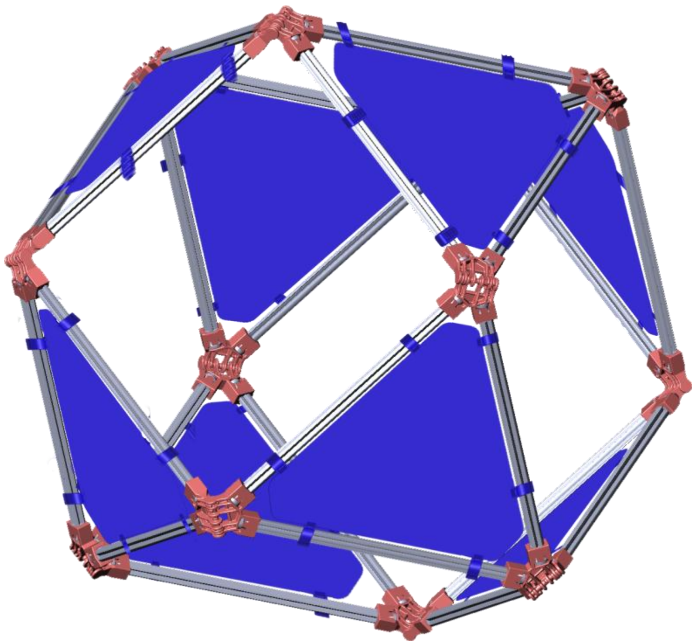
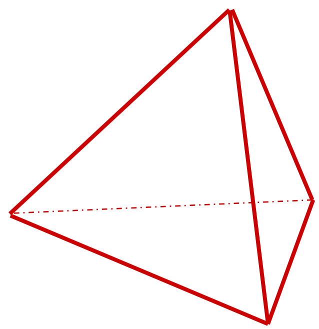


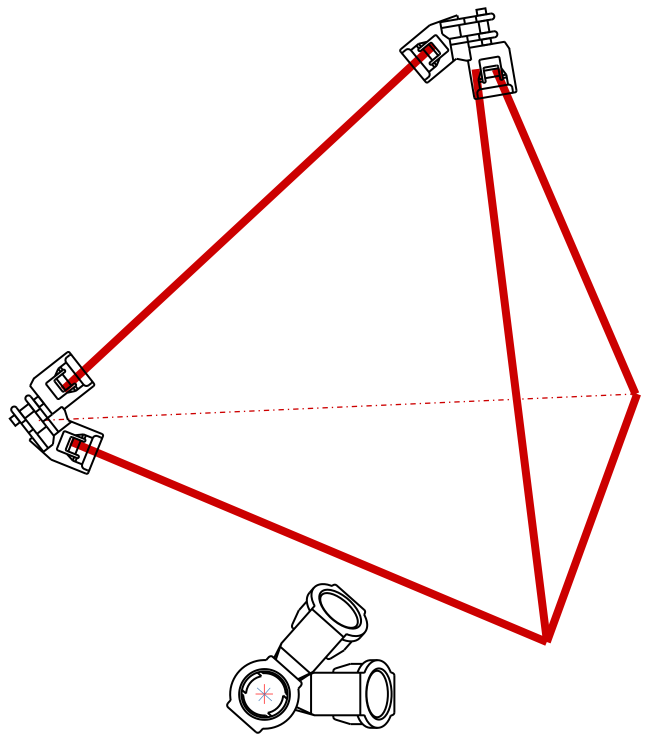
These “instruction” pages are a sample of possible guides. The intent is to provide examples of how PolyLinx components fit together to form full models. These consist of a mix of notes and directions provided for CAD development.



Note: Some of the figures in this guide are based on a prior component versions. Please refer to the parts brochure for current part forms

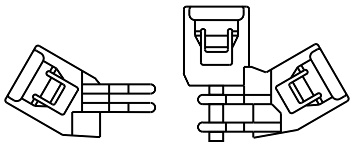
Tetrahedron



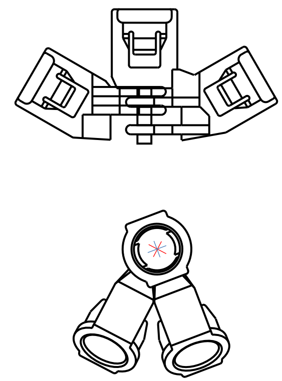


Upper Split Hub

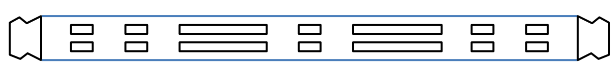
Lower Split Hub



4x



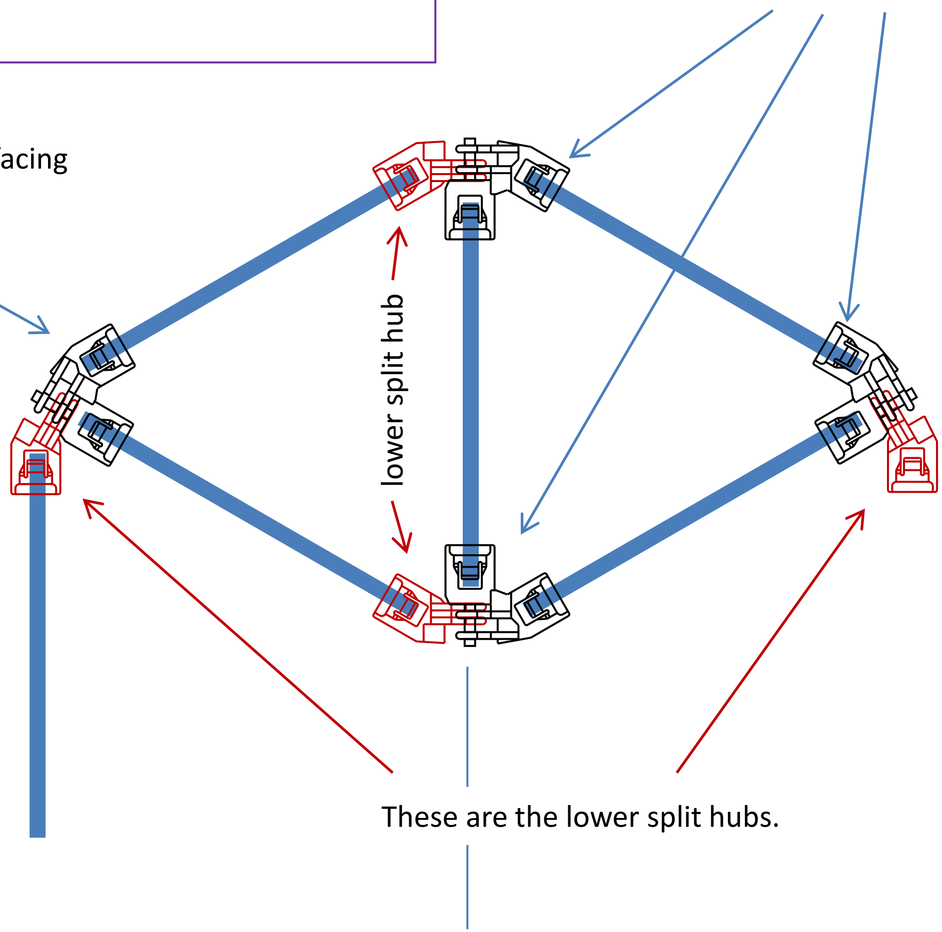
And 6 Struts



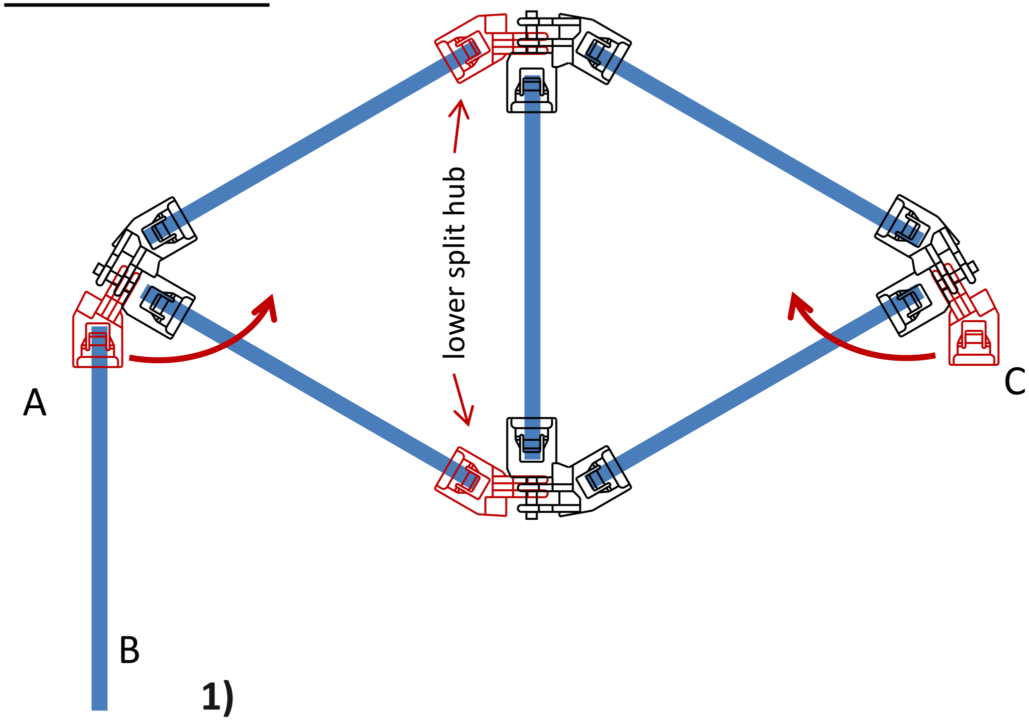
Tetrahedron

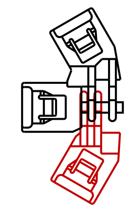
Notice the orientation of the hubs.

While such placement is not required – the hub elements can be in any orientation – this allows the sides to more easily “fold” together.



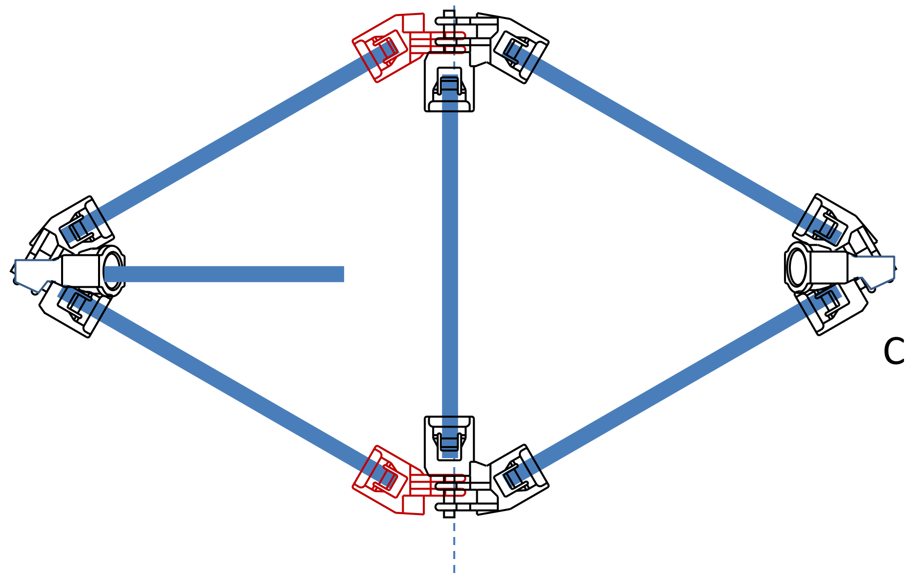
Tetrahedron



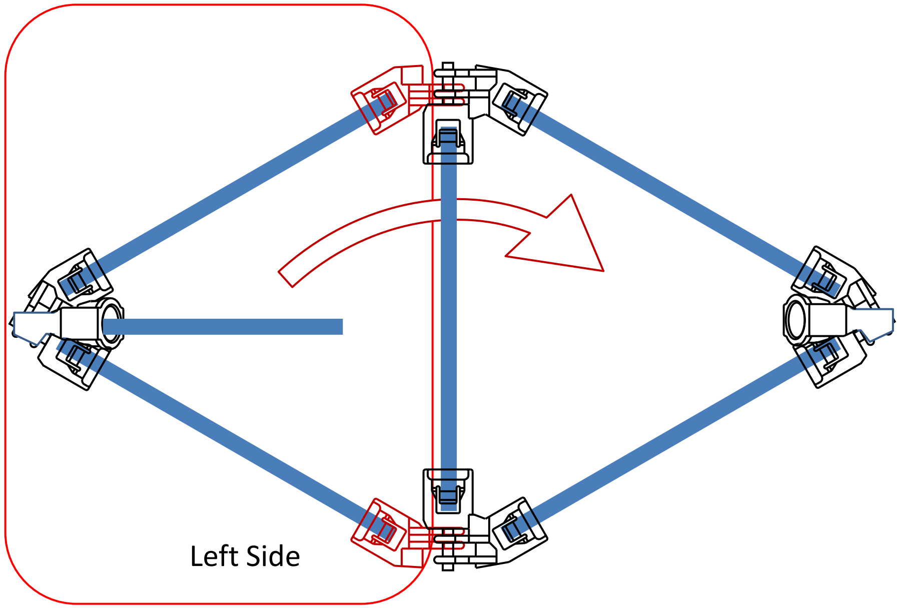


1)
Fold lower split hub slot, A, and attached strut, B, up, towards the center.

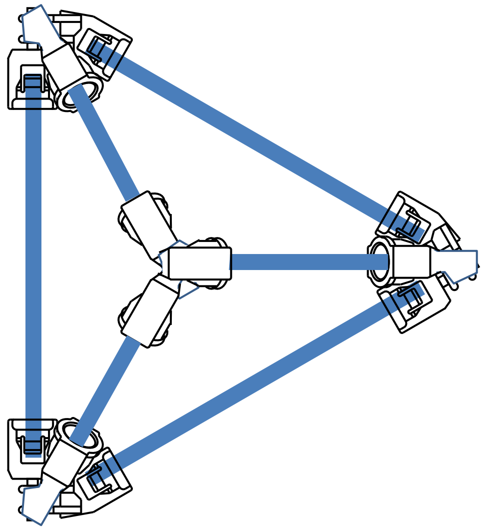
2)
Similarly, rotate the slot, C (lower split hub element)



Tetrahedron



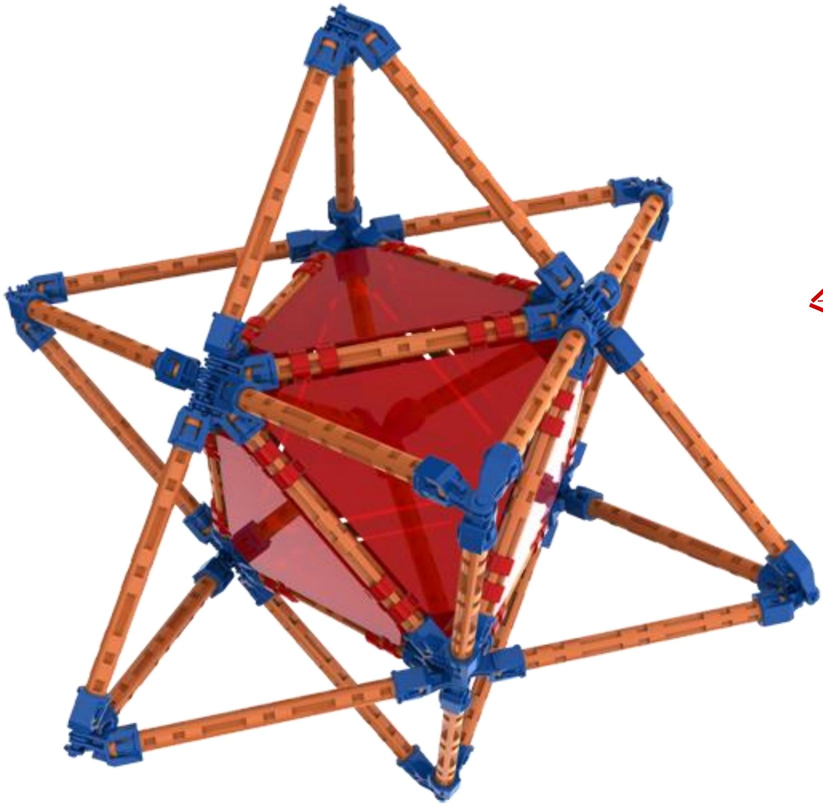
3)
The left side will easily fold over to the right side

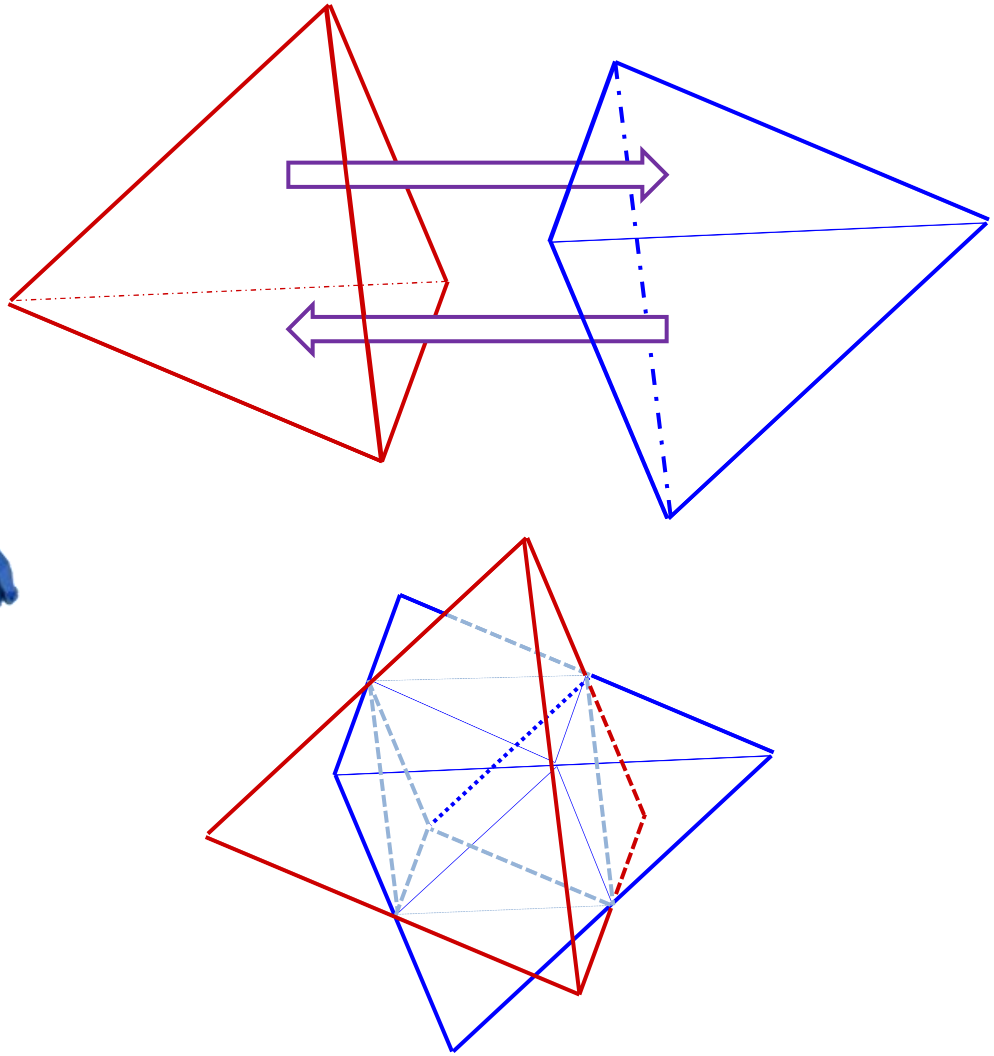


4)
Attach the loose strut to the remaining open hub slot – Finished!

The Poly-Star (Stella Octangula)

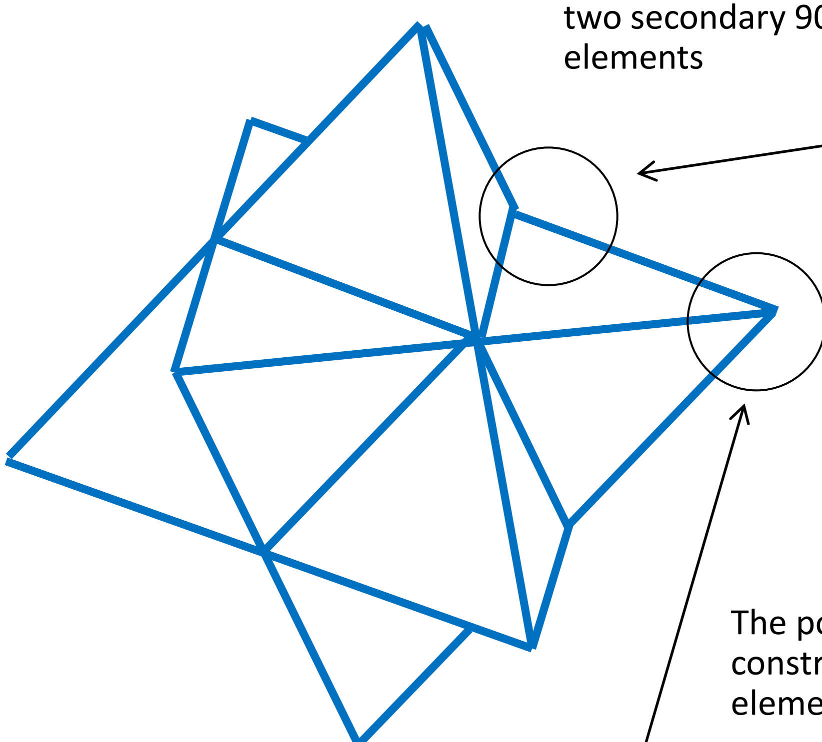
or compound of two tetrahedra

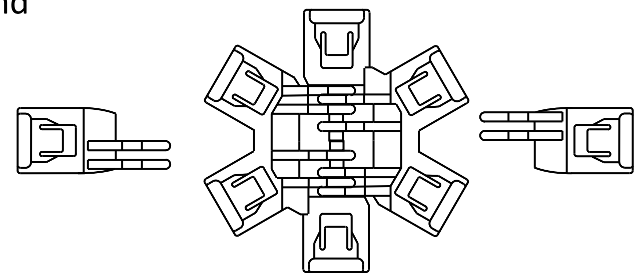




The Poly-Star

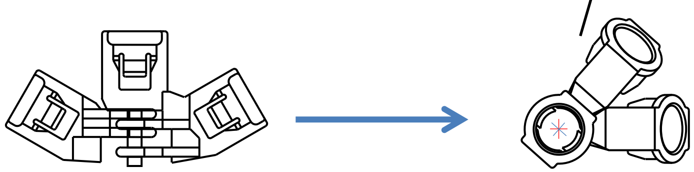
The body nodes are built from full hinge-hub pairs and two secondary 90° hub elements





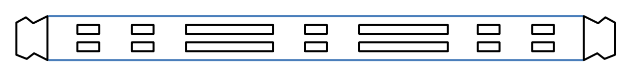
6x sets

The points (vertices) of the star are constructed from a pair of split hub elements



8x

And

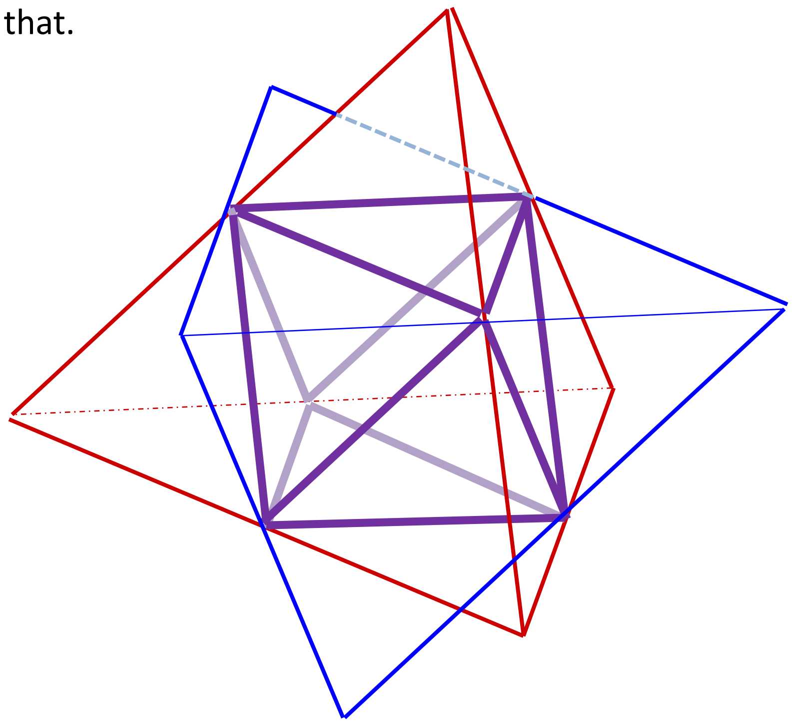


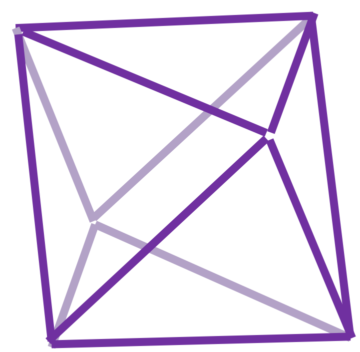
36 Struts

The Poly-Star

Notice the Octahedron inside (in purple).

Let’s start with that.



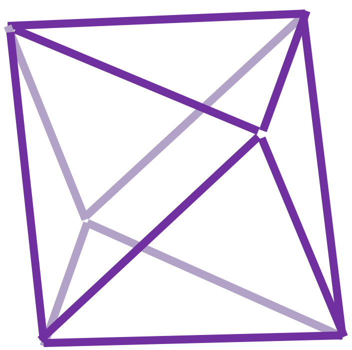


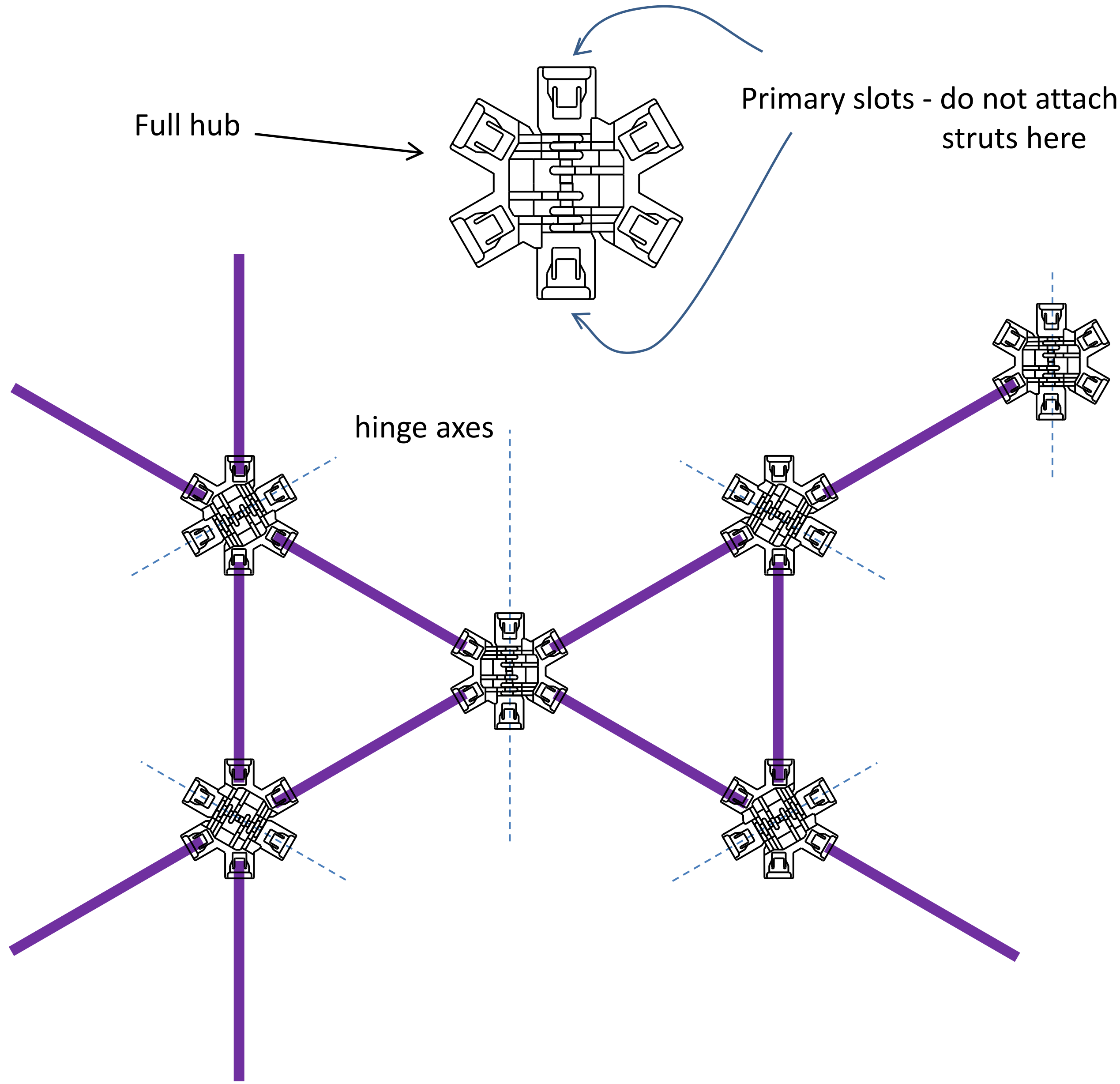
The Poly-Star

Building the inner octahedron

Start with
6 Full hubs
12 Struts

1) Build Flat

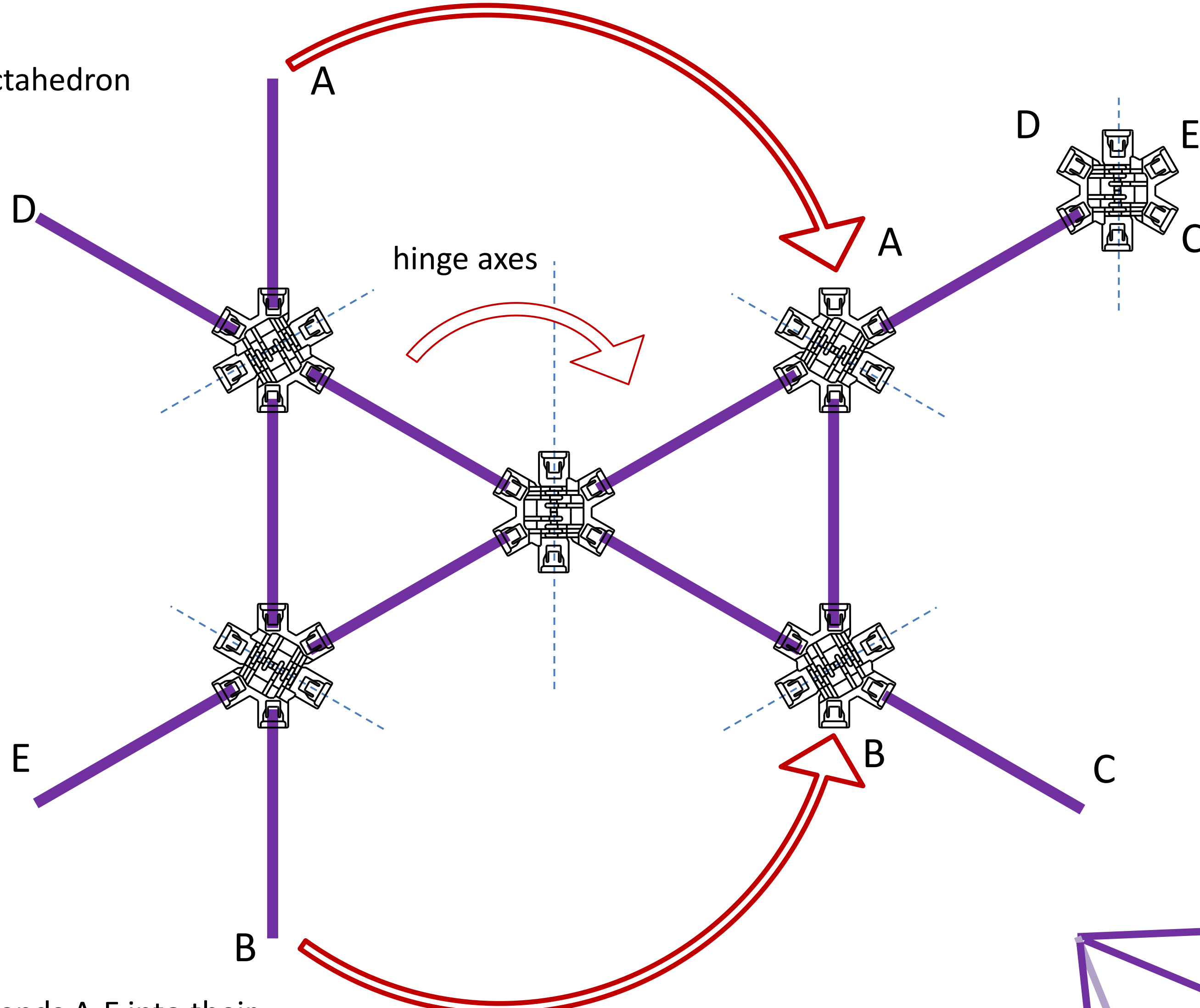




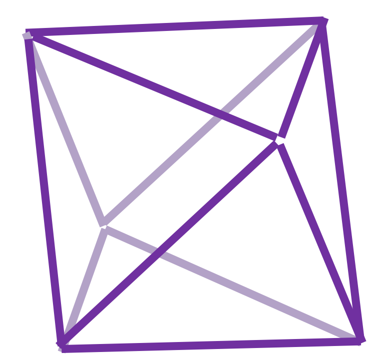
The Poly-Star

Building the inner octahedron

2) Fold Together

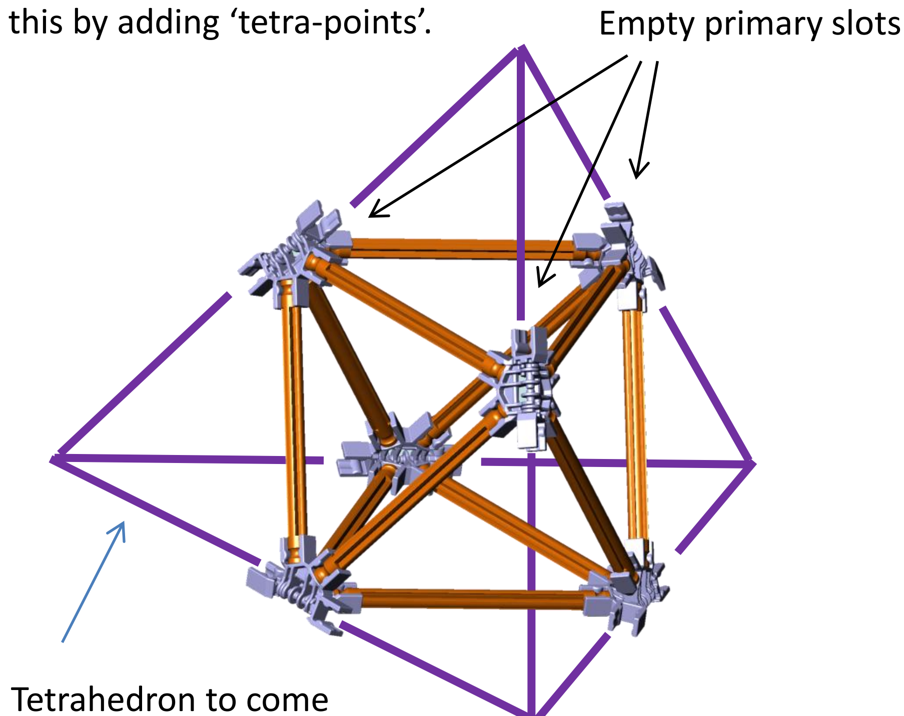


Connecting the strut ends A-E into their respective hub slots A-E as indicated. You will find that it is essentially 'automatic' when you are folding it together. A will really only want to snap into A, B into B…

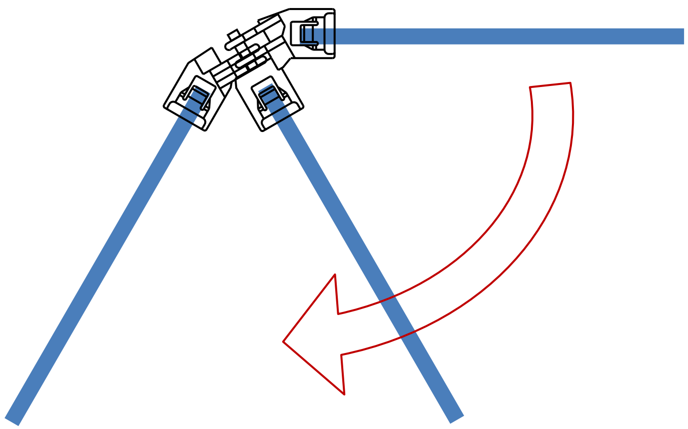


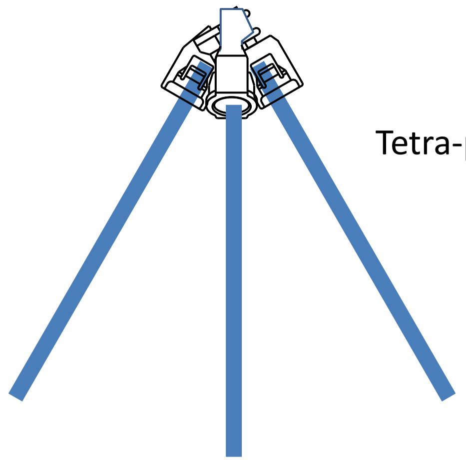
The Poly-Star

3) Complete the first tetrahedron.
Do this by adding ‘tetra-points’.



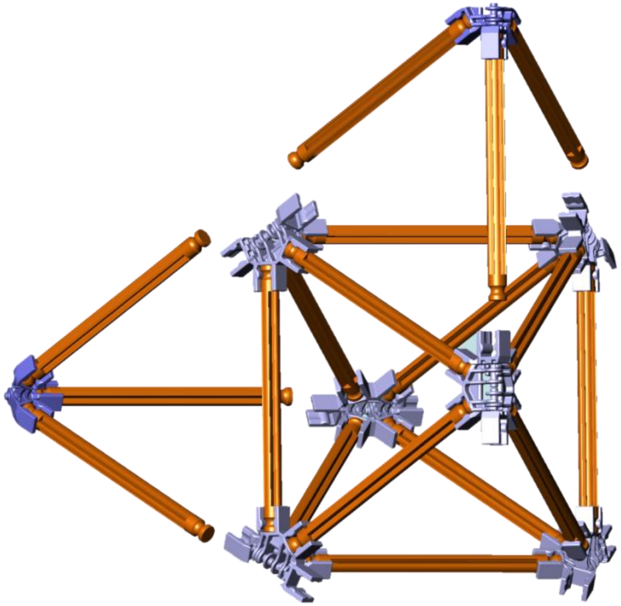
4 sets of Split Hubs

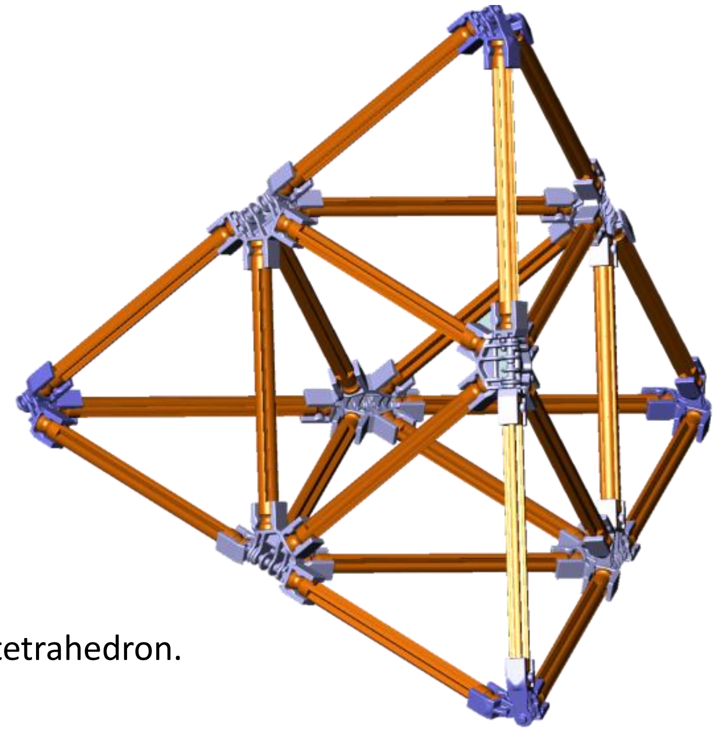




The Poly-Star

Snap the tetra-points to the octahedron.

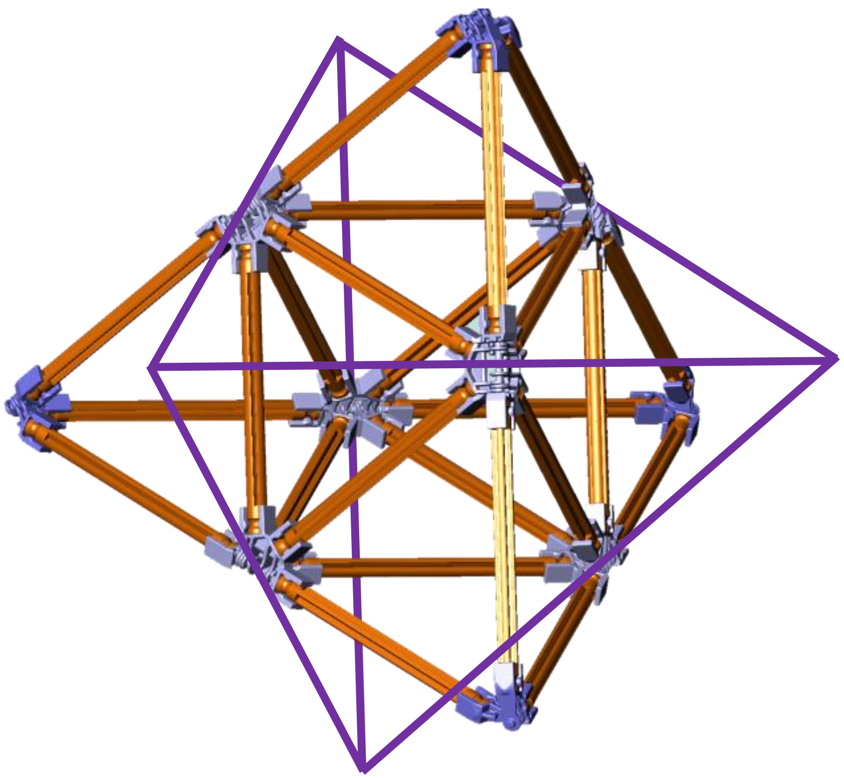




Completing the base tetrahedron.

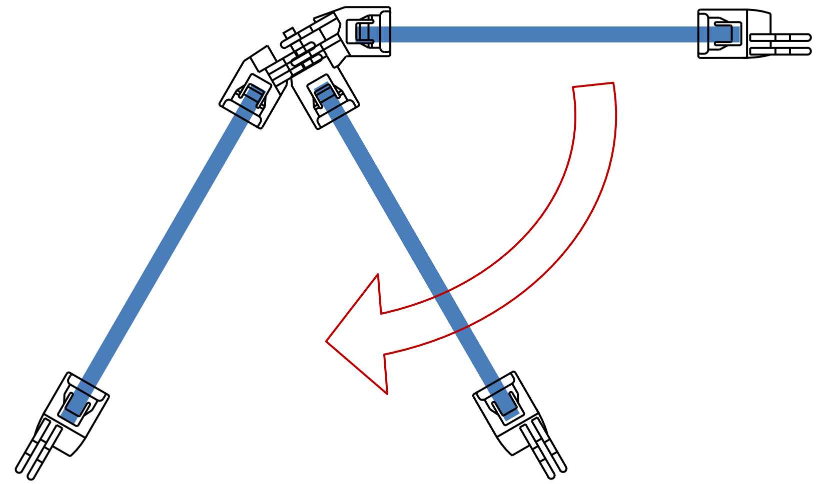
The Poly-Star

3) Build out the second tetrahedron by adding a second set of tetra-points



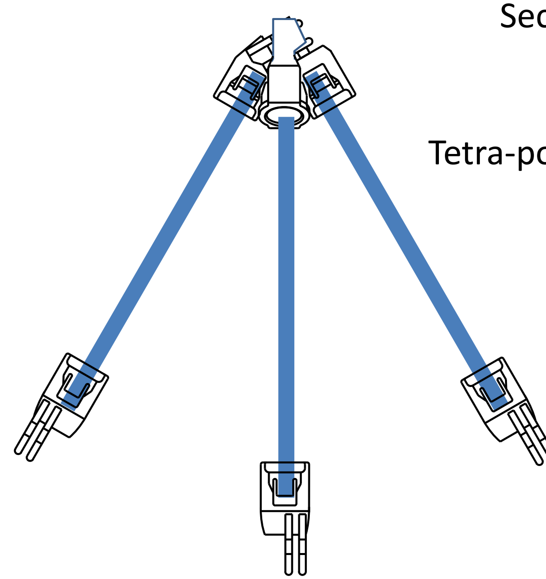
Empty primary slots

4 sets of Split Hubs



Secondary Slots

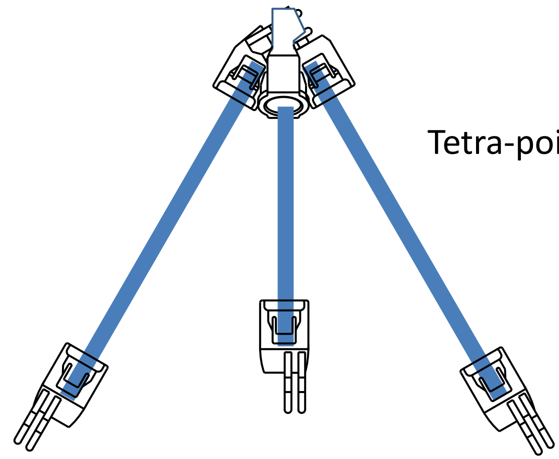
Tetra-point



The Poly-Star

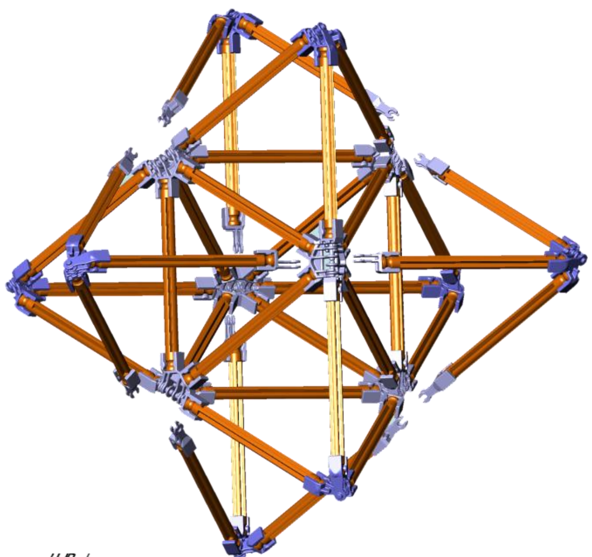
Adding the Final Points

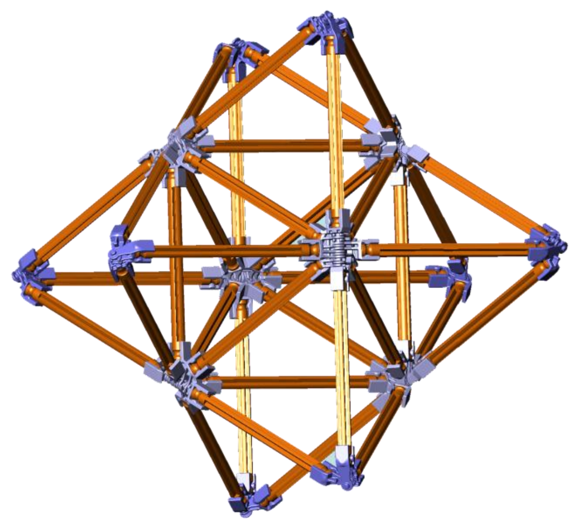
Assemble 4 sets of “tetra-points”, this time adding secondary slots to them.

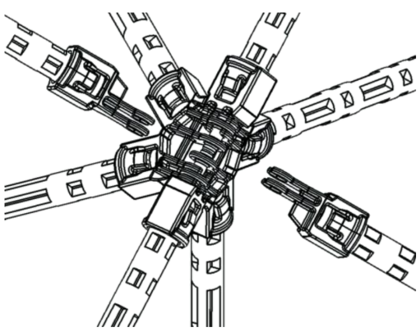


Tetra-point

Secondary Slots







The tetra-points are then snapped onto the full hubs, completing the star.

The Poly-Star

Alternate Construction

An Alternate way to build the is show in brief, below.

This is an approach that can be used on many PolyLinx structures, and that is to ‘build it flat”, then “fold it together”.

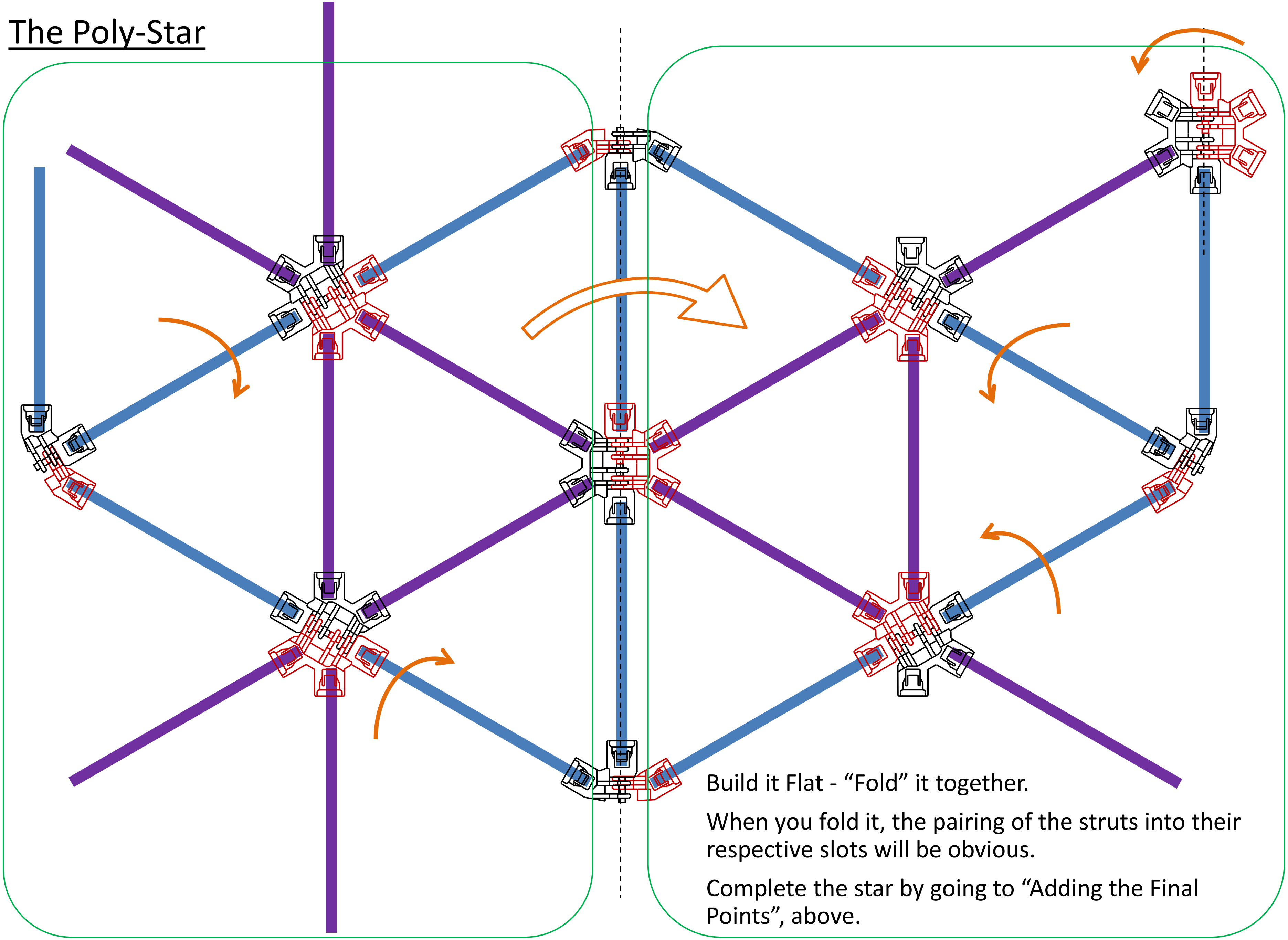
In this approach, orientation of the hubs is important, not just the axis. This will allow larger sides to ‘fold’ relative to the other.

For the Poly-Star, the base tetrahedron is built this way, then four tetra-points are added (not shown).

In the diagram below, it may be clear that the left half is free to rotate about the y-axis (indicated) independent of the right half.

Large multi-level structures can be built up in this manner and “folded together”.

The Poly-Star

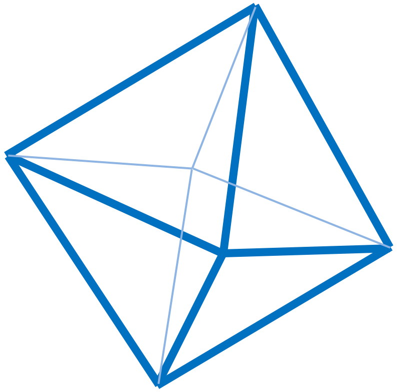


Build it Flat - “Fold” it together.

When you fold it, the pairing of the struts into their respective slots will be obvious.

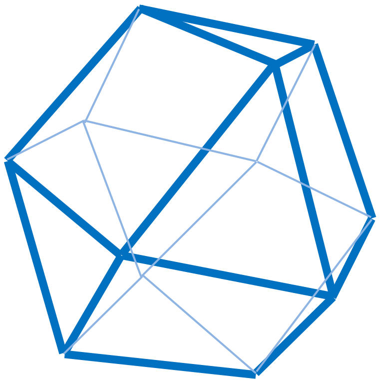
Complete the star by going to “Adding the Final Points”, above.

The Butterfly Structures



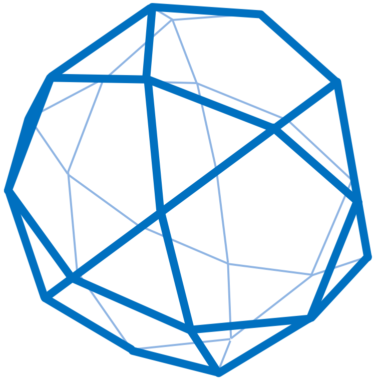
Octahedron

6 vertices = 6 hubs
12 struts



Cuboctahedron

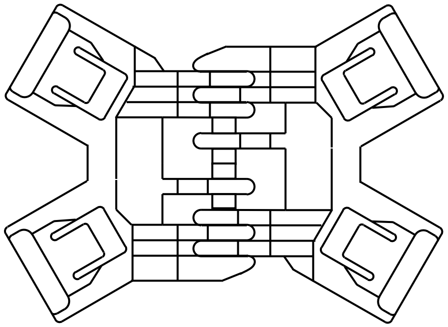
12 vertices = 12 hubs
24 struts



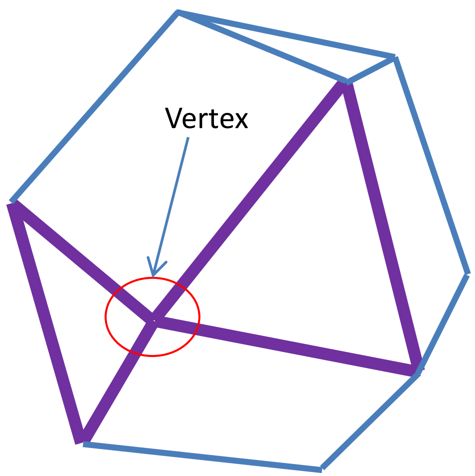
Icosidodecahedron

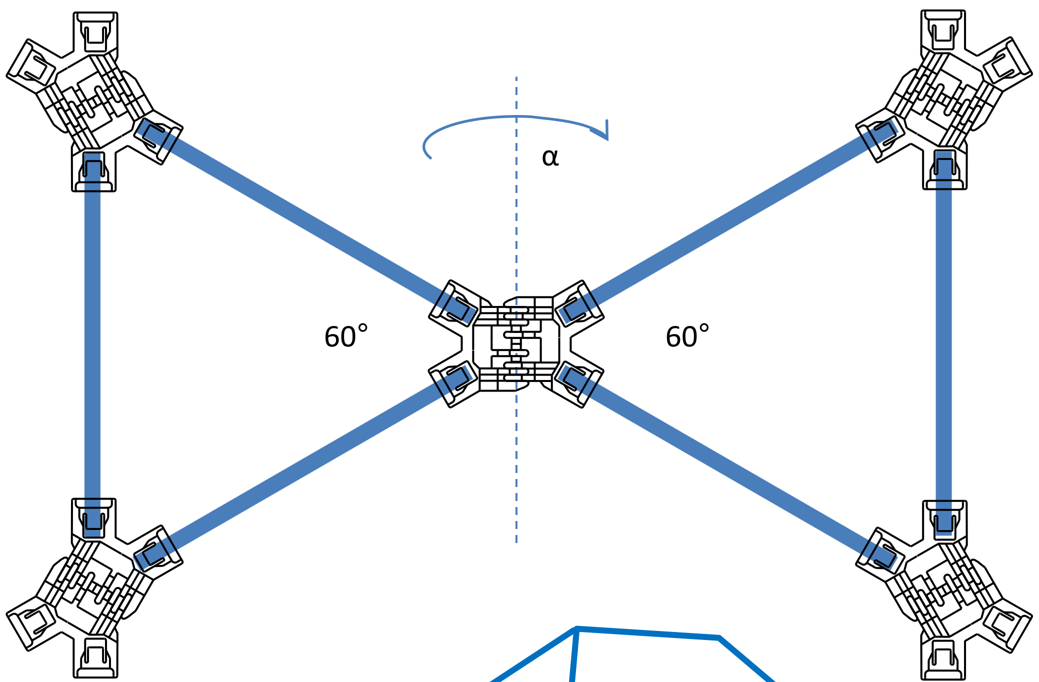
30 vertices = 30 hubs
60 struts

These polyhedra are constructed using only the Butterfly Hinge-Hub and Struts

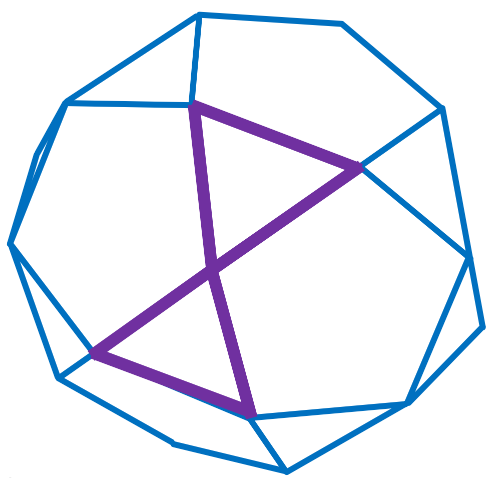


The Butterfly Structures





Every vertex (hub) can be viewed as two equilateral triangles meeting, and two regular polygons: a triangle, a square, or a pentagon. Each is derived by changing the angle, α, between the opposing triangles.



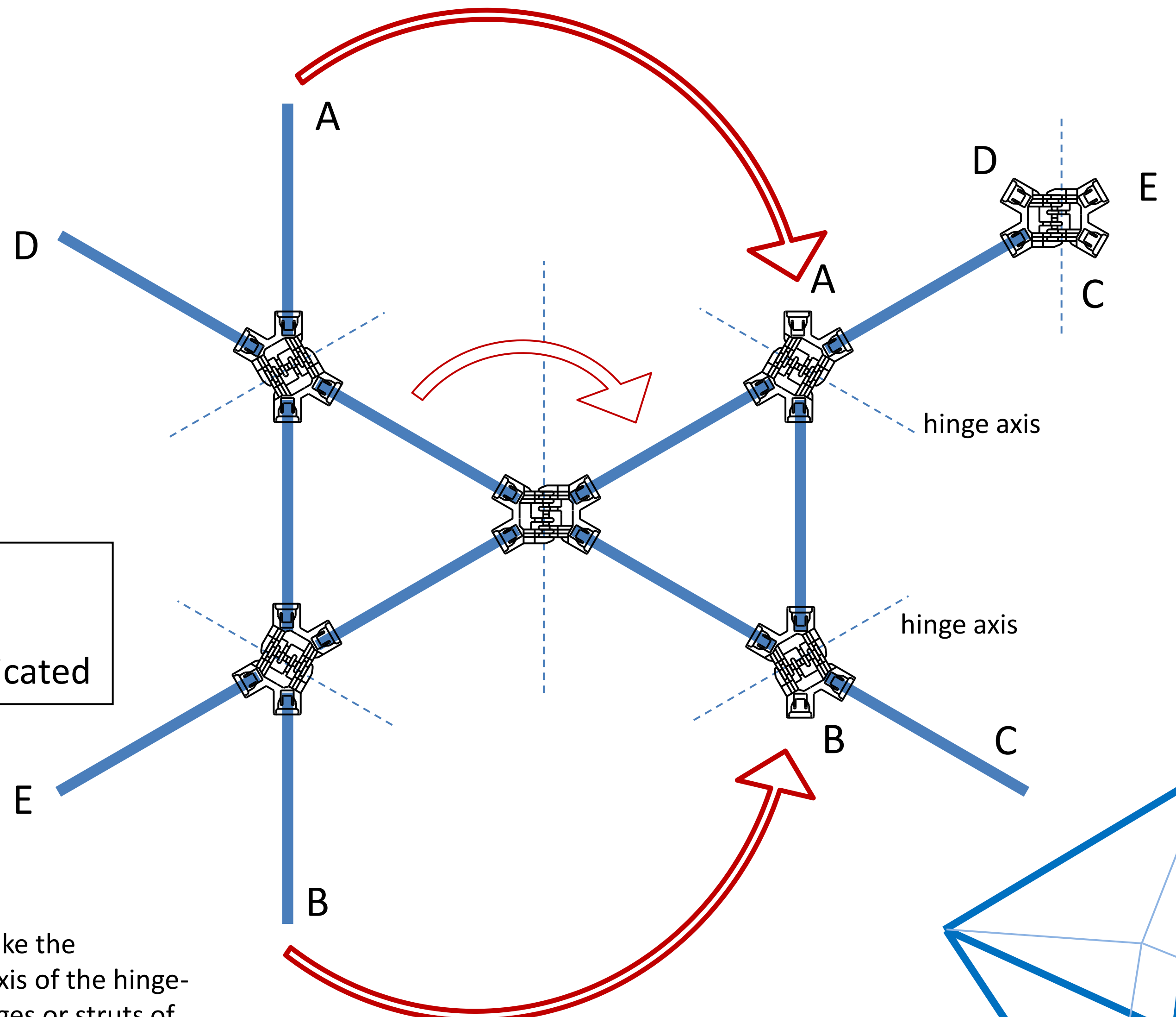
Polyhedra	adjacent polygon	*angle α
Octahedron	Triangle	$\cos^{-1}(1/3)=70.53°$
Cuboctahedron	Square	$180-\cos^{-1}(1/3)=109.47°$
Icosidodecahedron	Pentagon	$2\sin^{-1}((1+\sqrt{5})/2\sqrt{3})=138.19°$
		Whew!!!

***Not to worry, you don't need to know these angles.**
Simply fold the hinges until opposing pieces meet, and there you go!

The Butterfly Structures

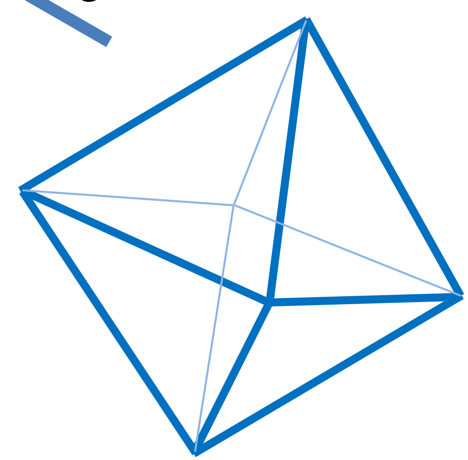
The Octahedron

6 vertices
12 struts



1) Build Flat
2) Fold Together!
- attach struts as indicated

You may notice that unlike the tetrahedra, where the axis of the hinge-hub aligned with the edges or struts of the triangles, here the hinge axes are not aligned with the edges.

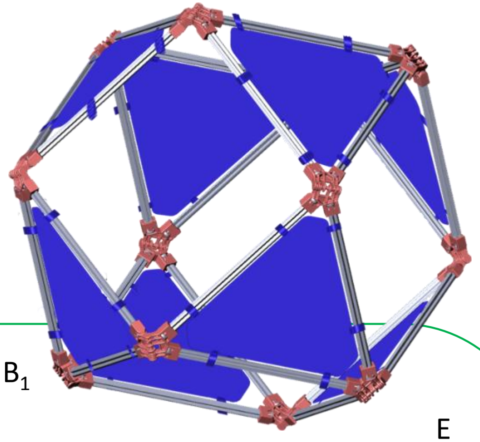


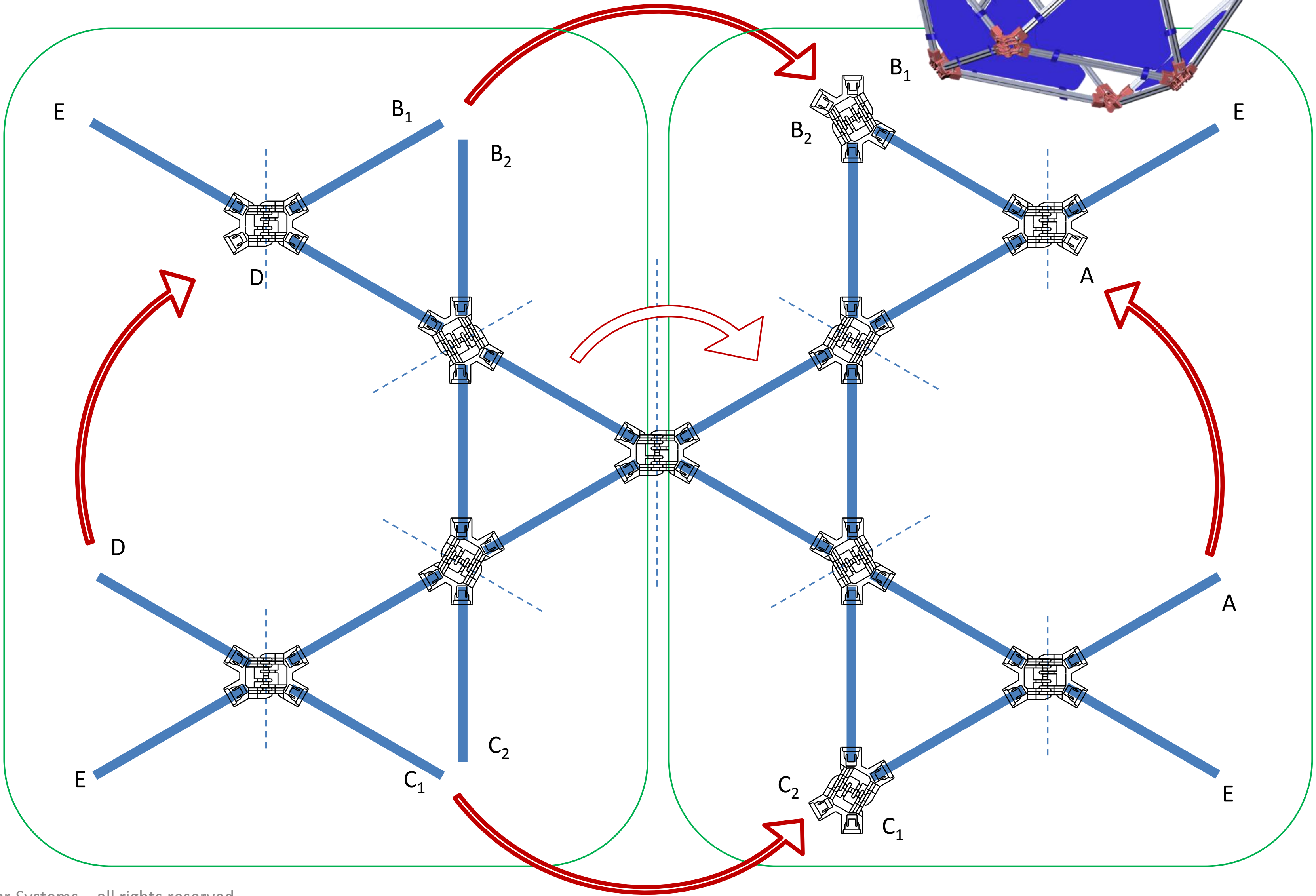
The Butterfly Structures

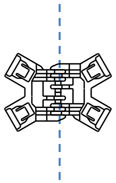
The Cuboctahedron

12 vertices
24 struts

Build Flat as indicated.
Fold together, attaching struts to hubs as shown, Strut A to Slot A, etc.
Hub E will collect-up remaining struts.



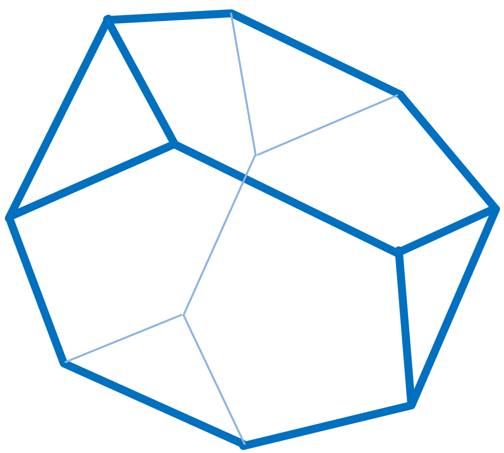




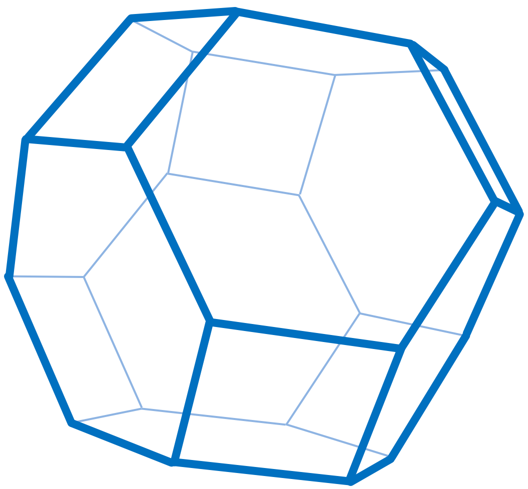
E Hub

A Few Hex Structures

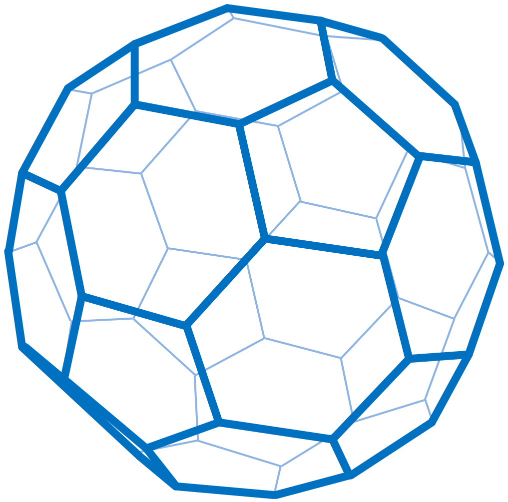
Truncated Tetrahedron



Truncated Octahedron



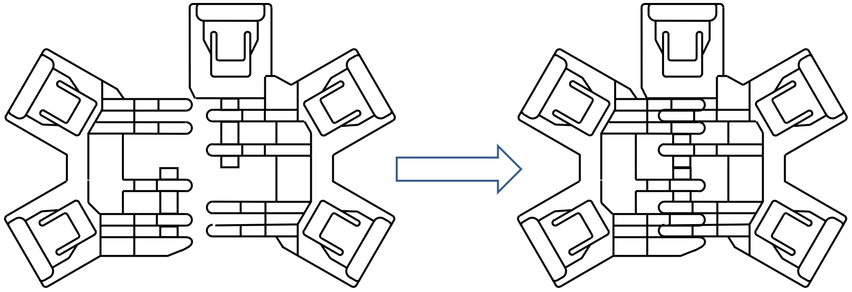
Truncated Icosahedron (Bucky Ball)



Note that all of these structures include a hexagon. They are built with the same PolyLinx elements used in the Nanotubes.

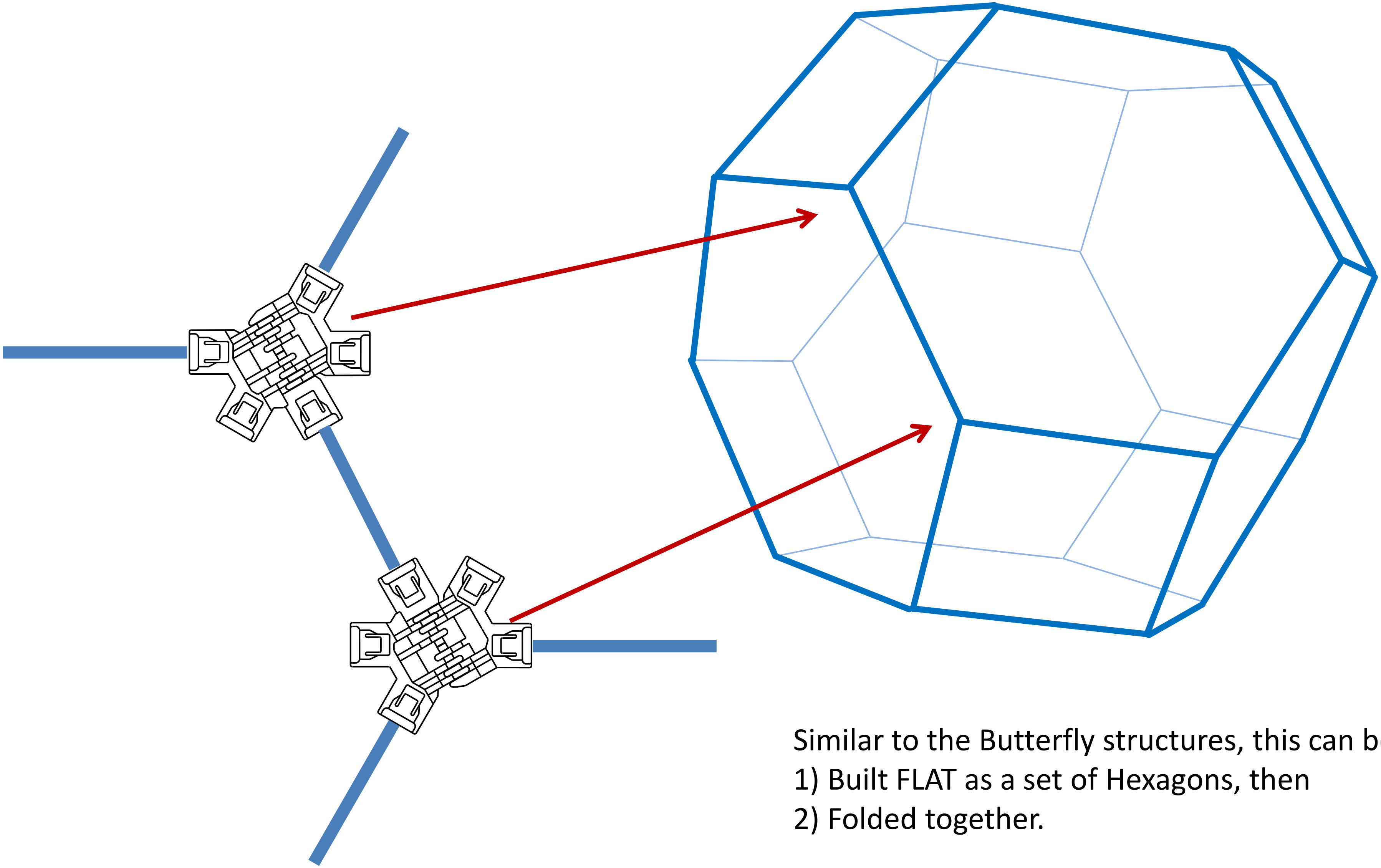
Each identical hub may be constructed of a half-hub and a half butterfly – the Beetle Hub

The difference in construction is how far the inner angle of the hub is opened.



The Beetle

Truncated Octahedron



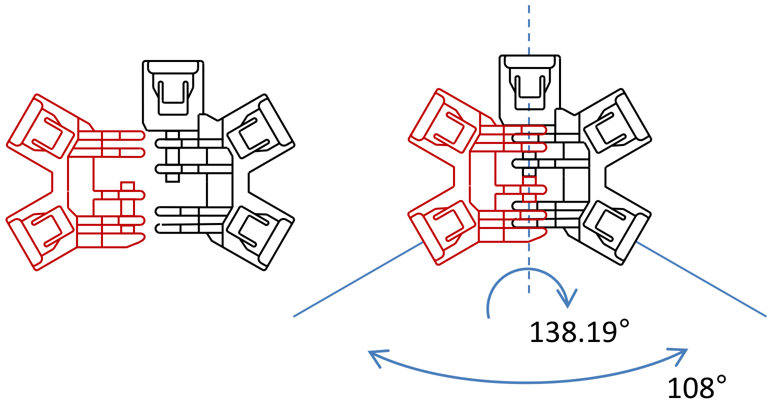
Similar to the Butterfly structures, this can be
1) Built FLAT as a set of Hexagons, then
2) Folded together.

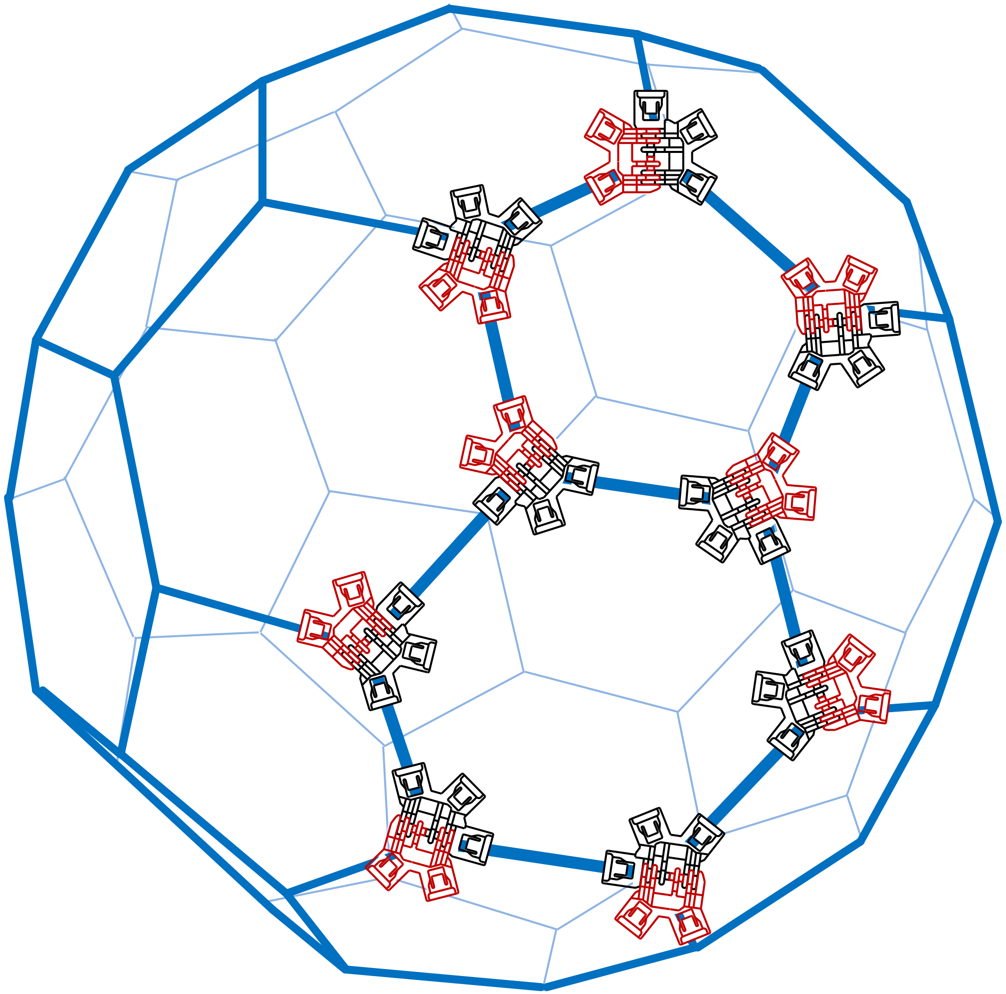
Truncated Icosahedron (Bucky Ball)

The truncated icosahedron models the soccer ball and the C_{60} carbon molecule.

It consists of 60 vertices (hubs) and 90 edges (struts). The surface is made up of regular hexagons and pentagons. The inner angles of the hexagons and pentagons are 120° and 108° respectively. The dihedral angle – that is, the angle between adjacent hexagons is 138.19°.

Each identical hub may be constructed of a half-hub and a butterfly



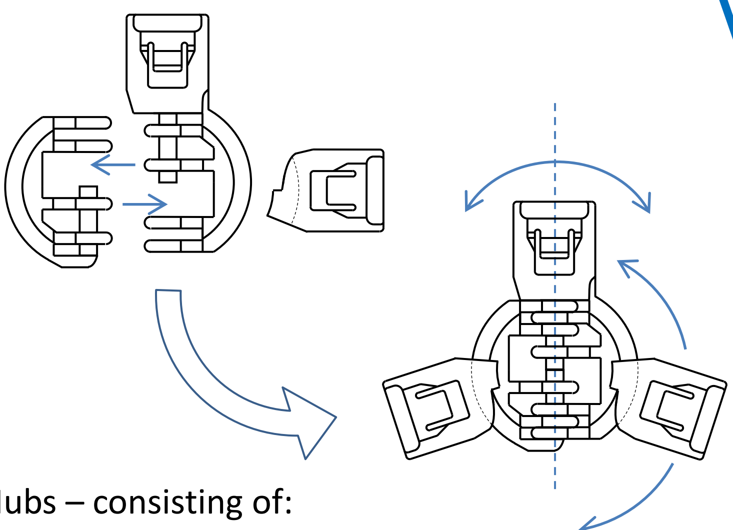


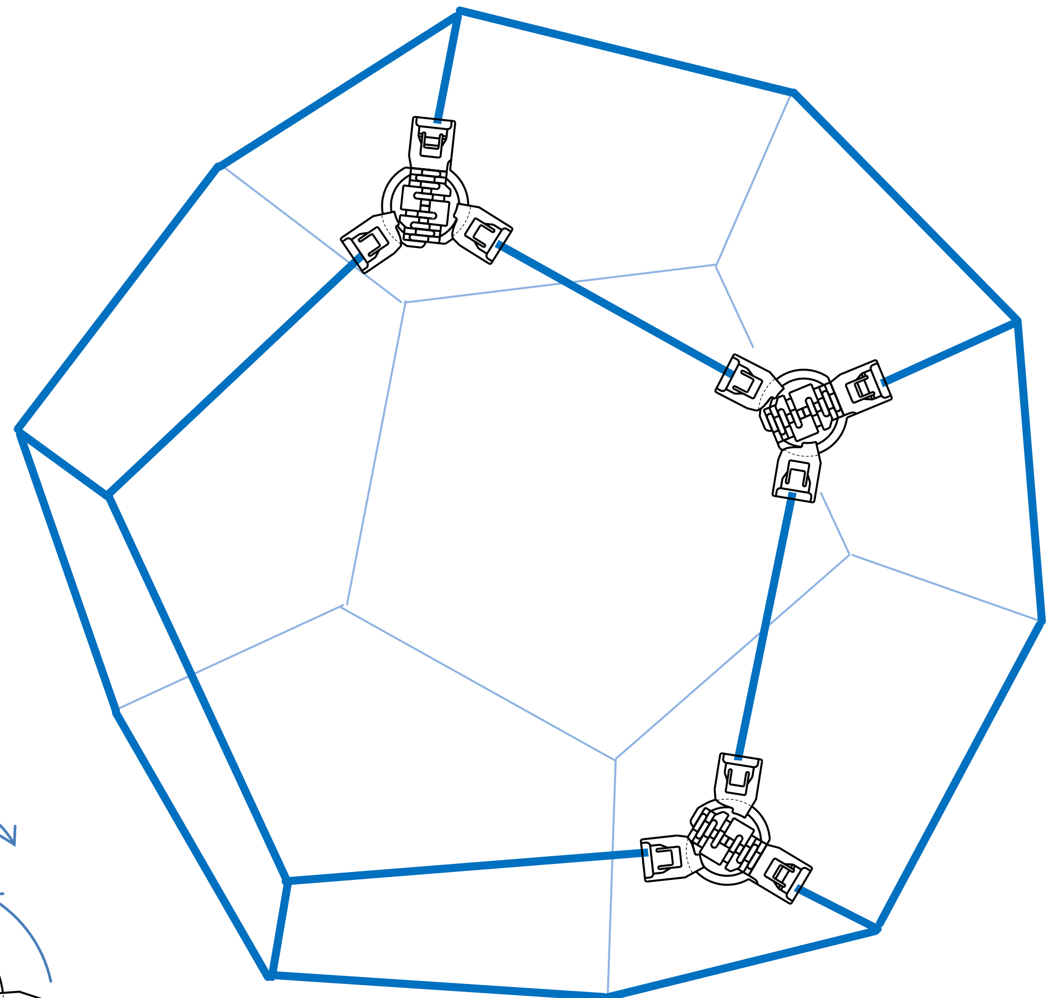
Fortunately, for the novice builder, no setting / adjustment of the angles is necessary… when you build it, it will "automatically" have the correct angles.

The Dodecahedron

The Dodecahedron is one of five Platonic Solids, where all the edges are the same length, all of the faces are identical polygons, in this case, pentagons, and where all of the angles of the polygons are the same (equiangular). The dodecahedron is made up of 12 pentagons, with a total of 20 vertices (hubs), and 30 edges (struts).

Construction is similar to the truncated icosahedron, but rather than fixed angle hubs, slider hubs are used.





20 Hubs – consisting of:

- Slider
- Slider with no primary slot
- 2 Slider slots

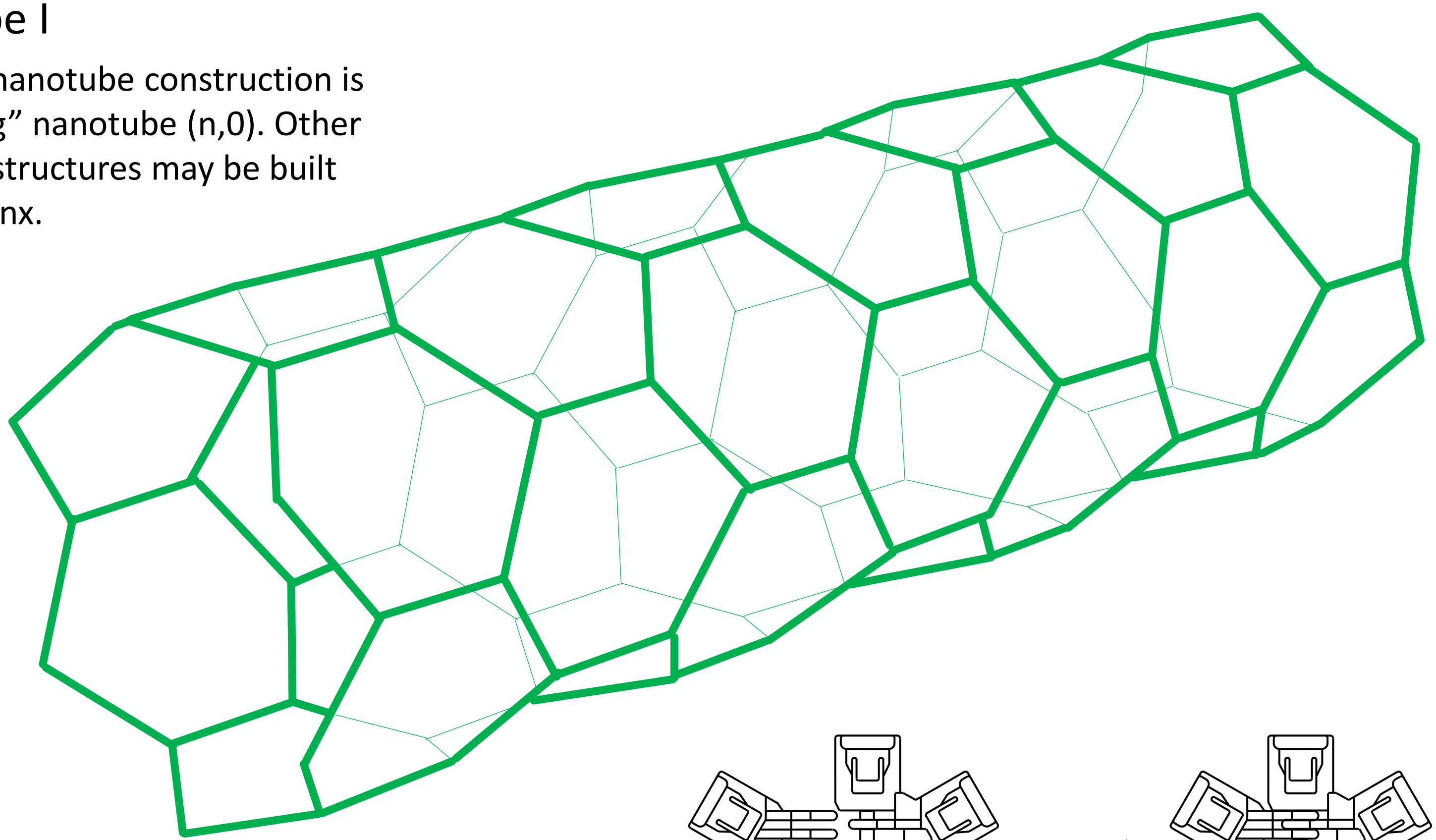
Tech Specs

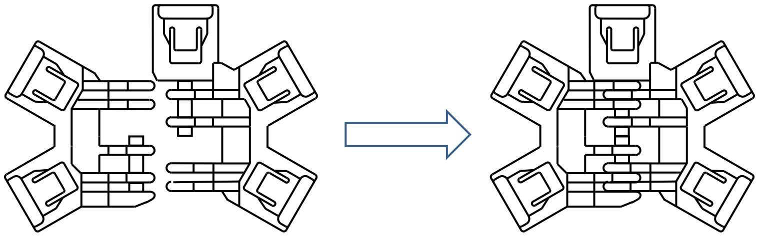
- Inner angle of the pentagons: 108 degrees
- Angle between faces (the dihedral angle, δ): 180-tan-1(2) or 116.56°
- When folded, the angle between the two sliders is geometrically “forced” to 108°

The PolyLinx Nanotube

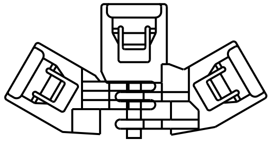
Nanotube I

This basic nanotube construction is of a “zigzag” nanotube (n,0). Other nanotube structures may be built with PolyLinx.





Beetle Hub



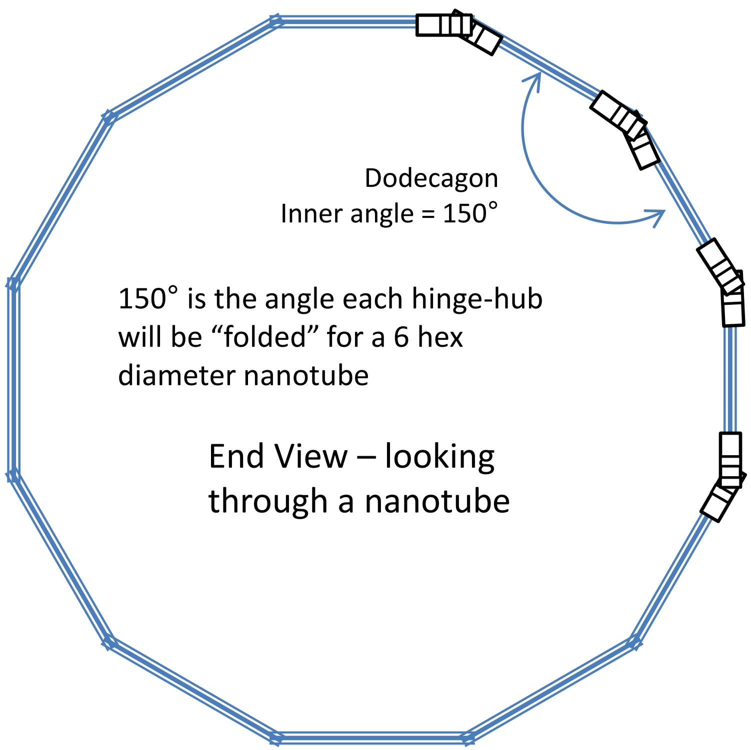
Split Hub

This uses the Beetle Hub configuration as shown at right, consisting of a Half Hub and a Half Butterfly. The ends of the nanotube use a split hub pairs

The PolyLinx Nanotube

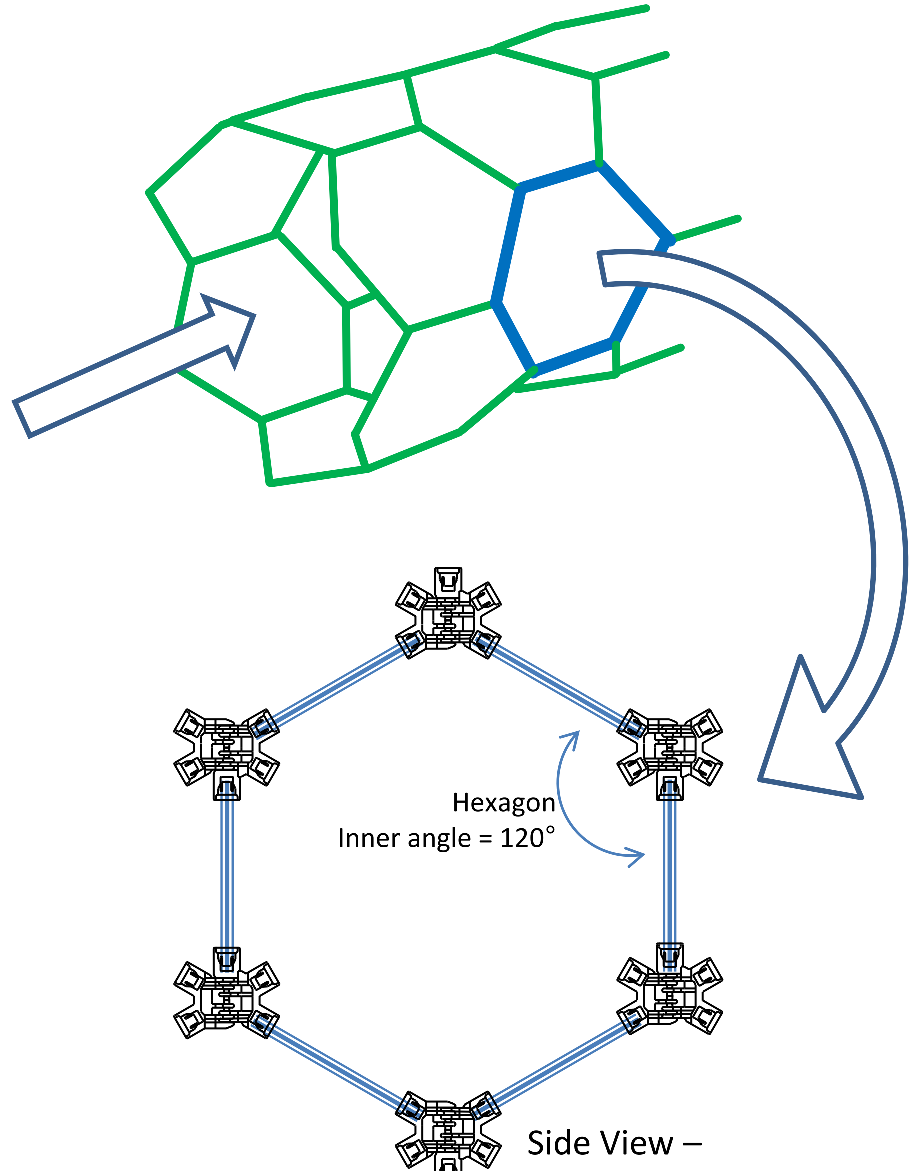
Use 1-5/16” struts for this design

This basic nanotube construction is of a “zigzag” nanotube (n,0). Other nanotube structures may be built with PolyLinx.



150° is the angle each hinge-hub will be “folded” for a 6 hex diameter nanotube

End View – looking through a nanotube



Side View –
A single nanotube “cell”

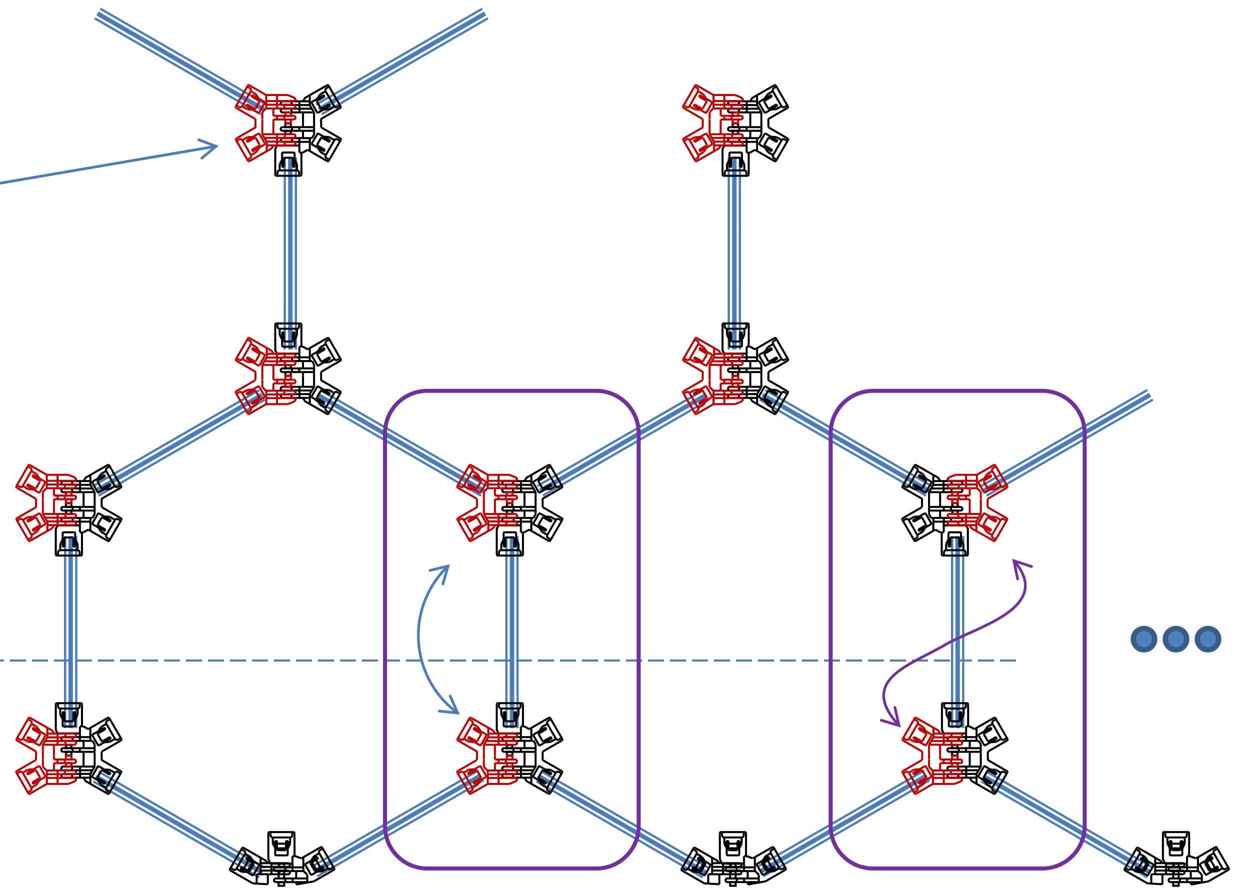
The PolyLinx Nanotube

Short struts are used in this design

Start by making a flat hex lattice

Hubs:
- Half-hub + Butterfly

Make sure the primary axes of all of the hub elements align vertically – this will be the direction of the tube



End of Tube

Full upper split hub (2 pieces) x 6 for hinges at end of tube
2x to include other end of tube

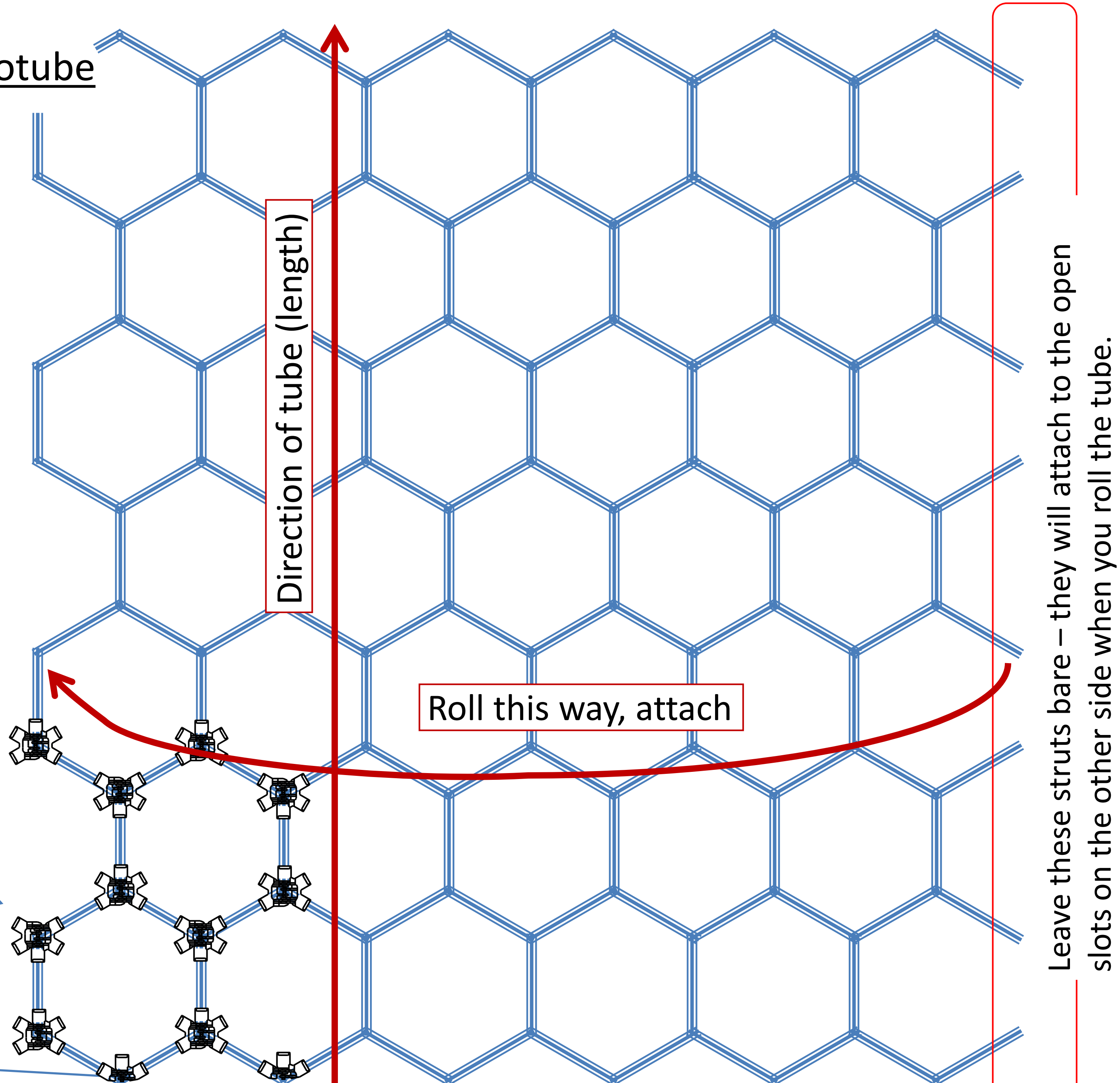
Butterfly hinge elements are on same side of strut – this makes it easier to "roll" the tube

Butterfly hinge elements are on opposite sides – this makes it a little harder to "roll" the tube (the rolling relies on the struts rotating in the slots) but makes for a more rigid structure.

The PolyLinx Nanotube

6 hex circumference
by 7 hex long

6.5”diam x 22”long



Each hub is made of 1 Half plus 1 Butterfly hub element

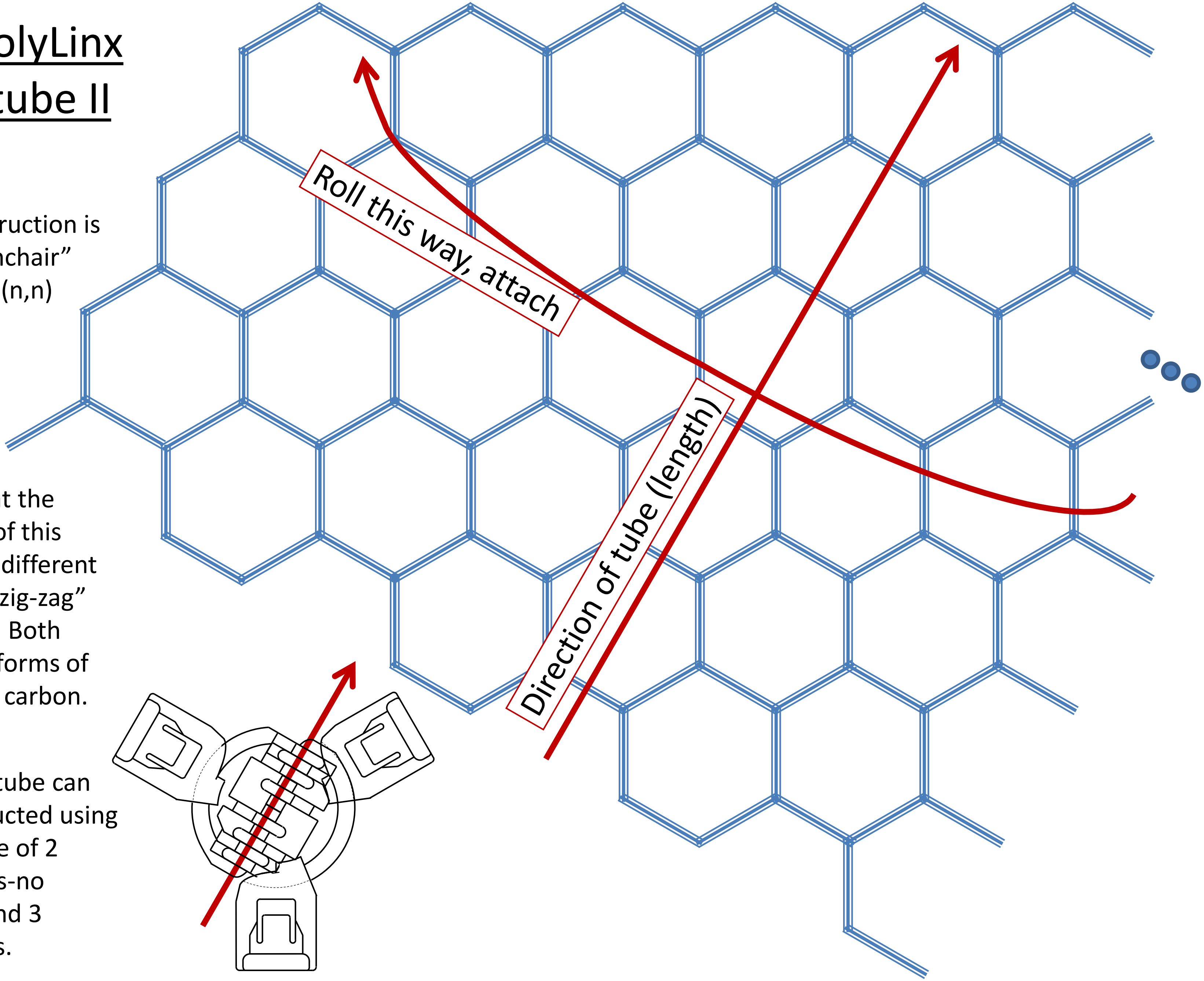
Spilt Hub Pair (2 pieces ea) x 6
2x to include upper end of tube

The PolyLinx Nanotube II

This construction is of an “armchair” nanotube (n,n)

Notice that the direction of this nanotube different than the “zig-zag” nanotube. Both types are forms of molecular carbon.

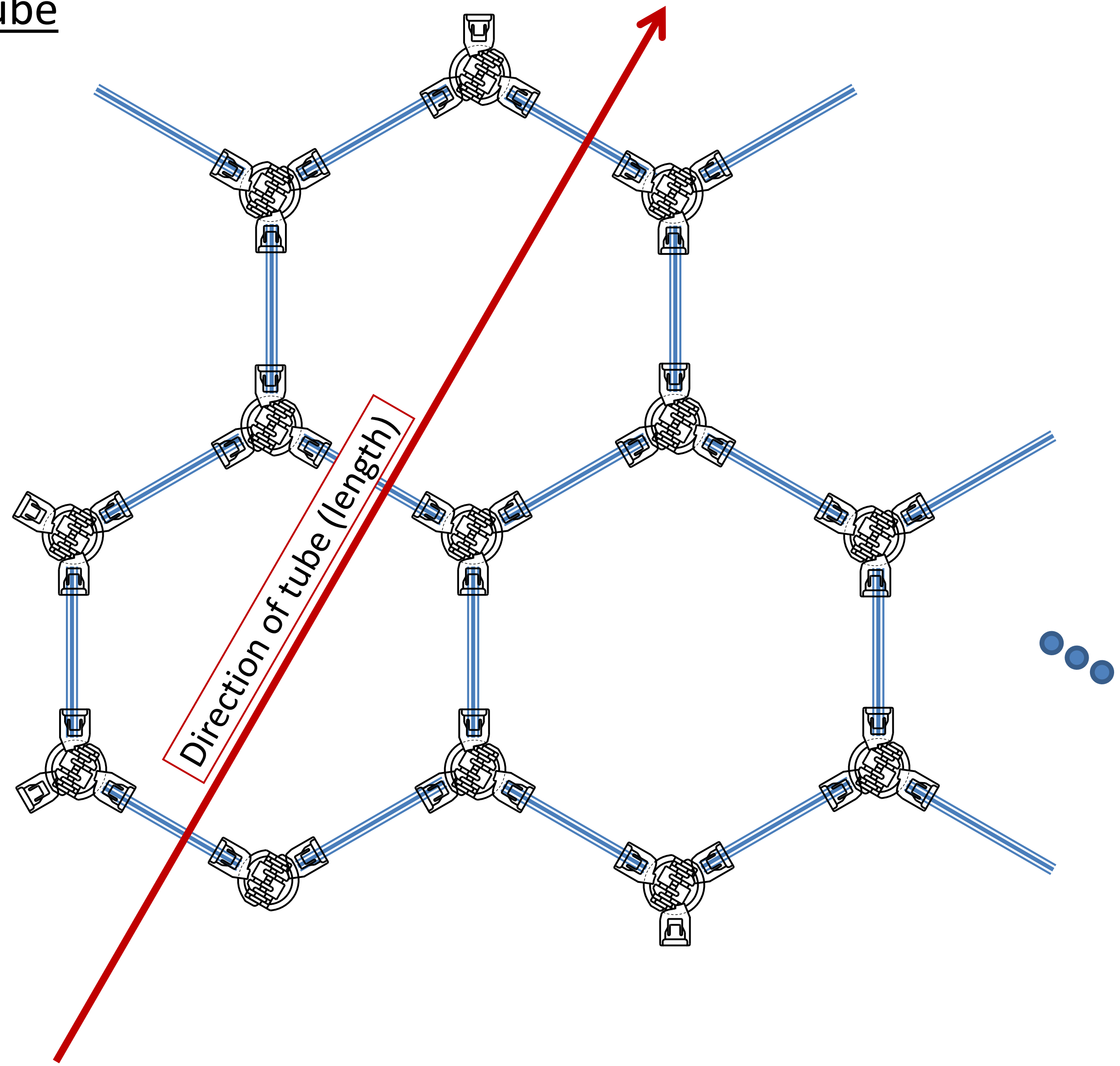
This nanotube can be constructed using hubs made of 2 slider hubs-no primary and 3 slider slots.



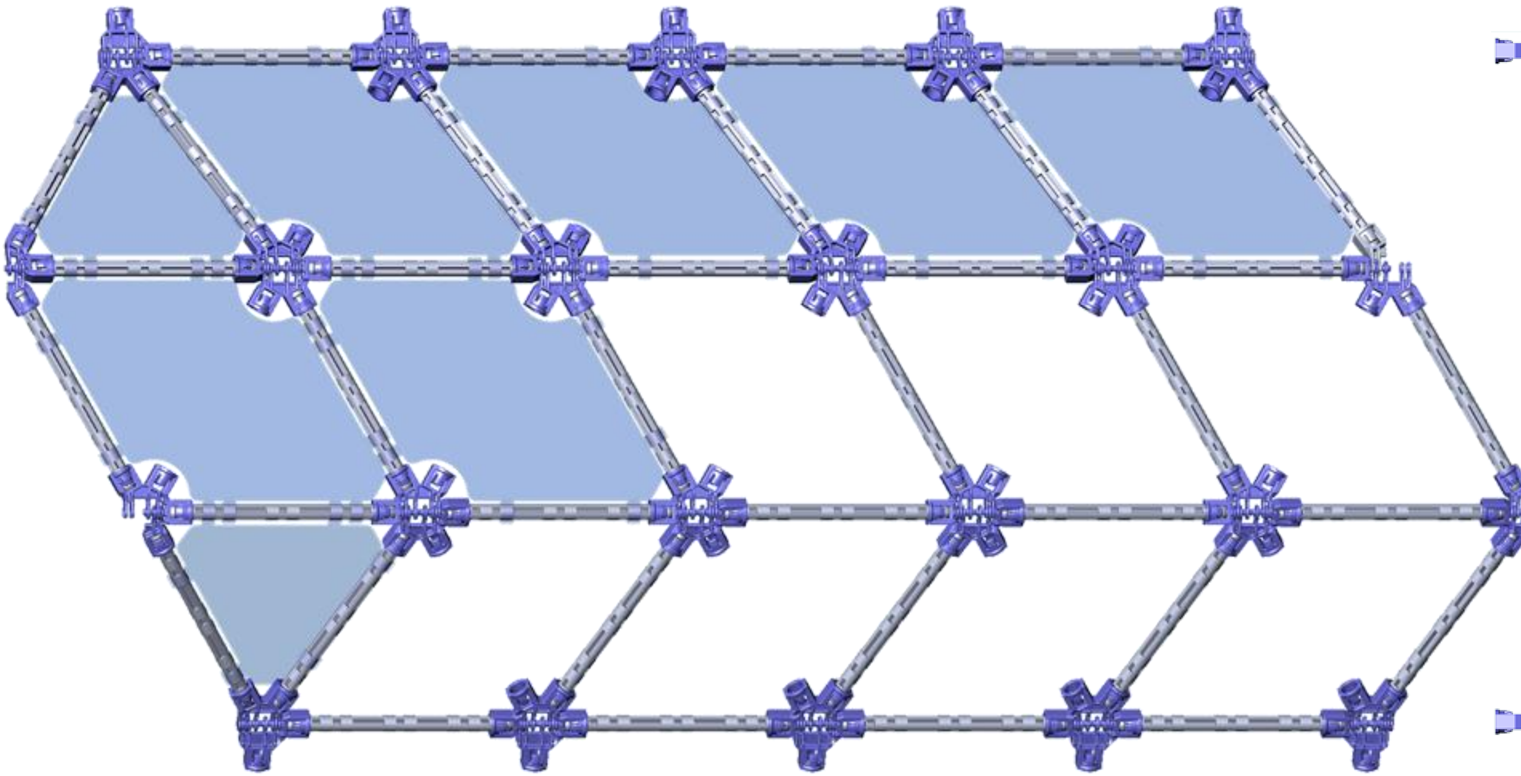
The PolyLinx Nanotube

Nanotube II

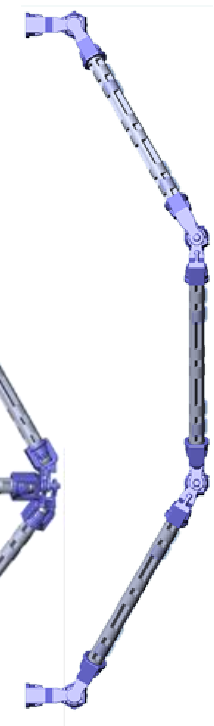
Short struts are used in this design



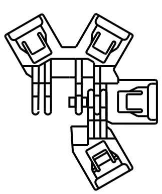
Space Cruiser



Side View

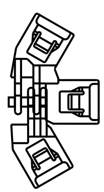


End View



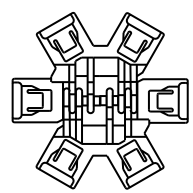
Full+LS
(2x)

LS=Lower Split

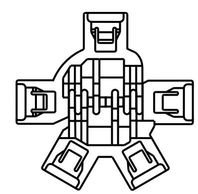


Full Split
(2x)

Upper/Lower Split

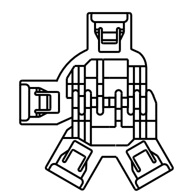


Full
(8x)



BF+90
(4x)

BF=Butterfly

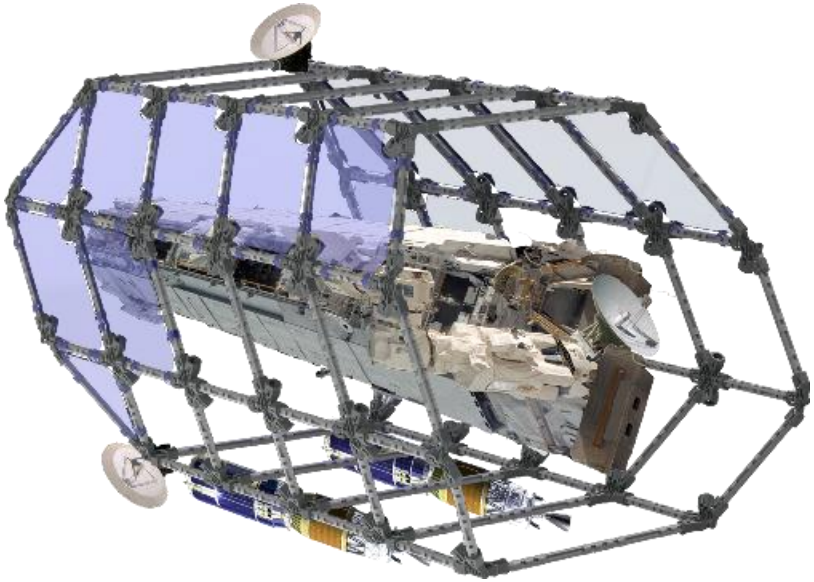


Full+90
(6x)

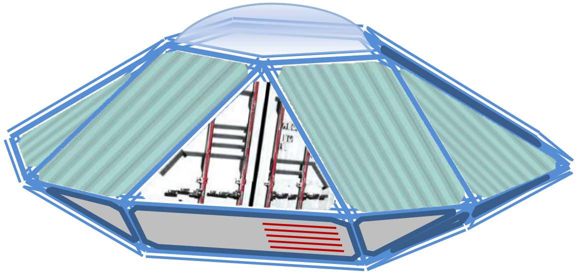
Side panel struts: 3.4”
Cross struts: 5.125”

Space Cruiser

The Space Cruiser model is strictly representative of possible models / kits that could be developed based on PolyLinx. It is assumed that additional design work, such as for rocket booster design, etc. would be required for completion. One alternative is that components ancillary to PolyLinx could be form and fit with Lego type building blocks.



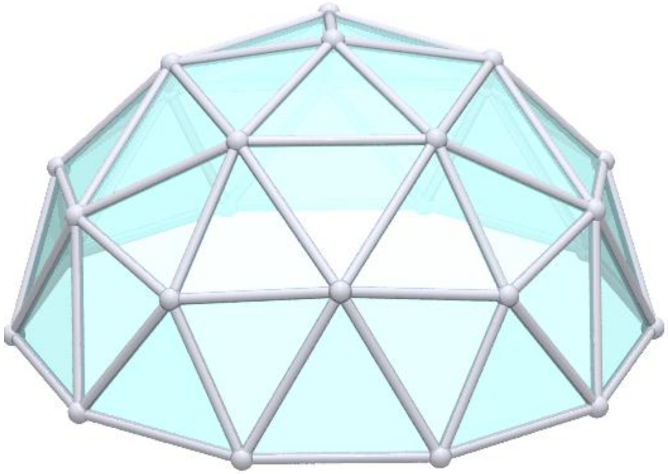
Another model in a similar vein is the flying saucer.



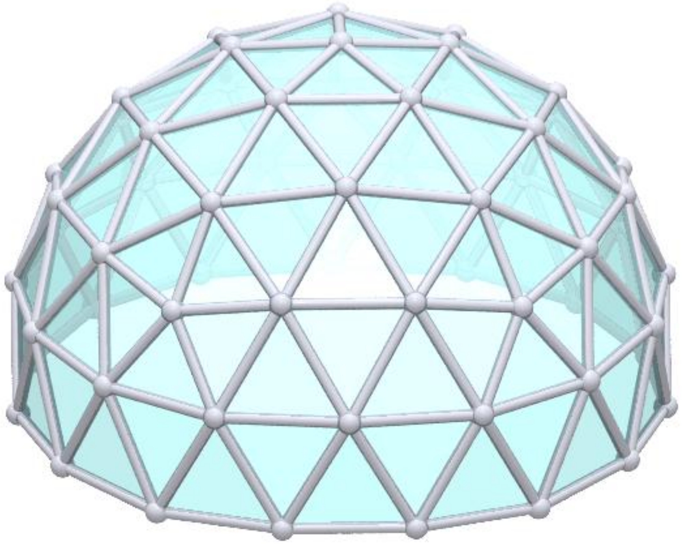
Geodesic Domes

Advanced

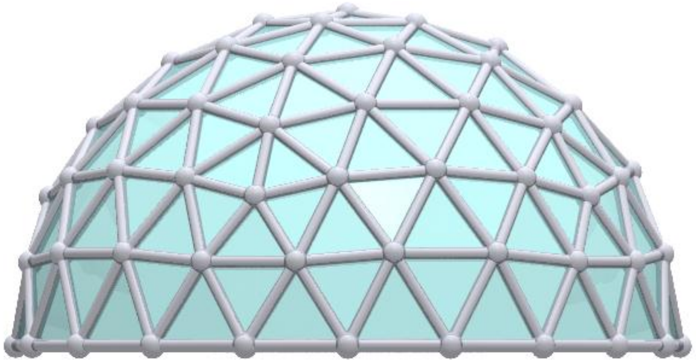
2v   1/2 Geodesic Dome



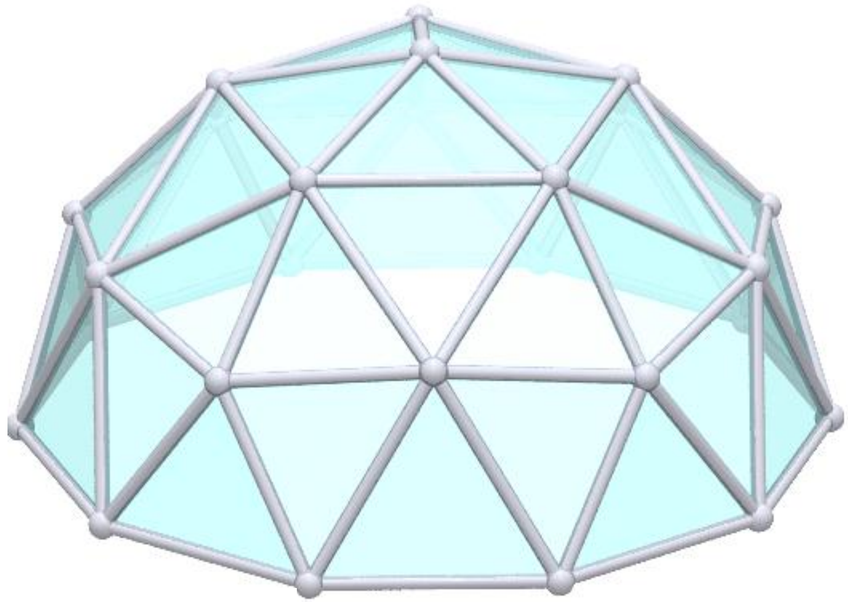
3v   5/9 Geodesic Dome

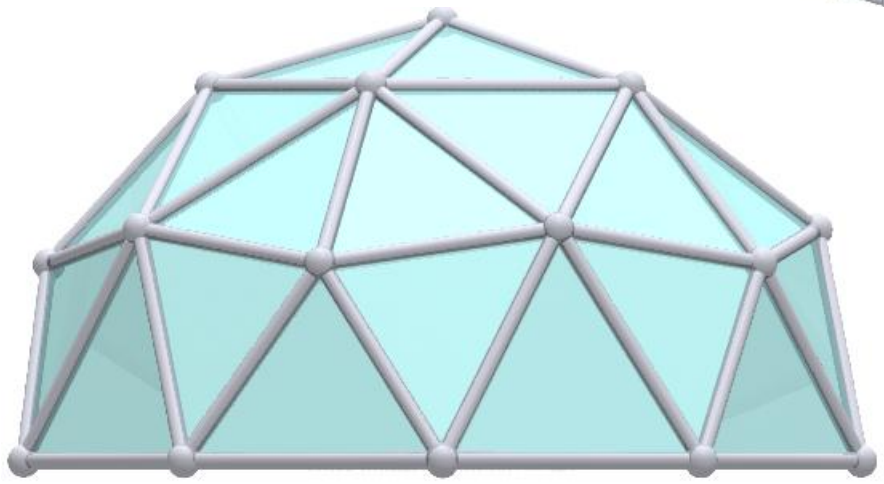


4v   6/12 Geodesic Dome



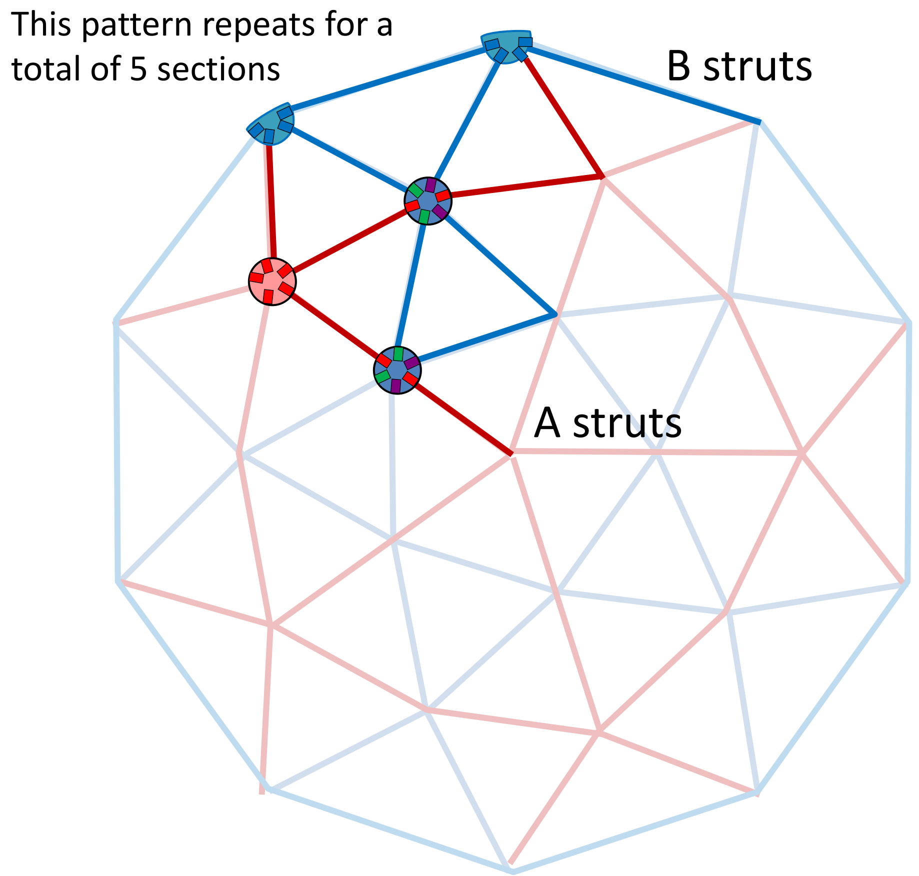
2v 1/2 Geodesic Dome





2v 1/2 Geodesic Dome

Parts	qty req'd
A struts	30
B struts	35
Penta hinge	6
6-way full flex hinge	10
4-way (dome edge) hinge	10



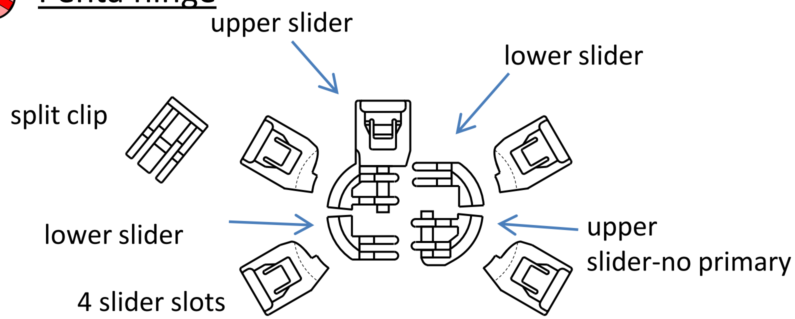
Hub element totals

36	upper slider elements
10	upper split elements
6	upper-no primary slider
32	lower slider elements
82	slider slots
6	split clips
20	hinge clip sets (40 elements)
65	struts (2 custom lengths)
257	Total parts
277	parts counting 2 per hinge clip

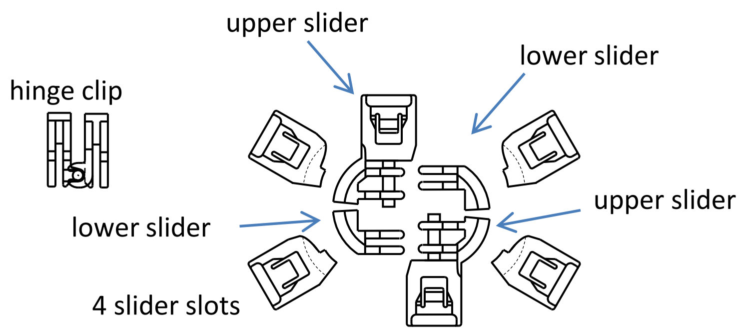
2v 1/2 Geodesic Dome

Again, there is no need to manually set the angles between the struts. All of the angles of the Geodesic dome are determined by the geometries of the dome and the given fixed strut lengths. Simply “build it”; the various angles will define themselves!

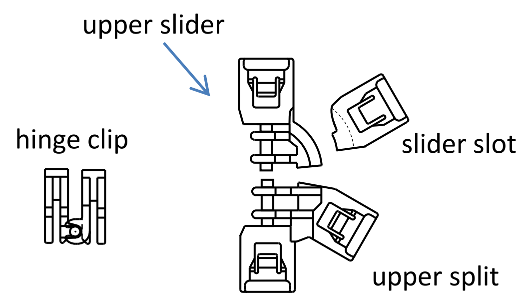
Penta hinge



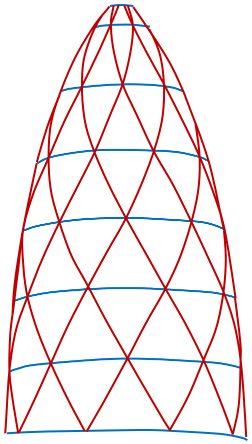
6-way full flex hinge

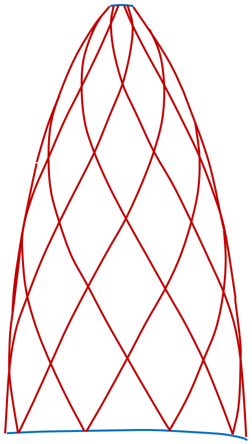


4-way (dome edge) hinge

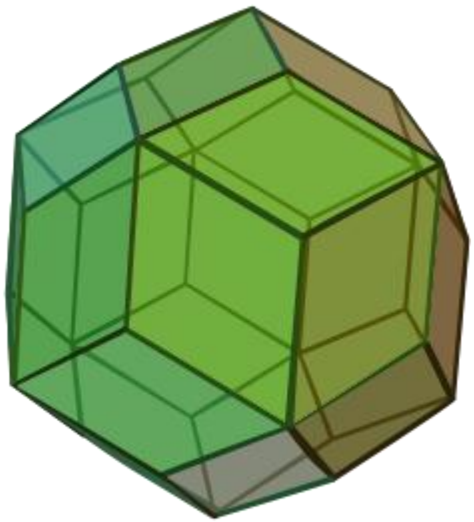


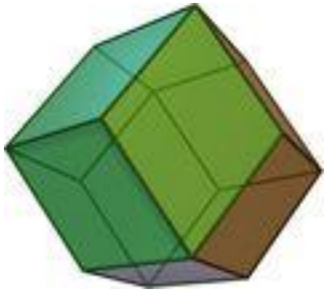
The Gherkin
Saint Mary Axe, London

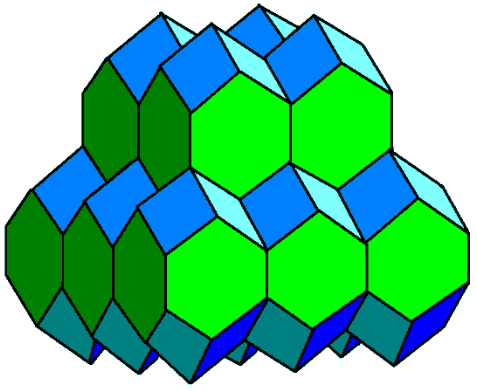




Build with butterfly sliders: Each hub includes 2 slider on hub w/ no primary, 4 slider slots







This 3D molecular lattice is a very straight forward design, requiring only full slider hubs, secondary hubs and struts.