EXPERIENCE WORKSHOP

THE EXPERIENCE-CENTERED MATH/ART MOVEMENT

www.experienceworkshop.org

KIKS

Kids Inspiring Kids for STEAM

Experience Workshop's STEAM material

LET'S BUILD A GIANT DOME!

Dr. Kristóf Fenyvesi
University of Jyväskylä

Co-funded by the
Erasmus+ Programme
of the European Union

Geodesic
Dome
EXPERIENCE WORKSHOP
MATH/ART MOVEMENT
4DFRAME
www.4dframe.com

World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html

Photo: Joep Rutgers

World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html

Photo: Joep Rutgers

World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html

Photo: Bart van Overbeeke

Photo: Bart van Overbeeke

Photo: Bart van Overbeeke

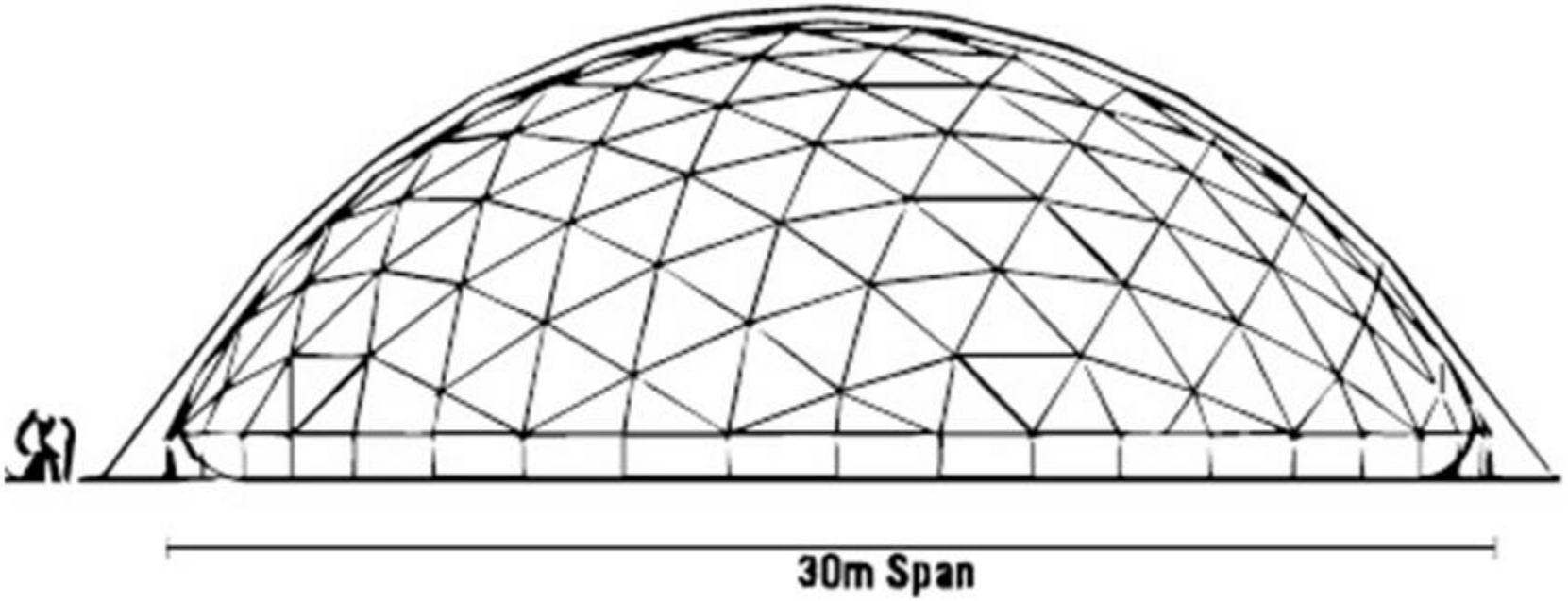
World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html

Photo: Joep Rutgers

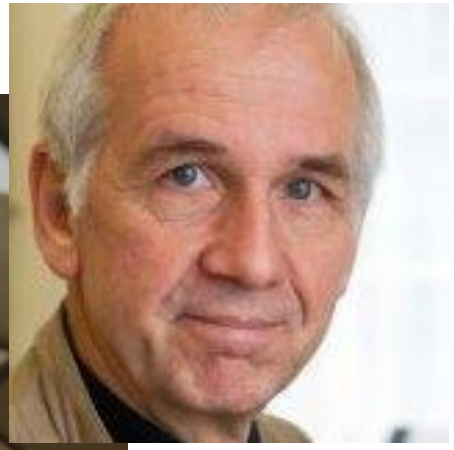
World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html

Photo: Bart van Overbeeke

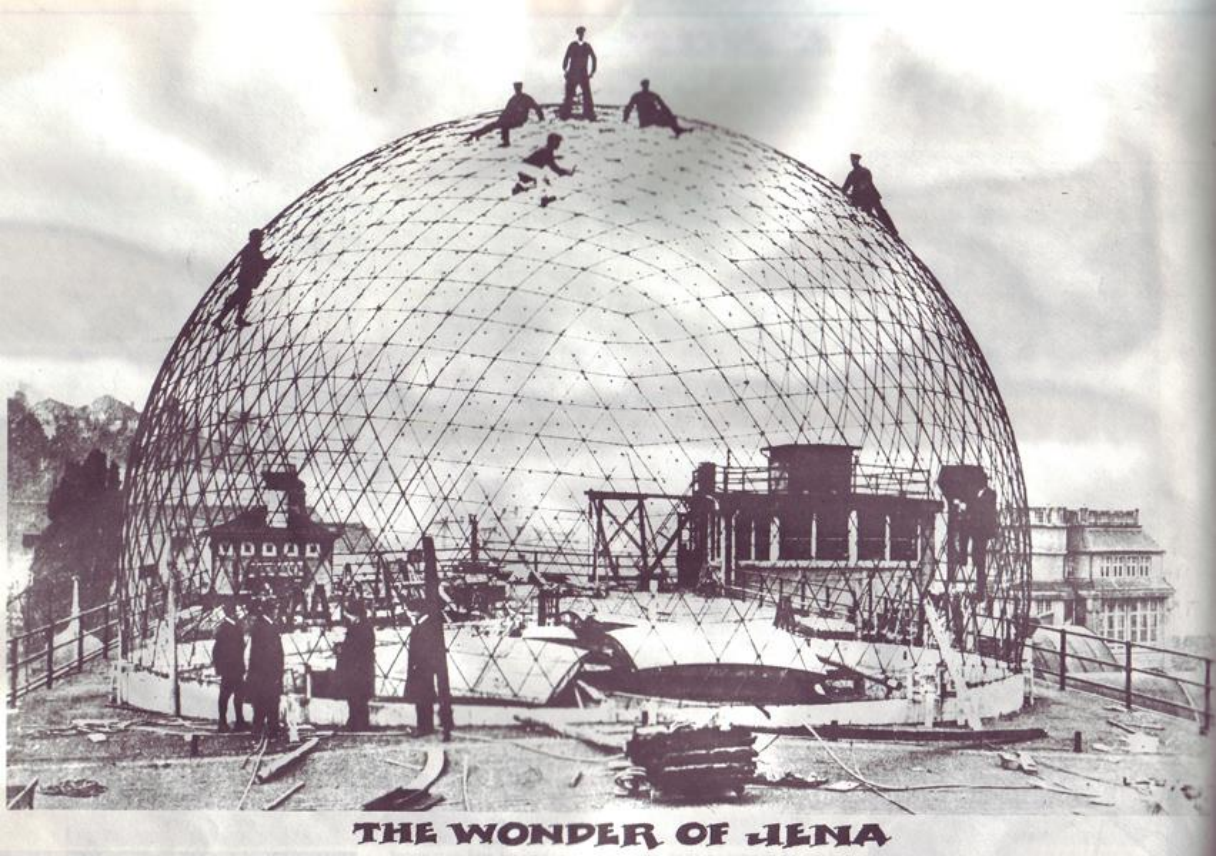
World's largest ice dome, built in Finland in 2014.
More information: http://www.structuralice.com/pykrete-dome.html



Other examples…

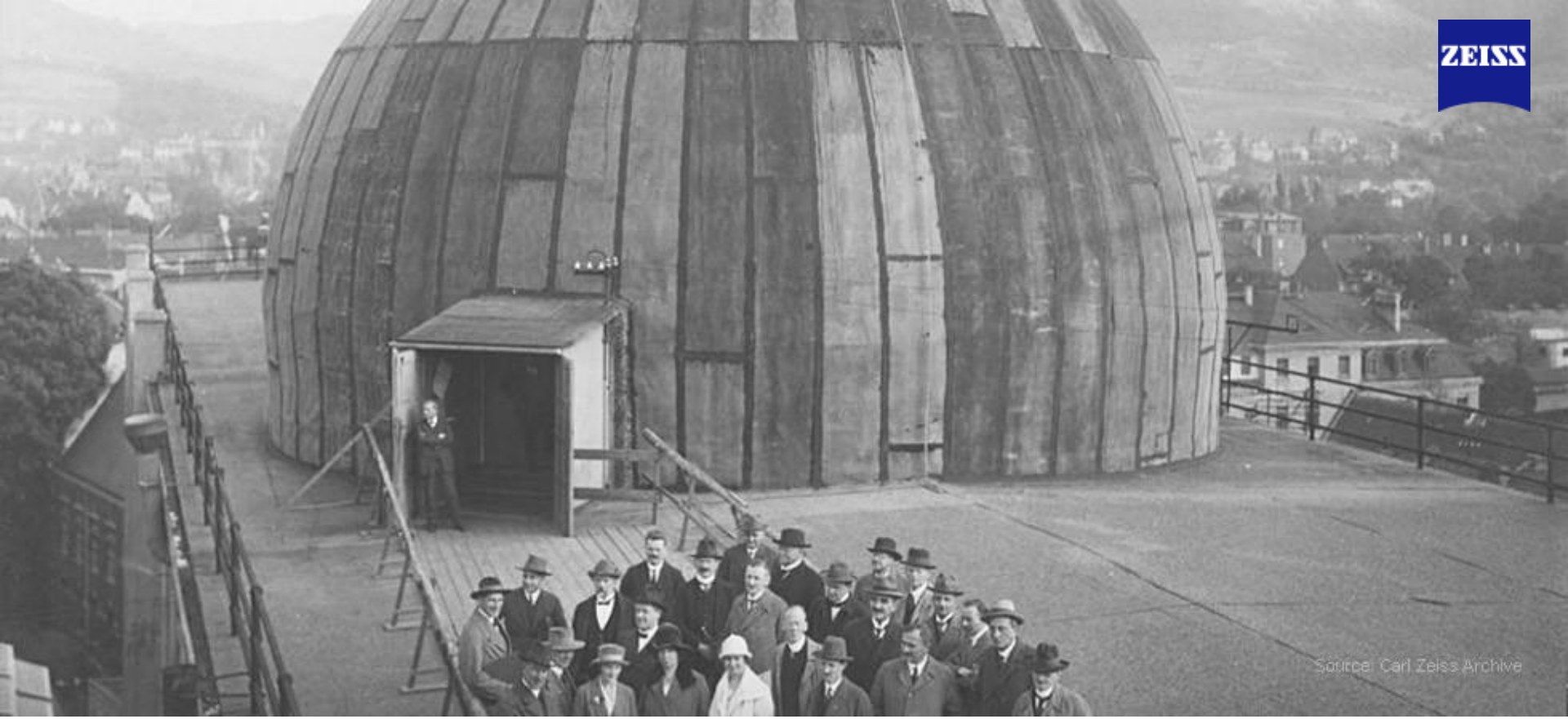


Leonardo da Vinci's dome structure, reconstructed by Rinus Roelofs



The honour of being the first to design a geodesic structure goes to **Dr. Walter Bauersfeld,** chief designer at the **Carl Zeiss Optical Works in Jena in 1922** at the time called **'The Wonder of Jena'.**

This structure formed the shell of the Zeiss Planetarium. 25 more were built including one in Chicago in 1930.



Did You Know…

…that the World's First Planetarium Was Erected on the Roof of the ZEISS Factory?

The first artificial night sky was shown in Jena in the summer of 1923. 10 years earlier, Heidelberg astronomer Max Wolf had suggested the planetarium idea to Oskar von Miller, founder of the Deutsches Museum in Munich. He, in turn, approached Carl Zeiss Jena. After an interruption caused by World War I and a whole host of design issues, **Walther Bauersfeld, Chief Engineer at ZEISS**, developed Model I, which was tested in a specially built, 16-meter dome on the roof of the factory in Jena. Beginning in August 1924, presentations were also offered to the public. The very first projector was in service at the Deutsches Museum from 1925 to 1960, and it continues to be on display to this day.

Some decades later **Richard Buckminster "Bucky" Fuller**, an American architect, engineer and visionary thinker popularized the special structure of the geodesic dome throughout the world.

According to his plans, **a geodesic dome was designed to cover the American pavilion for the World Fair in Montreal in 1967.**

The building is still can be seen.

Its diameter is 80 m and it is 65 m high.

Some decades later **Richard Buckminster "Bucky" Fuller**, an American architect, engineer and visionary thinker popularized the special structure of the geodesic dome throughout the world.

According to his plans, **a geodesic dome was designed to cover the American pavilion for the World Fair in Montreal in 1967.**

The building is still can be seen.

Its diameter is 80 m and it is 65 m high.

From where does the name "geodesic" comes from?

Some decades later **Richard Buckminster "Bucky" Fuller**, an American architect, engineer and visionary thinker popularized the special structure of the geodesic dome throughout the world.

According to his plans, **a geodesic dome was designed to cover the American pavilion for the World Fair in Montreal in 1967.**

The building is still can be seen.

Its diameter is 80 m and it is 65 m high.

The Greek word *Geodos* is meaning Earth.

"Geodesic" means *Earth-like…*

"Spaceship Earth," the AT&T Pavilion at Epcot in Disney World, Florida.

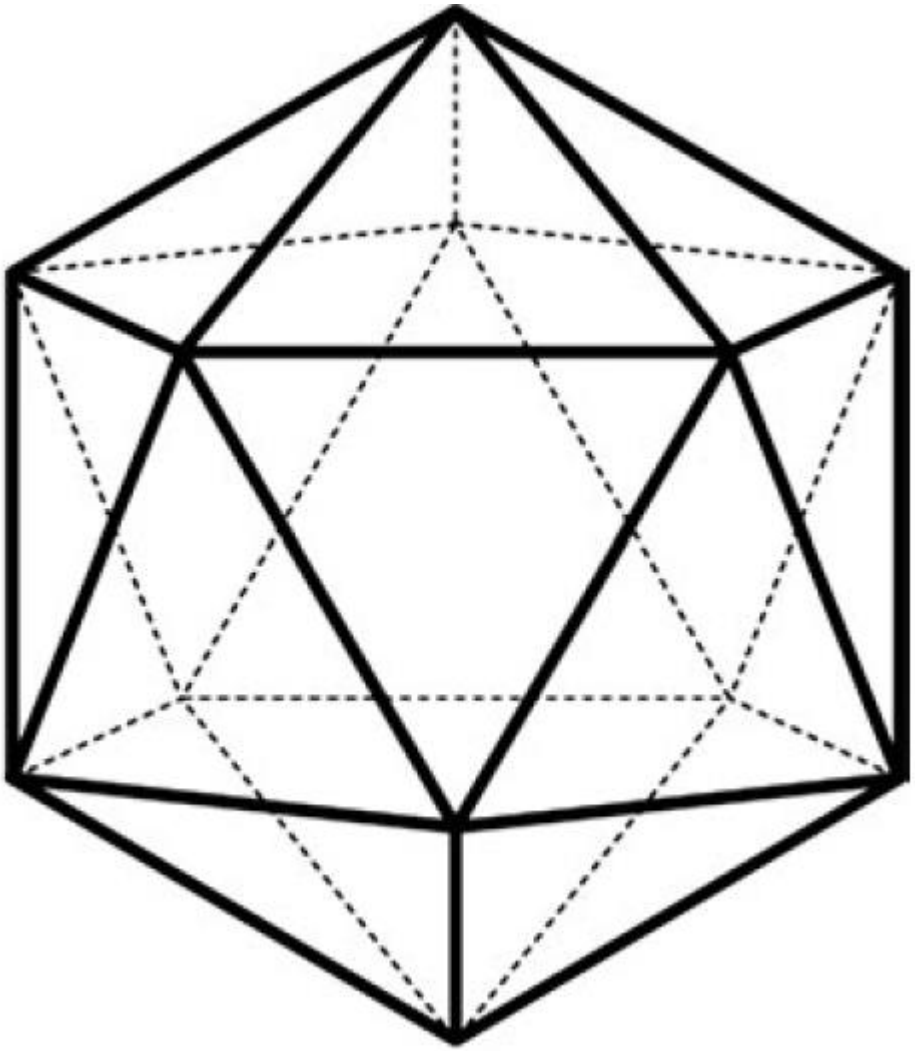
The People's Meeting Dome by Tejlgaard & Jepsen, Denmark

Nature House, a gorgeous geodesic dome home located on the Sandhornøya island of northern Norway.

A geodesic dome is a spherical or partial-spherical shell structure or lattice shell based on a network of great circles (geodesics) on the surface of a sphere.

The geodesics intersect to form triangular elements that have local triangular rigidity and also distribute the stress across the structure.

(Cf. http://en.wikipedia.org/wiki/Geodesic_dome).

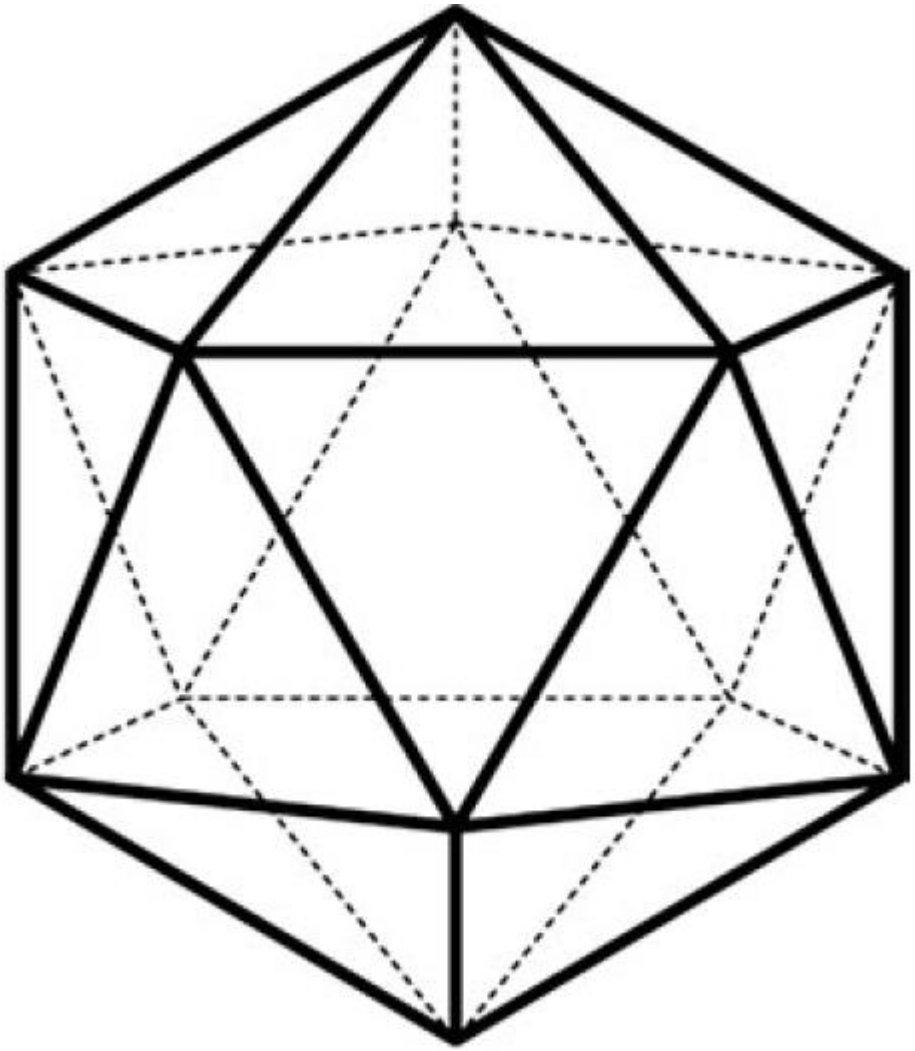


The construction of Fuller's geodesic dome is based on the geometric shape, called **icosahedron.**

If you take a closer look at the figure, you can see that each edge of the icosahedron is of the same length, triangles being components of the structure are equal in size.

The icosahedron is composed of 20 identical equilaterals and a sphere can be circumscribed around the structure.

Features concerning the edges of the geodesic dome are denoted by the frequency number.



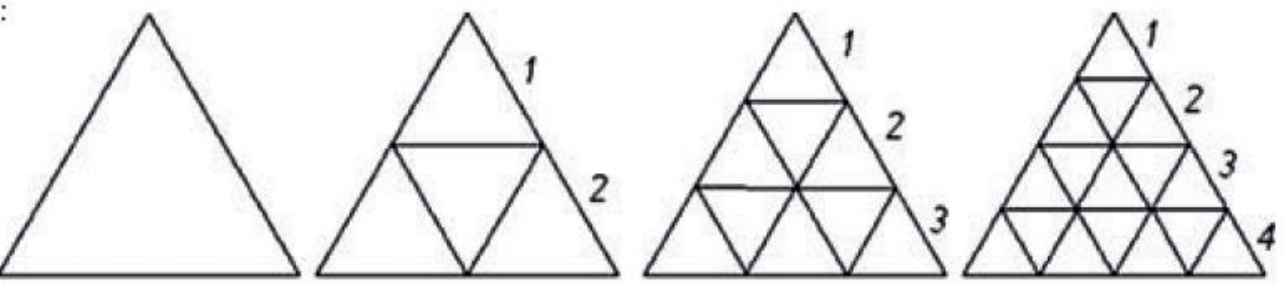
The construction of Fuller's geodesic dome is based on the geometric shape, called **icosahedron.**

If you take a closer look at the figure, you can see that each edge of the icosahedron is of the same length, triangles being components of the structure are equal in size.

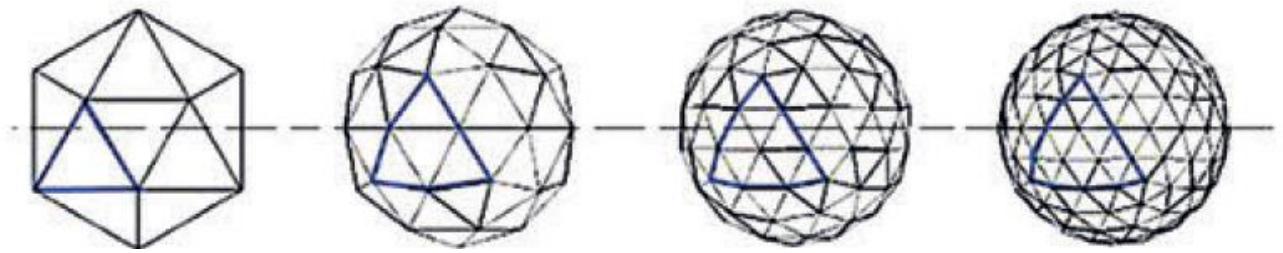
The icosahedron is composed of 20 identical equilaterals and a sphere can be circumscribed around the structure.

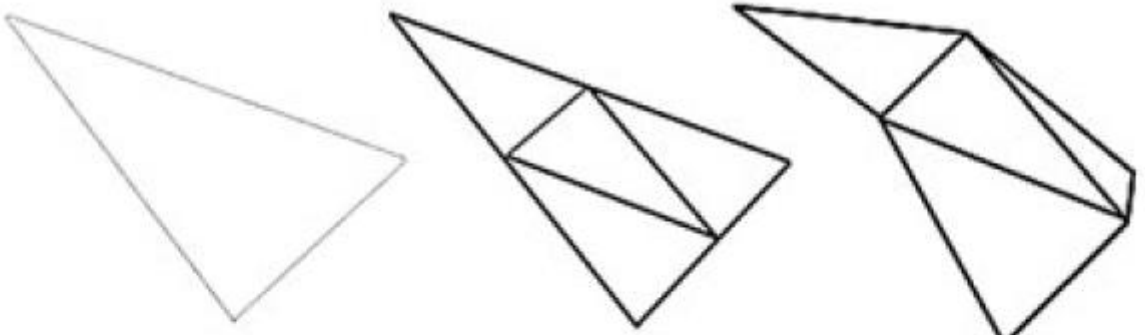
Features concerning the edges of the geodesic dome are denoted by the frequency number.

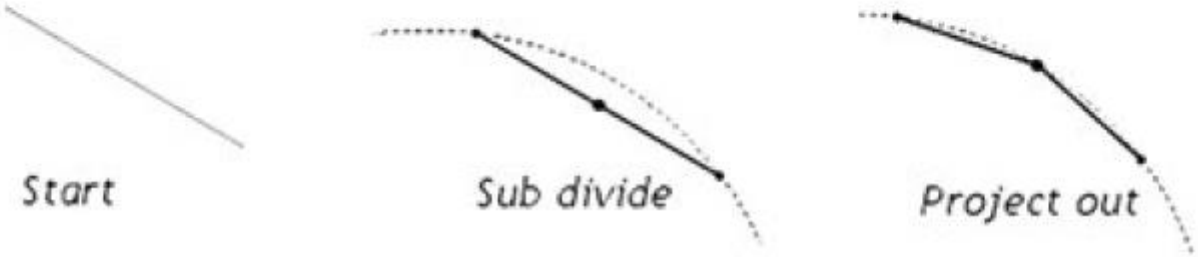
Because of the equal length of edges the frequency number of a geodesic dome generated from a regular icosahedron is 1.



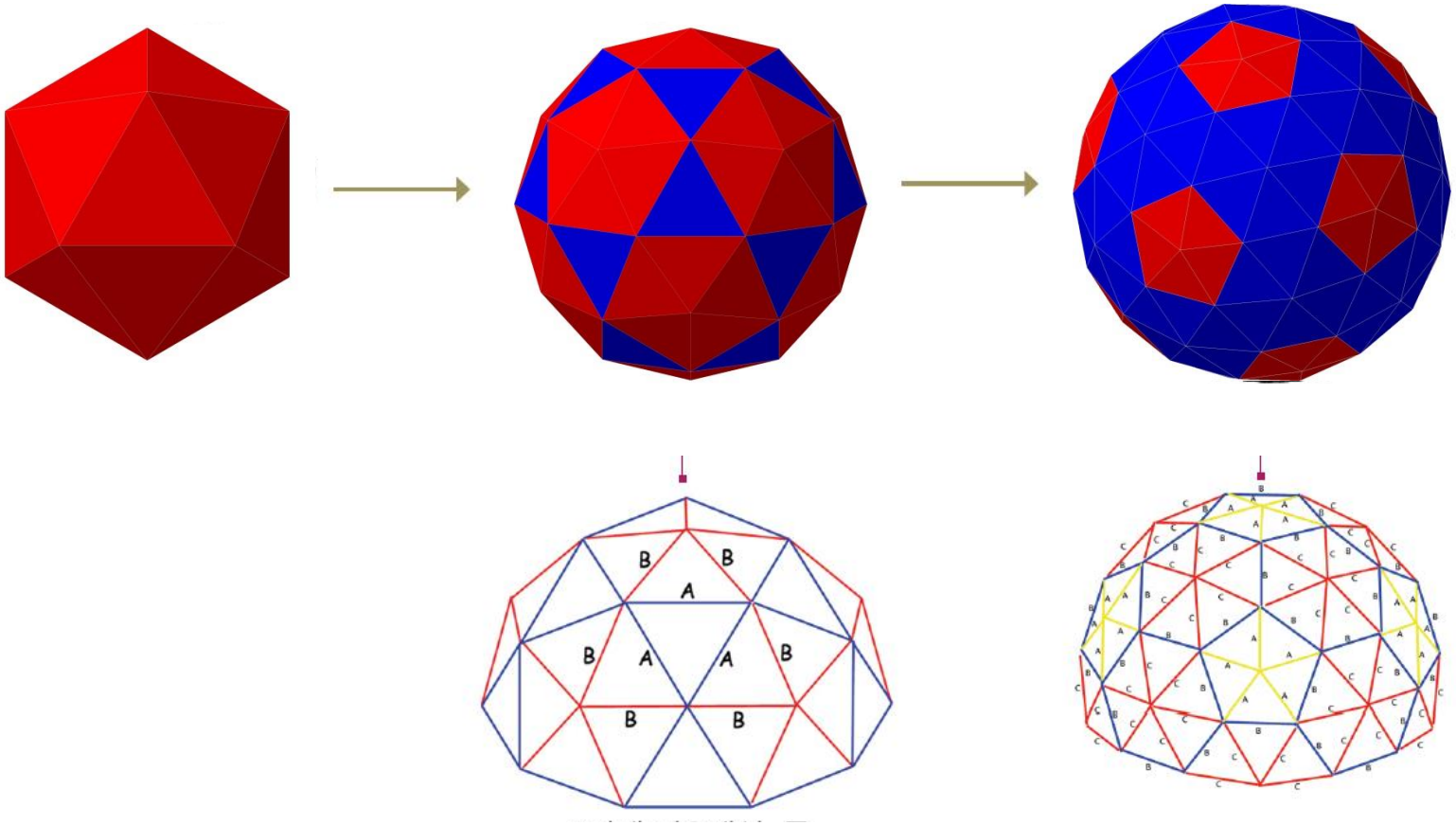
1v 2v 3v 4v







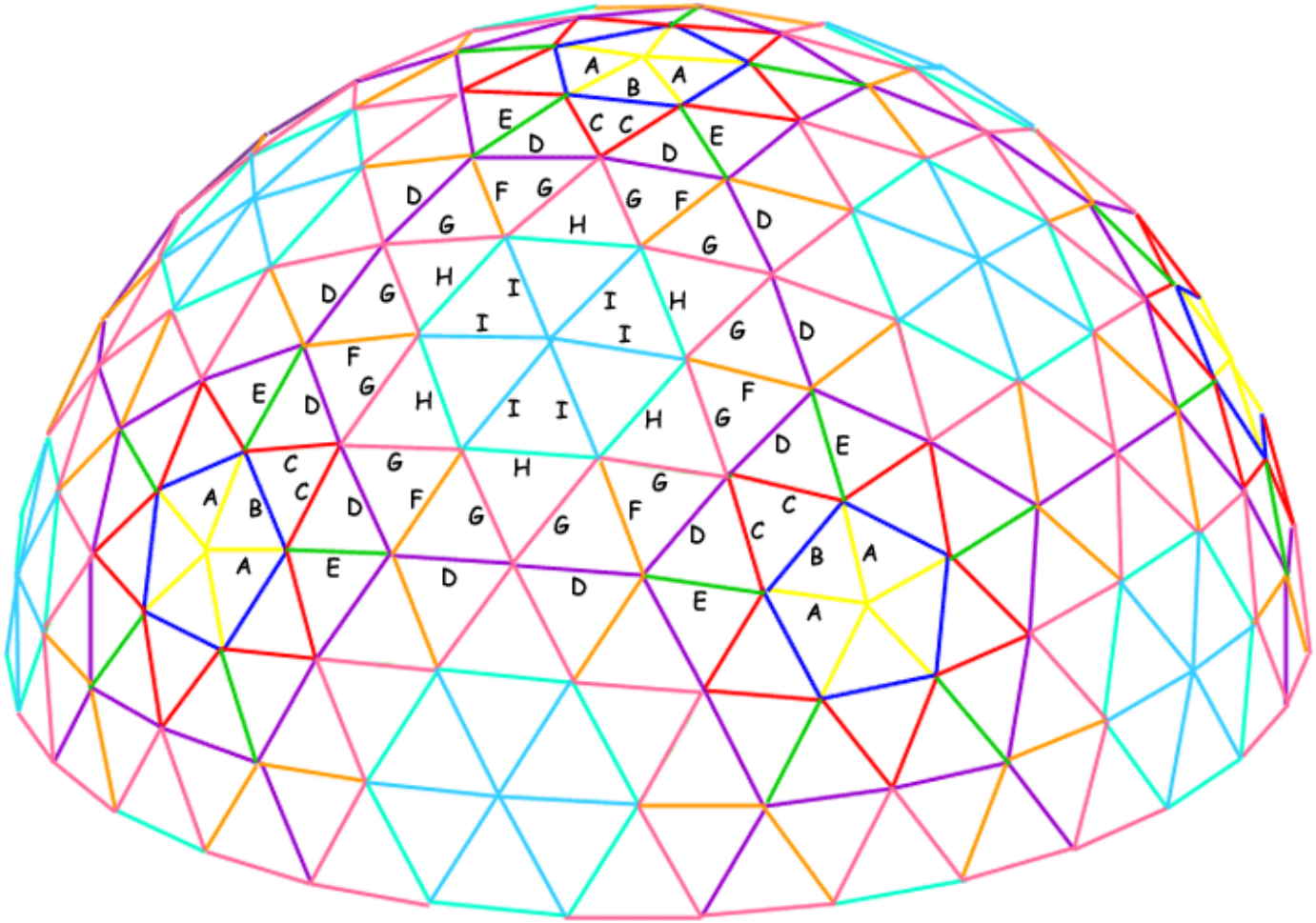
Start Sub divide Project out


B
B
A
B
A
A
B
B
B

대한민국 발명체험교구
4D프레임
www.4dframe.com

Geodesic Dome

Components	Length of each tube		Needed pieces
	before	after	
A	53	42	30
B	60	49	30
C		47	60
D		52	90
E		48	30
F		51	60
G		53	130
H		55	65
I	60	56	60
5-way connectors			12
6-way connectors			380



http://desertdomes.com/domecalc.html

Material Setting

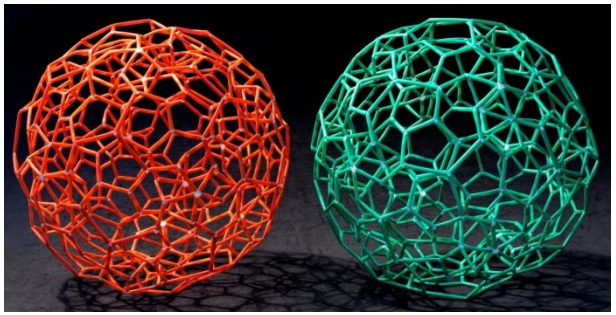
EXPERIENCE WORKSHOP

THE EXPERIENCE-CENTERED MATH/ART MOVEMENT

www.experienceworkshop.hu

Introduction of 4D Frame

For Free Imagination and Infinite creativity

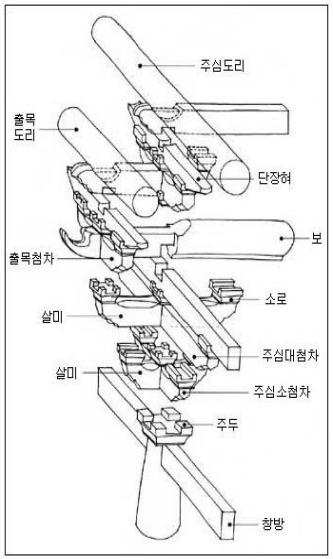


4D Land Corporation / 4D Math and Science Creativity Institute, KOREA

The Brand : 4D Frame

- The 4Dframe educational modelling kit is based upon the analysis of building techniques utilized in the construction of Korea's traditional, wooden buildings, in which no any nails have been used.
- 4Dframe has been proved to be a very appropriate tool for developing various skills in the transdisciplinary framework of STEAM learning.

Traditional Korean Wooden Palace



Principle of Architecture

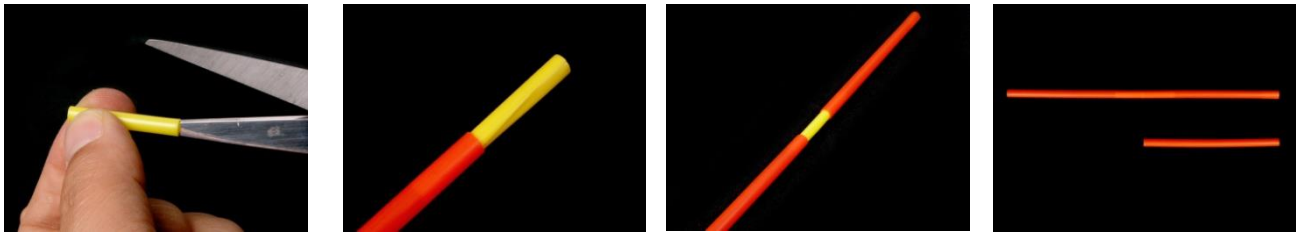
4D Frame Tube

4D Frame Connector

4D프레임

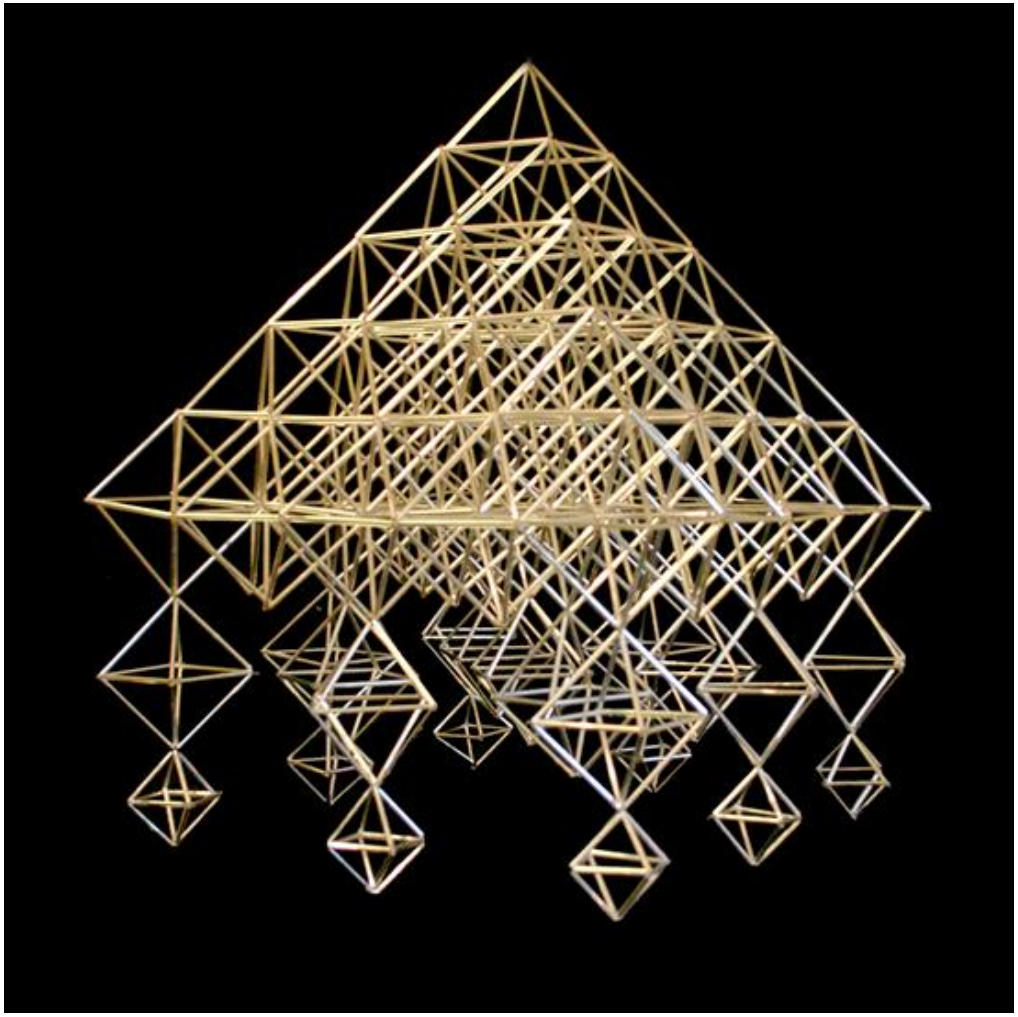
Character : Flexibility

Bend, Cut & Connect!



Character : Infinite Expansion

Character : Infinite Expansion



The traditional Nordic christmas decoration: the himmeli

4D프레임

National Science Museum

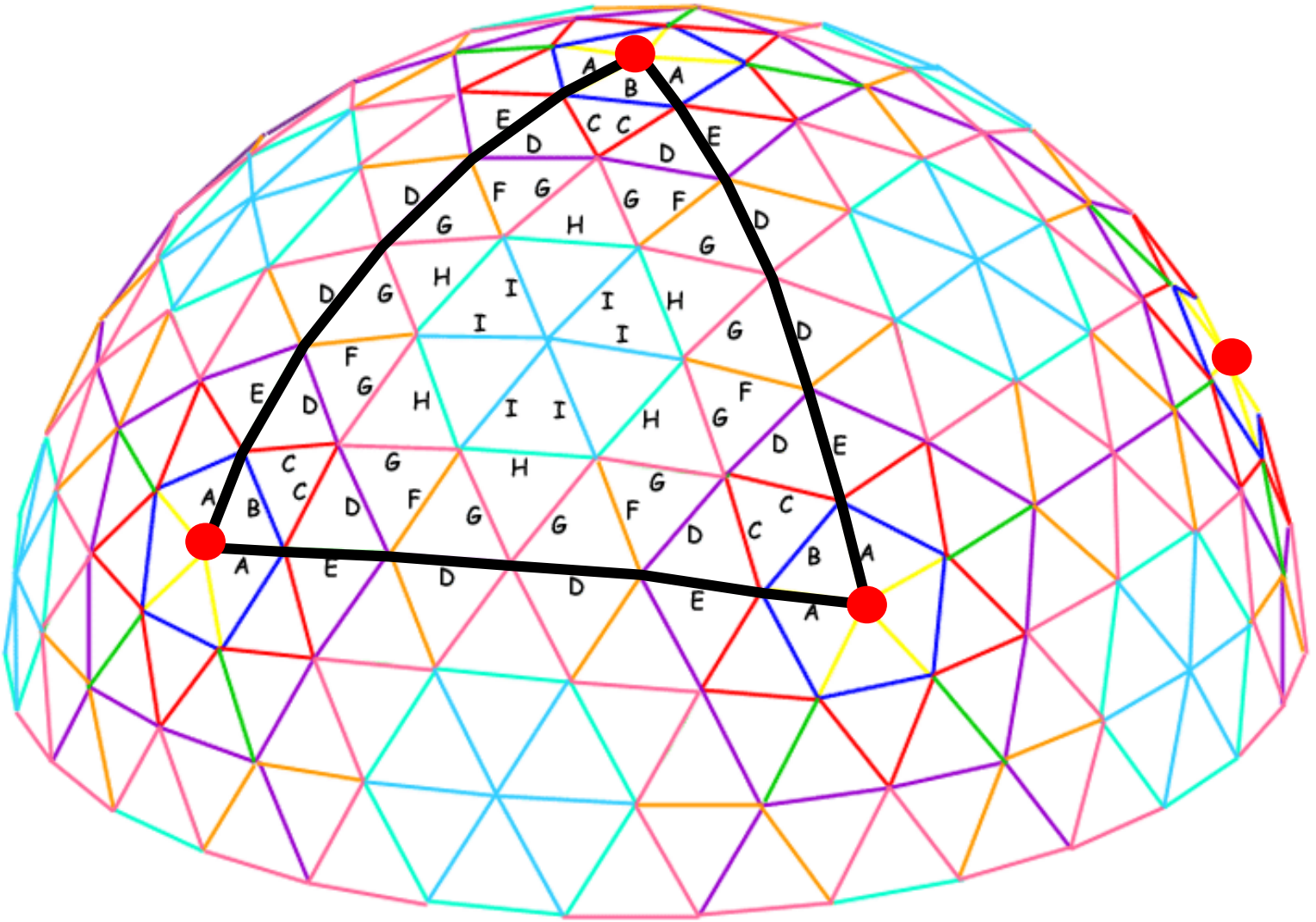
4D프레임 제3의 흙 누리과학체험관
4D프레임 제3의 흙 누리과학체험관

Geodesic Dome building materials for assembling

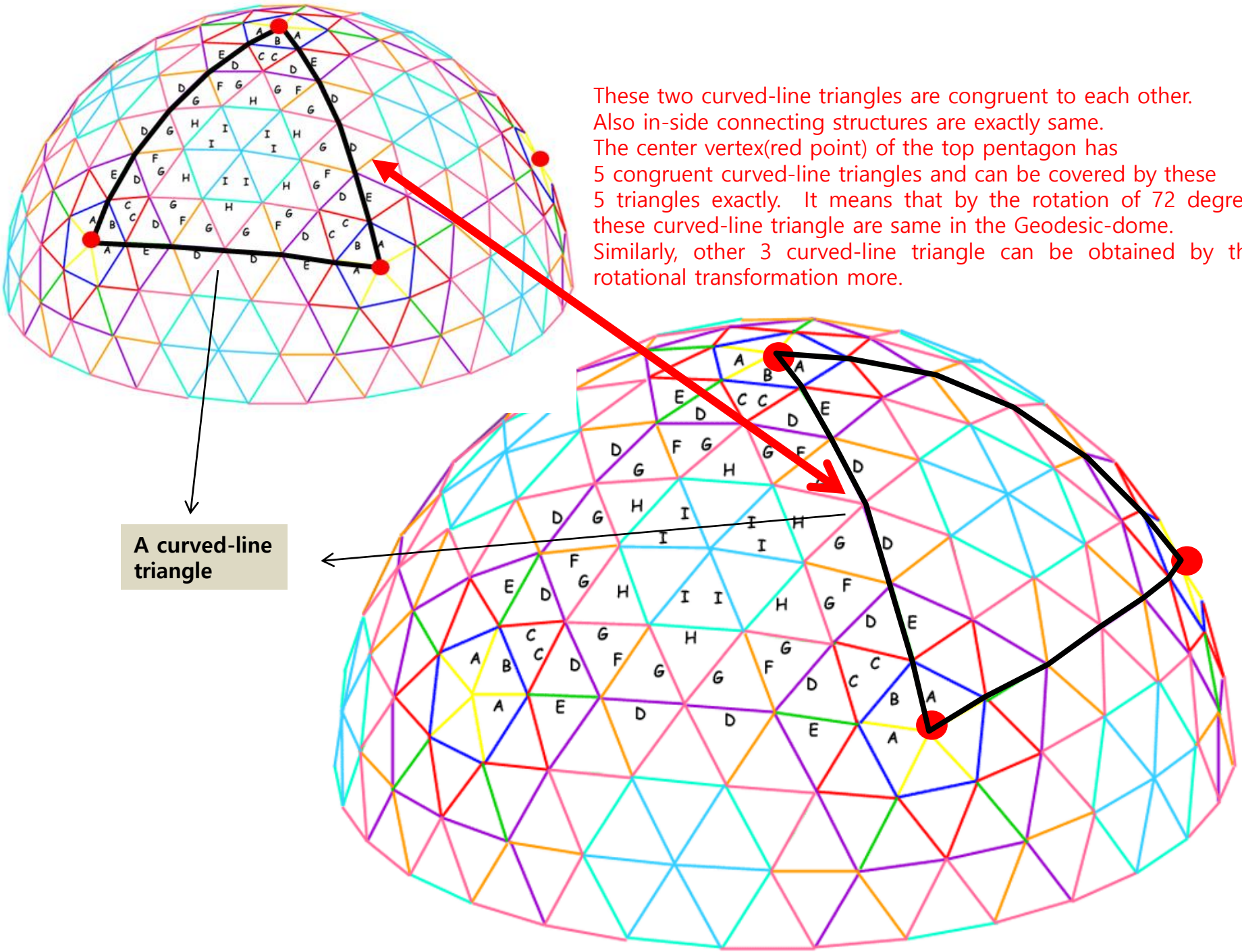
A : 42cm 30pcs
B : 49cm 30pcs
C : 47cm 60pcs
D : 52cm 90pcs
E : 48cm 30pcs
F : 51cm 60pcs
G : 53cm 130pcs
H : 56cm 60pcs
I : 56cm 60pcs
5-way connectors : 12pcs
6-way connectors : 380pcs

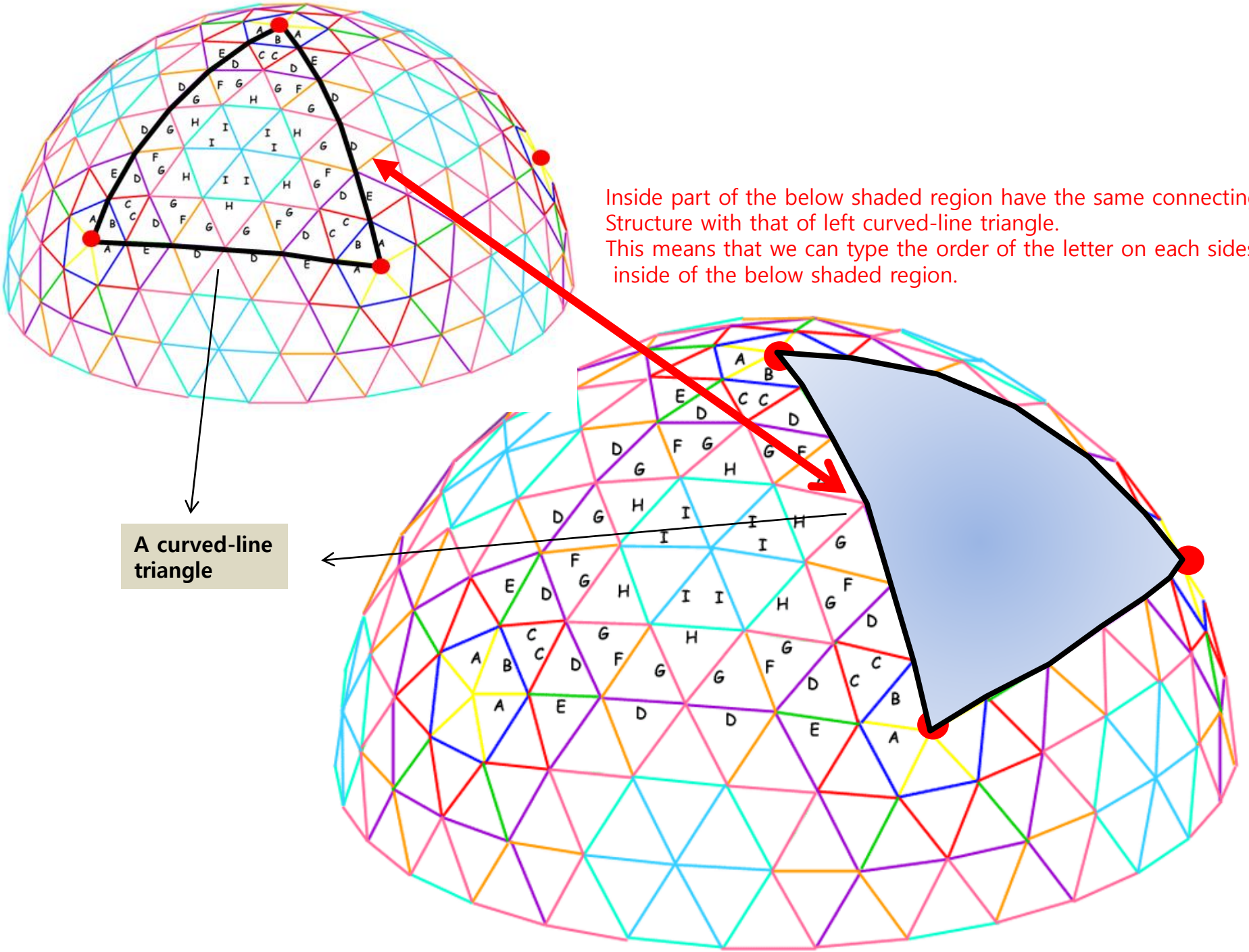
Some Explanation about Mathematical structure for constructing Geodesic Dome

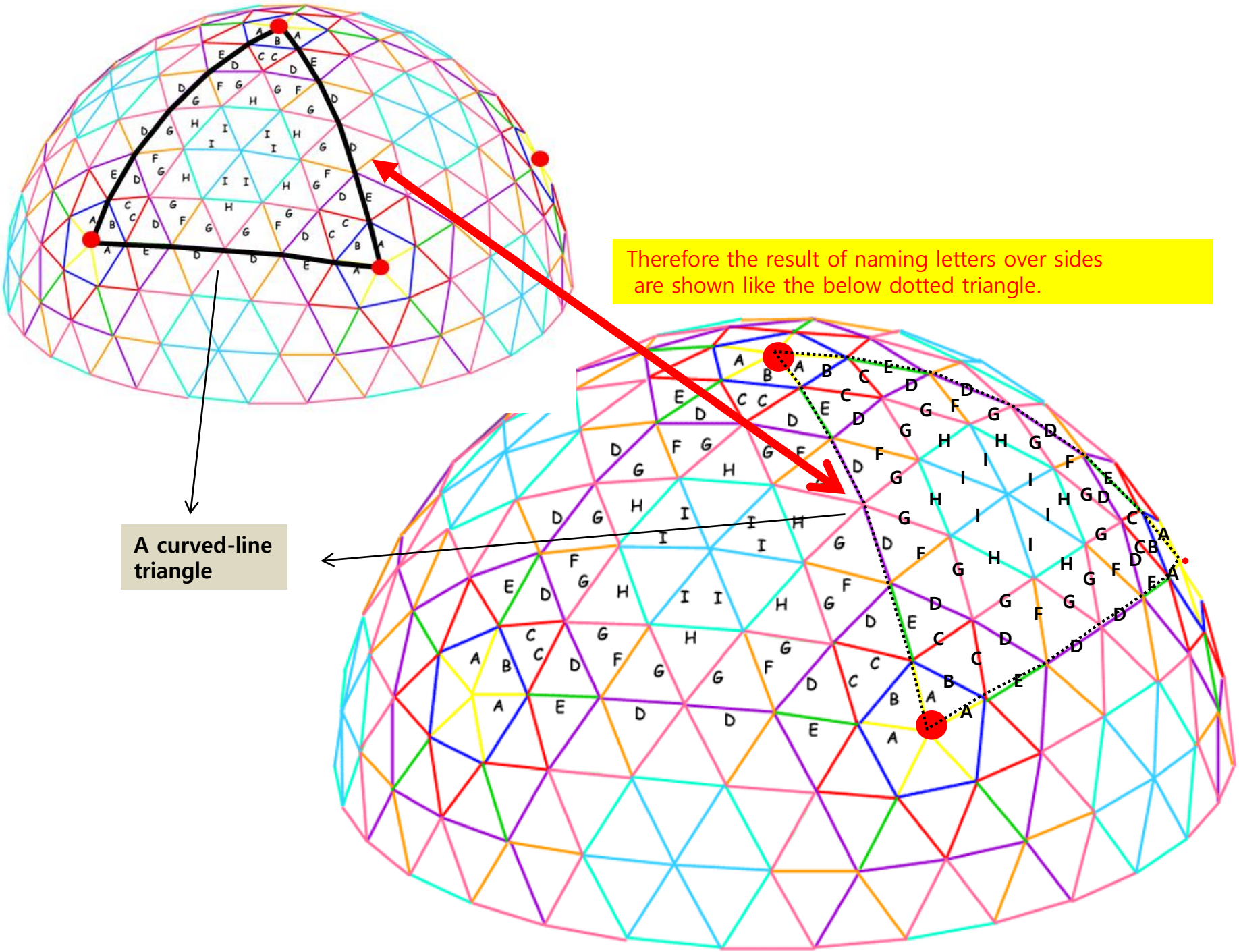
Understanding the structure of Geodesic Dome for connecting frames



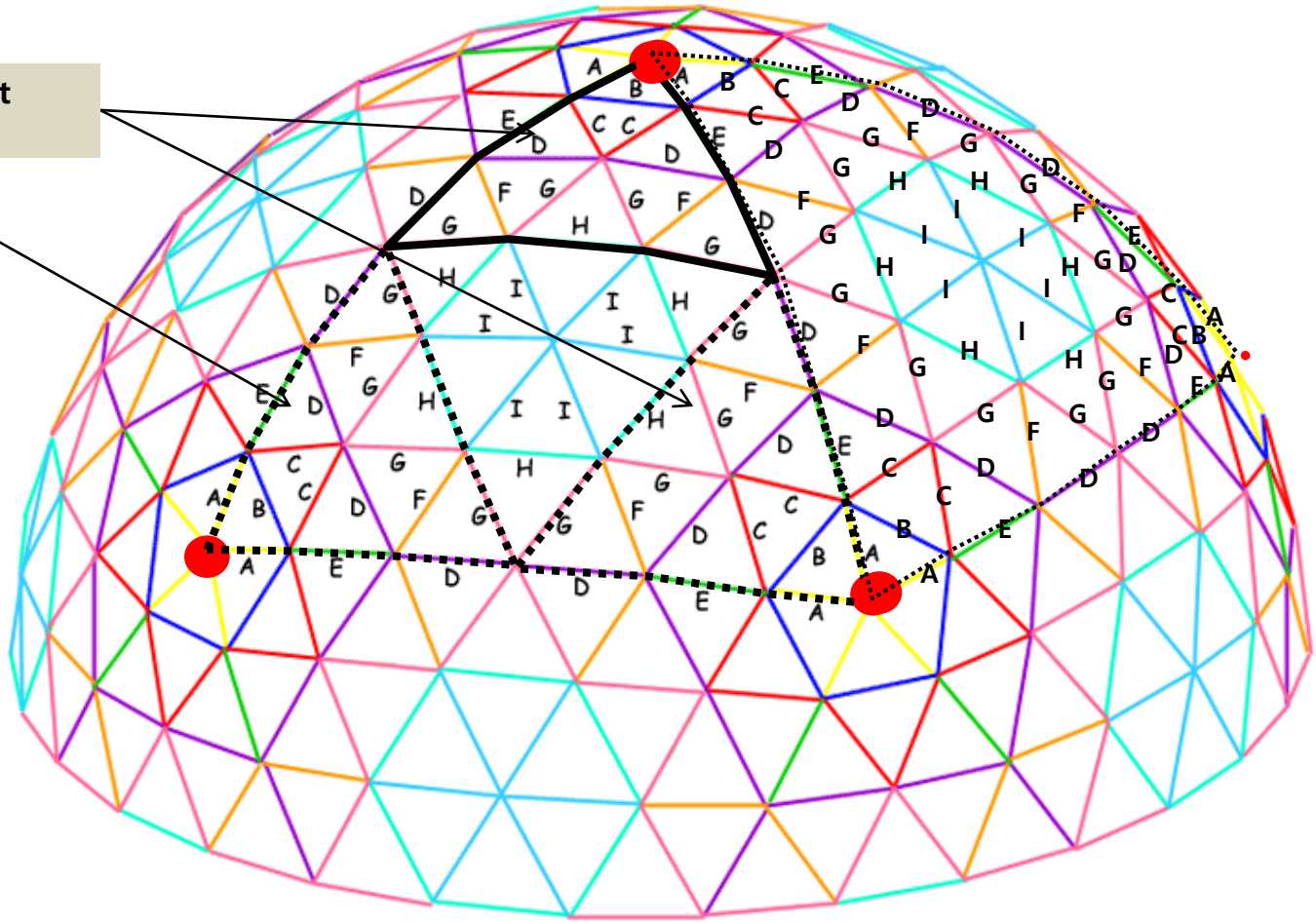
Above triangular side part has 5 symmetric shapes congruent to the letter-wise symbolized figure part on the above figure. It means that if you understand the connecting structure on the forepart, then the remaining part for connecting can be done similarly.


These two curved-line triangles are congruent to each other.
Also in-side connecting structures are exactly same.
The center vertex(red point) of the top pentagon has
5 congruent curved-line triangles and can be covered by these
5 triangles exactly. It means that by the rotation of 72 degree,
these curved-line triangle are same in the Geodesic-dome.
Similarly, other 3 curved-line triangle can be obtained by the
rotational transformation more.
A curved-line triangle

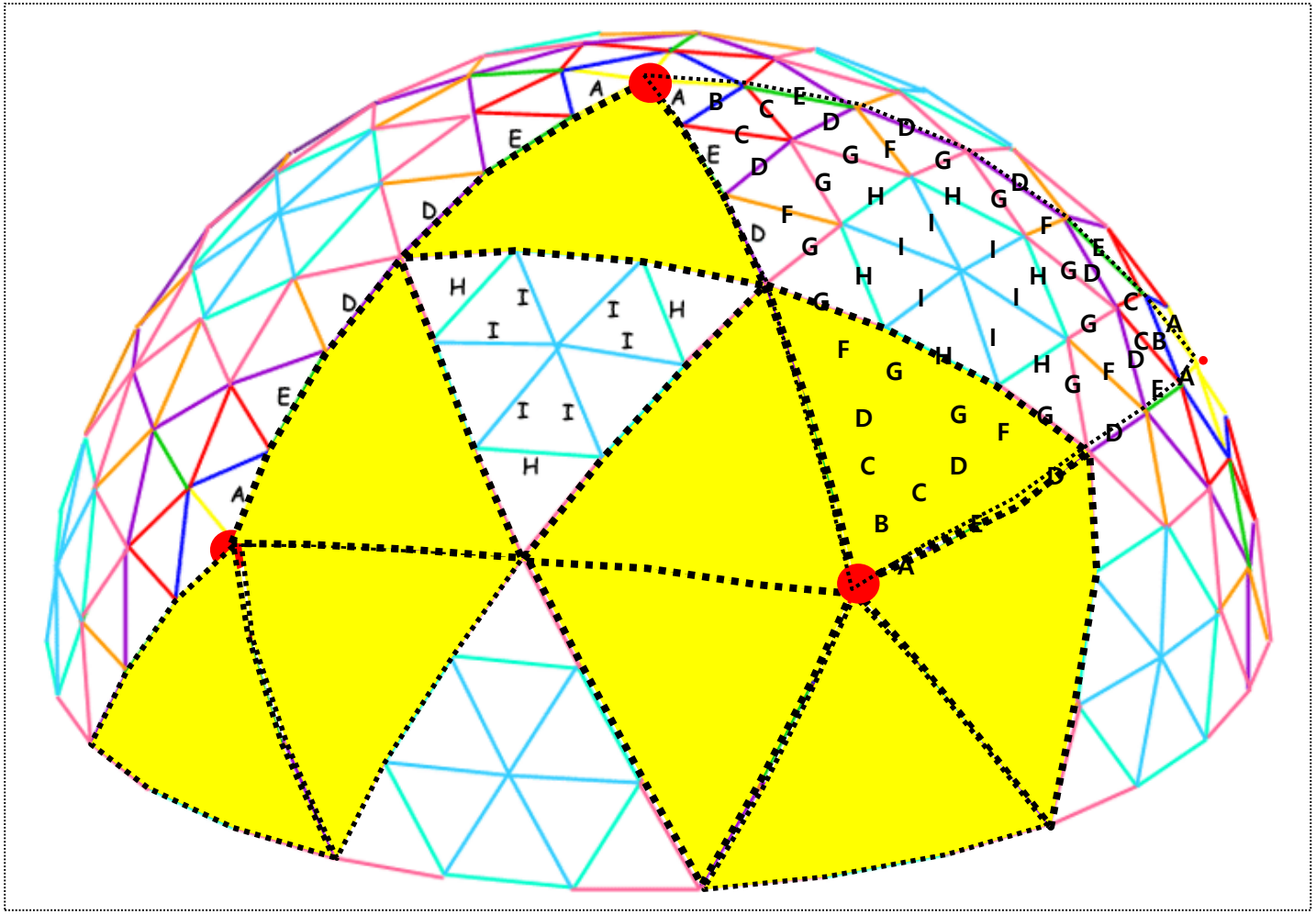

Inside part of the below shaded region have the same connecting Structure with that of left curved-line triangle.
This means that we can type the order of the letter on each sides inside of the below shaded region.
A curved-line triangle


Therefore the result of naming letters over sides are shown like the below dotted triangle.
A curved-line triangle

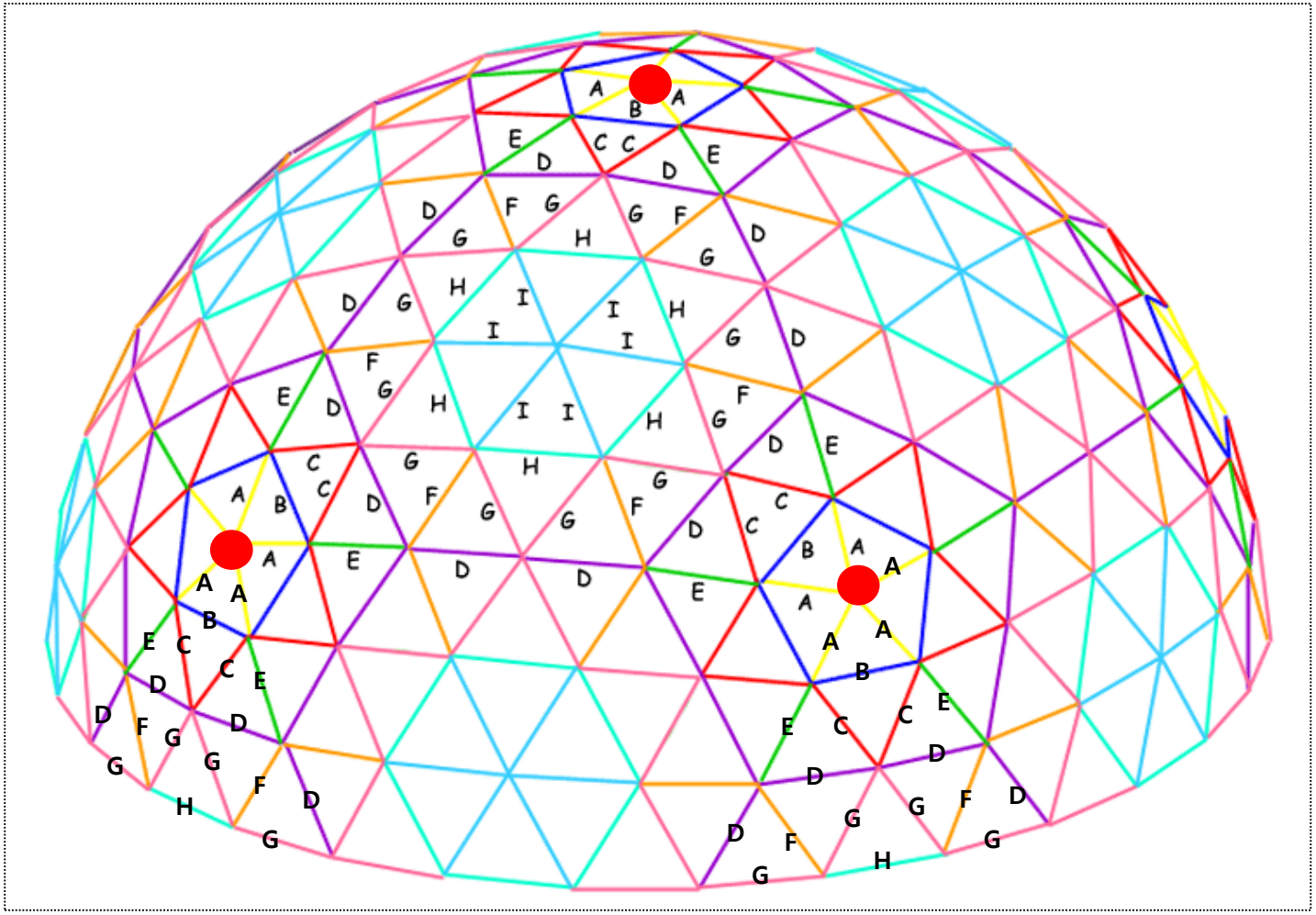
Congruent trianglular part
Of curved-line triangle



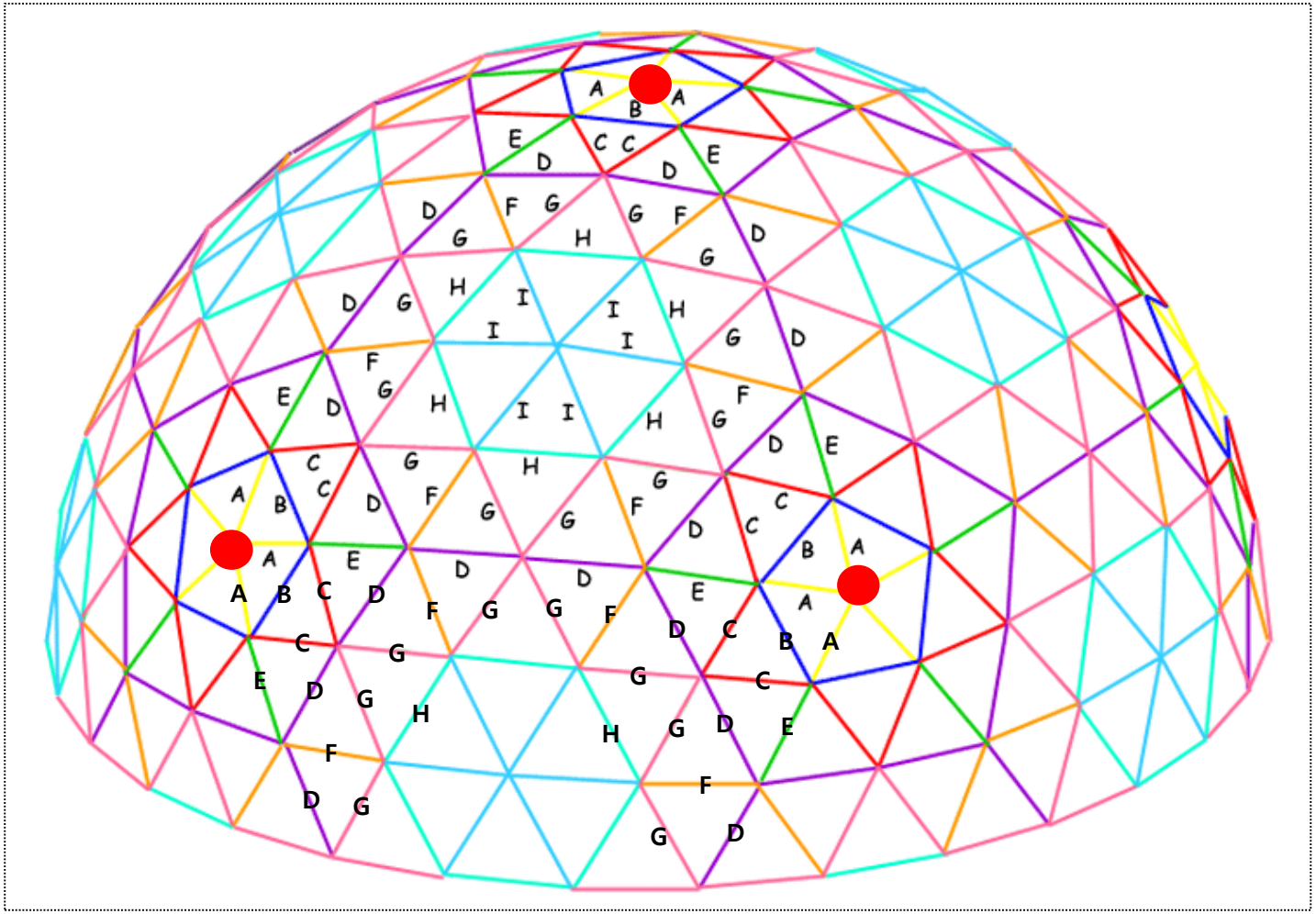
These all yellow-shaded region(curve-line triangle) are congruent to each other by adequate transformation (flip, or 72 degree rotation,



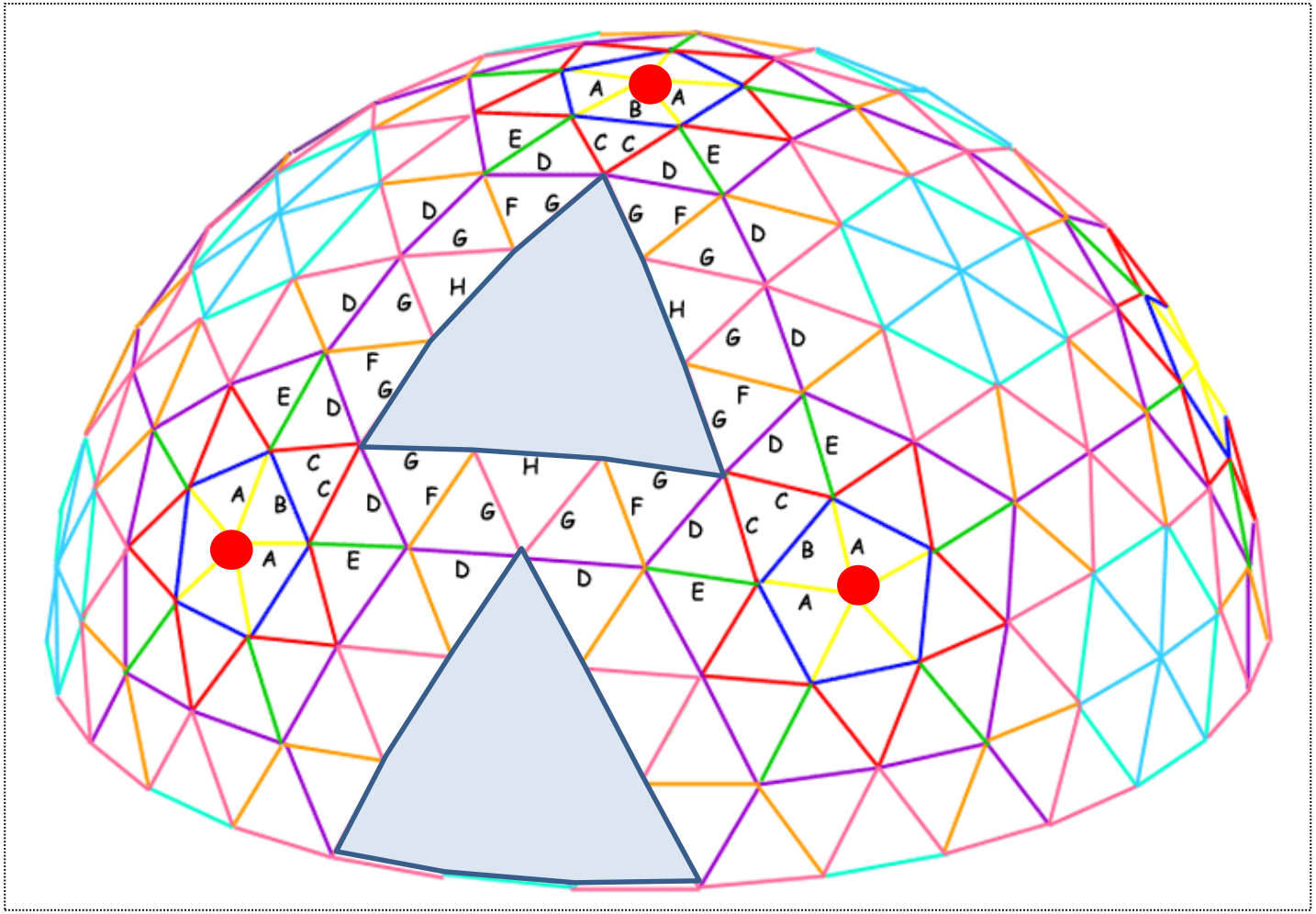
These all yellow-shaded region(curve-line triangle) are congruent to each other by adequate transformation (flip, or 72 degree rotation,



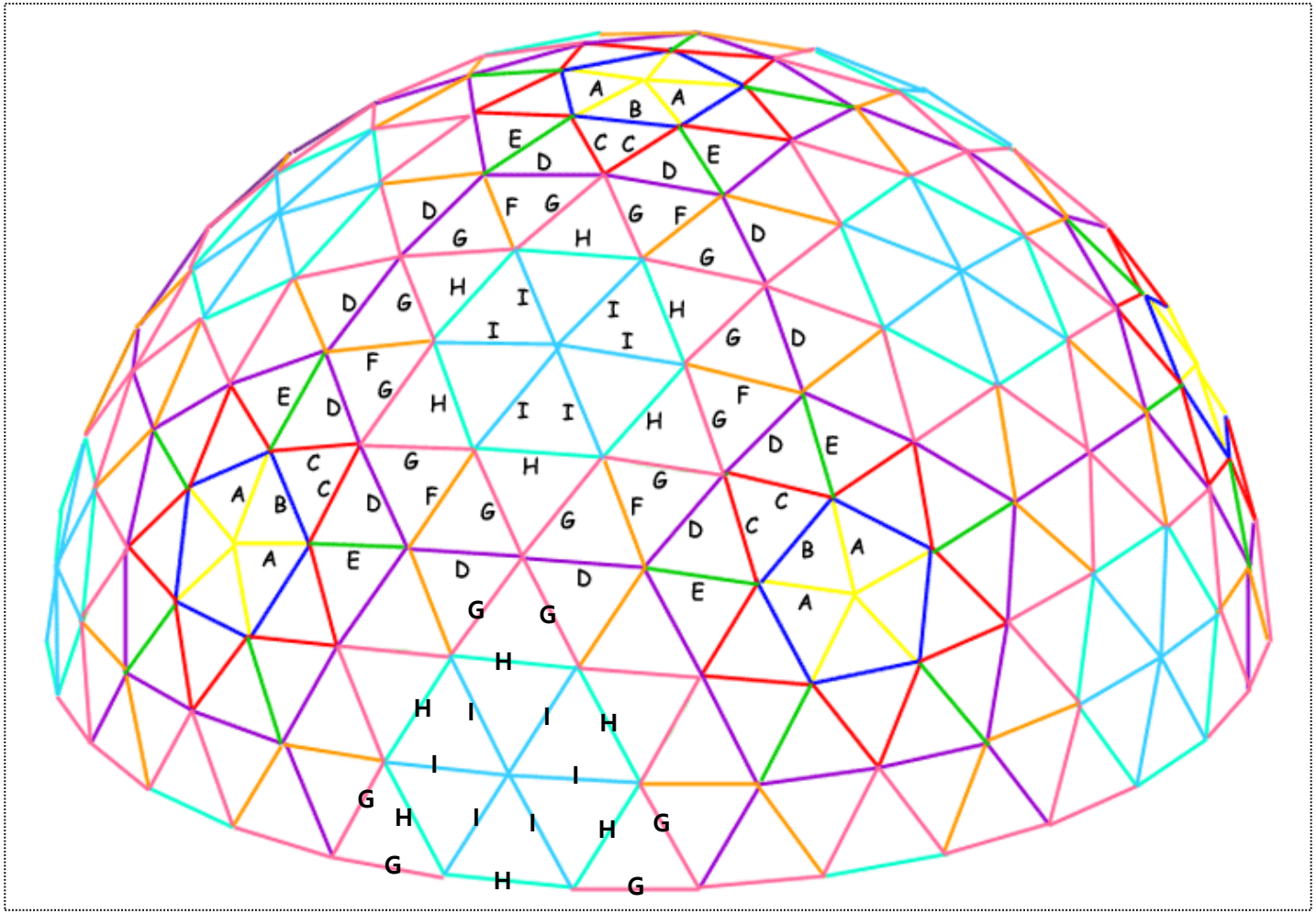
These all yellow-shaded region(curve-line triangle) are congruent to each other by adequate transformation (flip, or 72 degree rotation,



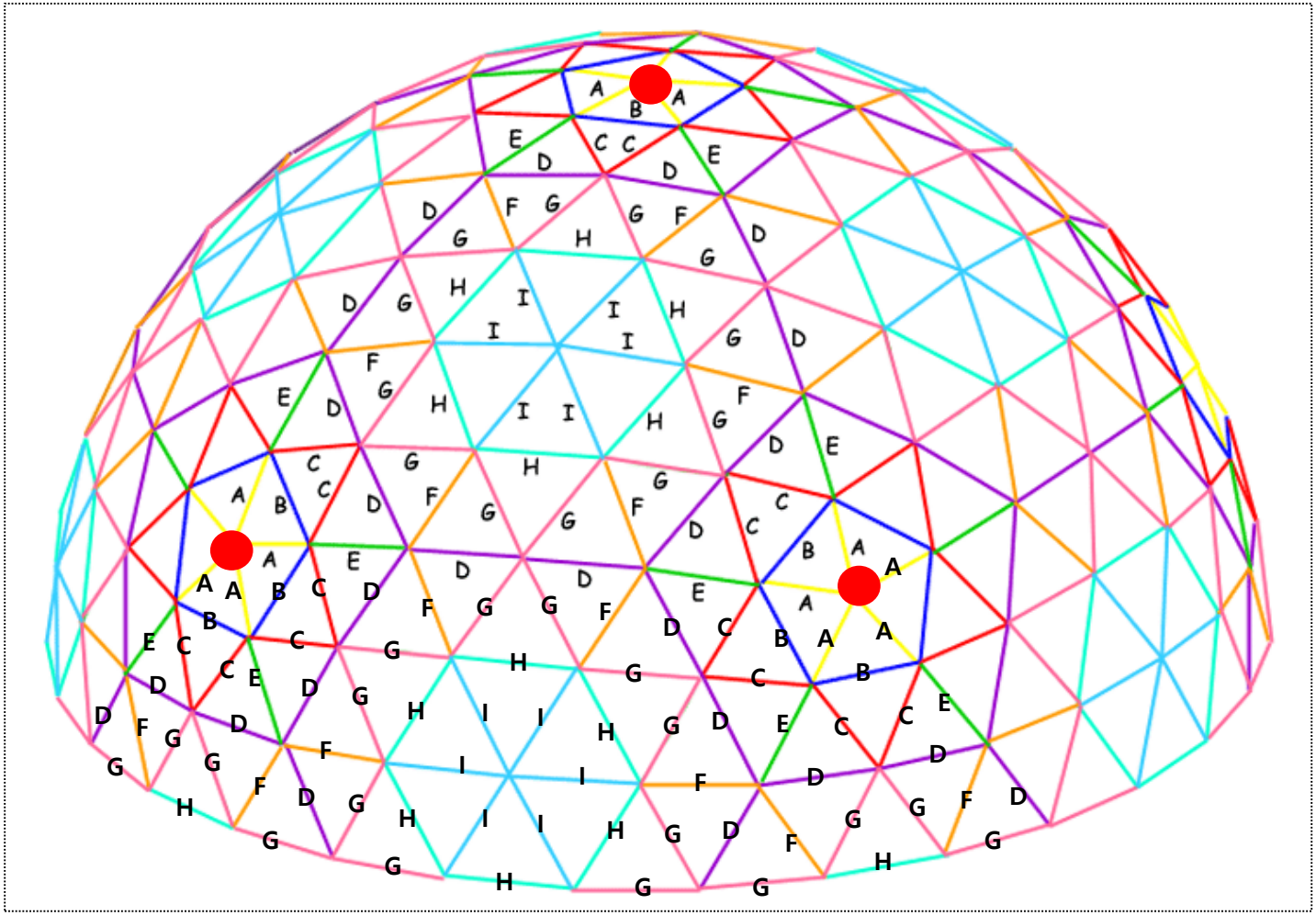
These two blue-shaded region(curve-line triangle) are congruent to each other by adequate transformation



These two blue-shaded region(curve-line triangle)) are congruent to each other by adequate transformation

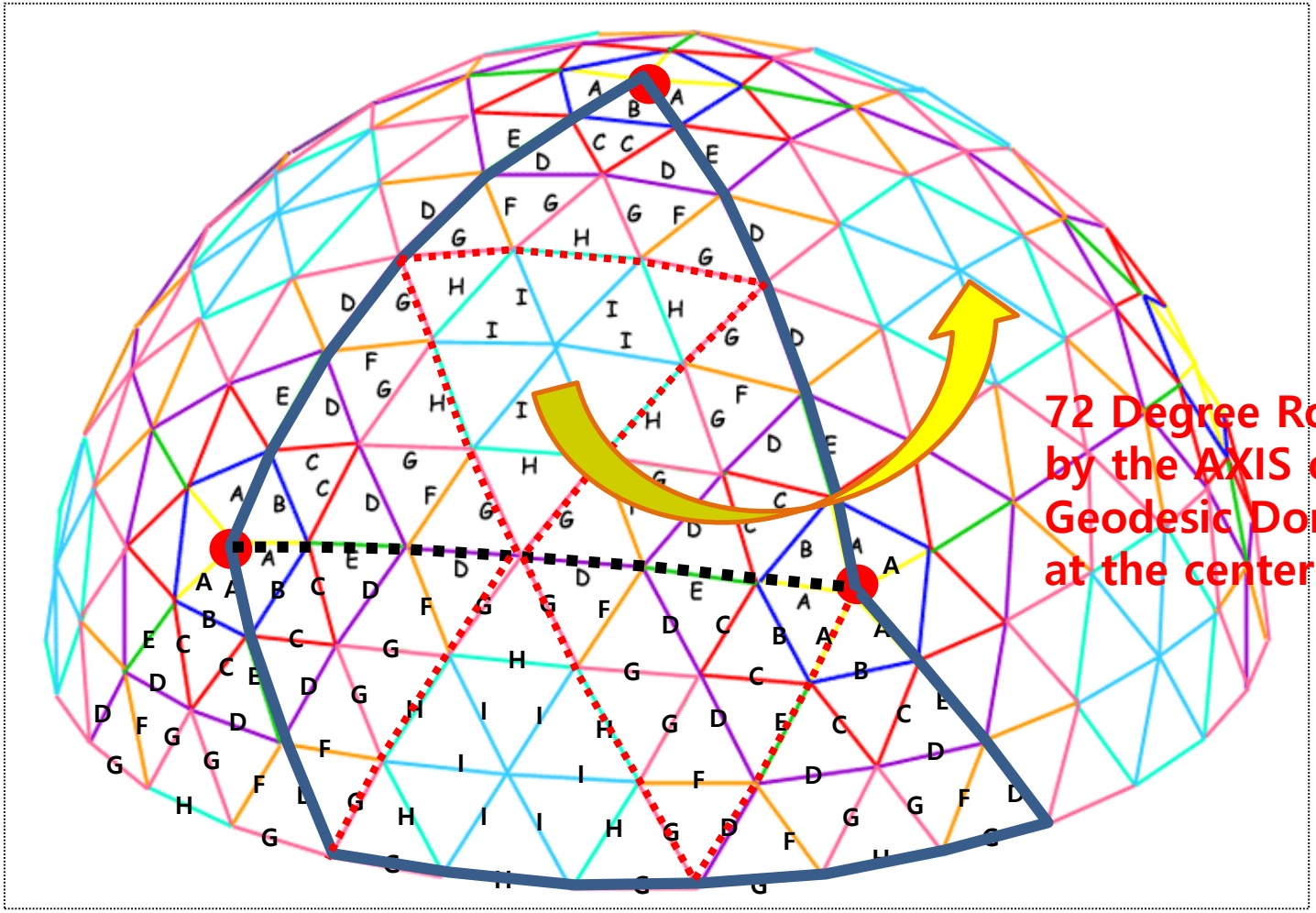


If we summarize congruent information about letters on each side
over ONE PART AMONG OF 5 congruent surrounding parts of Geodesic Dome



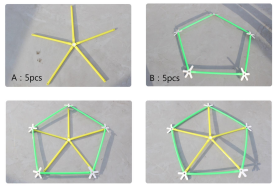
CONCLUSION

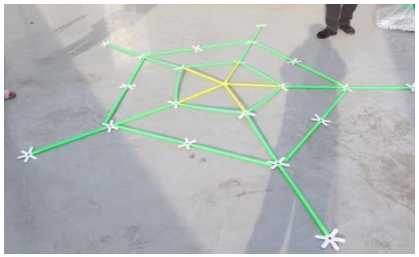
If you see the below region, 72 degree rotation can make us fix which letters on the corresponding sides have been written. It means that even though we cannot see the other face on Geodesic Dome, by our moving by 72 degree rotation, information about connecting letter (on each sides) over other faces can be induced by this rotation.

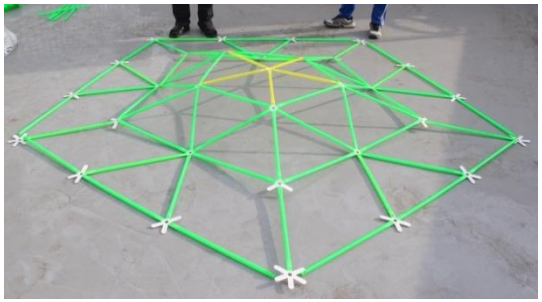


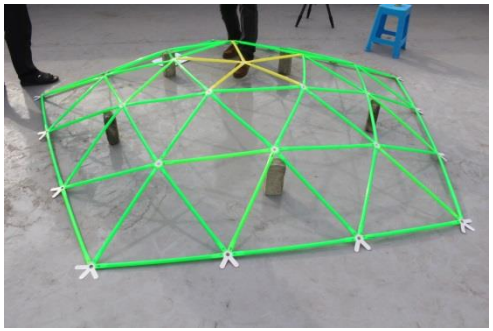
72 Degree Rotation by the AXIS of Geodesic Dome at the center of Top Pentagon

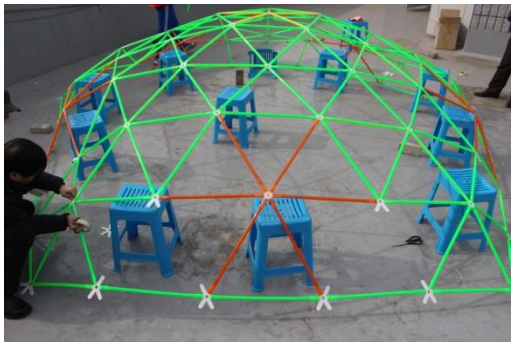
Constructing Geodesic Dome

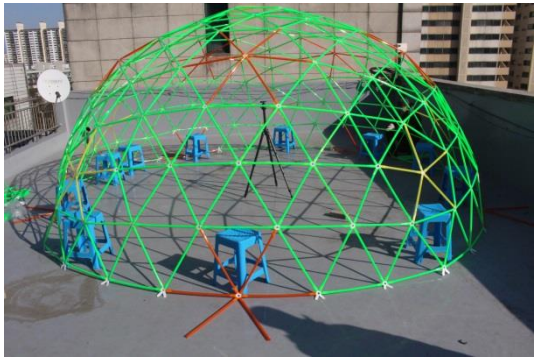


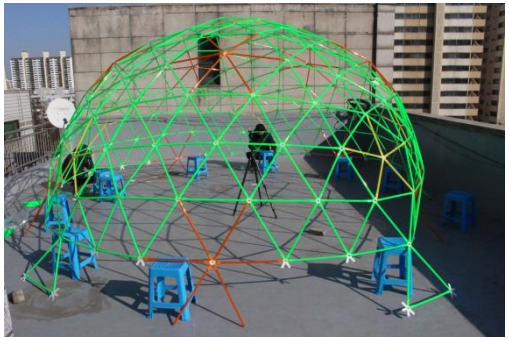


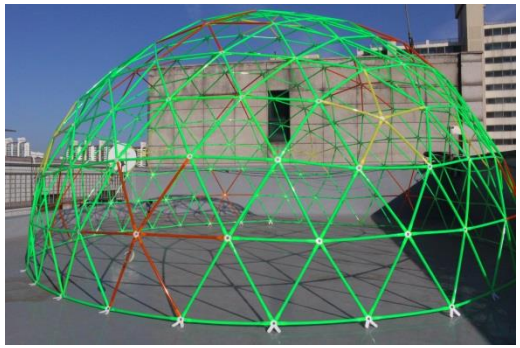






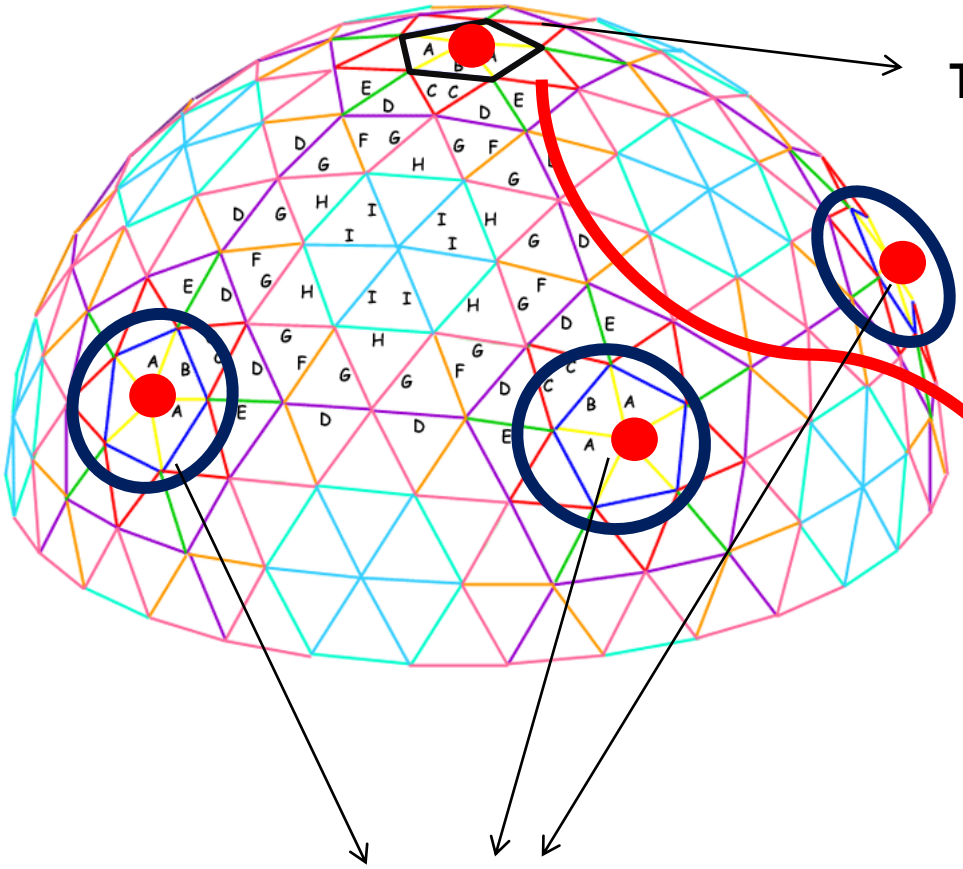






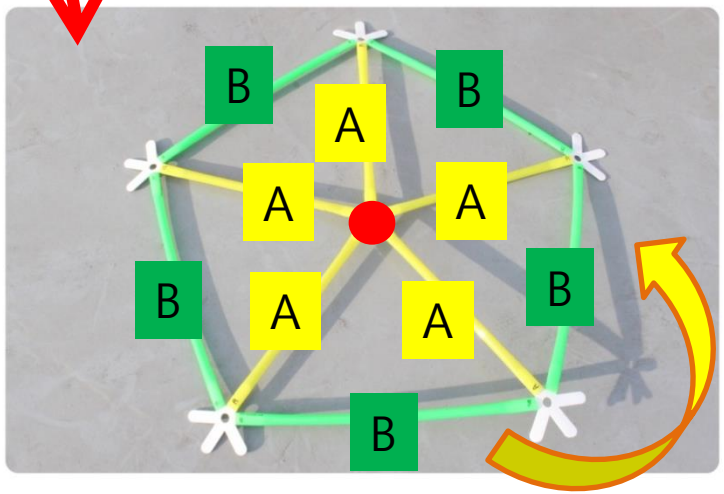
TOTAL CONSTRUCTION PROCESS OF GEODESIC DOME

Top part Pentagon



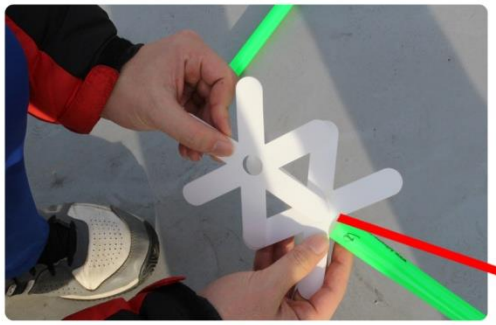
Top part pentagon

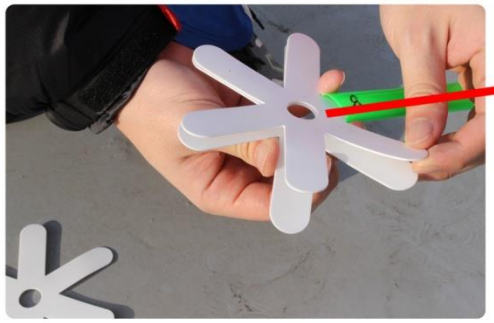
Side part 5 pentagons

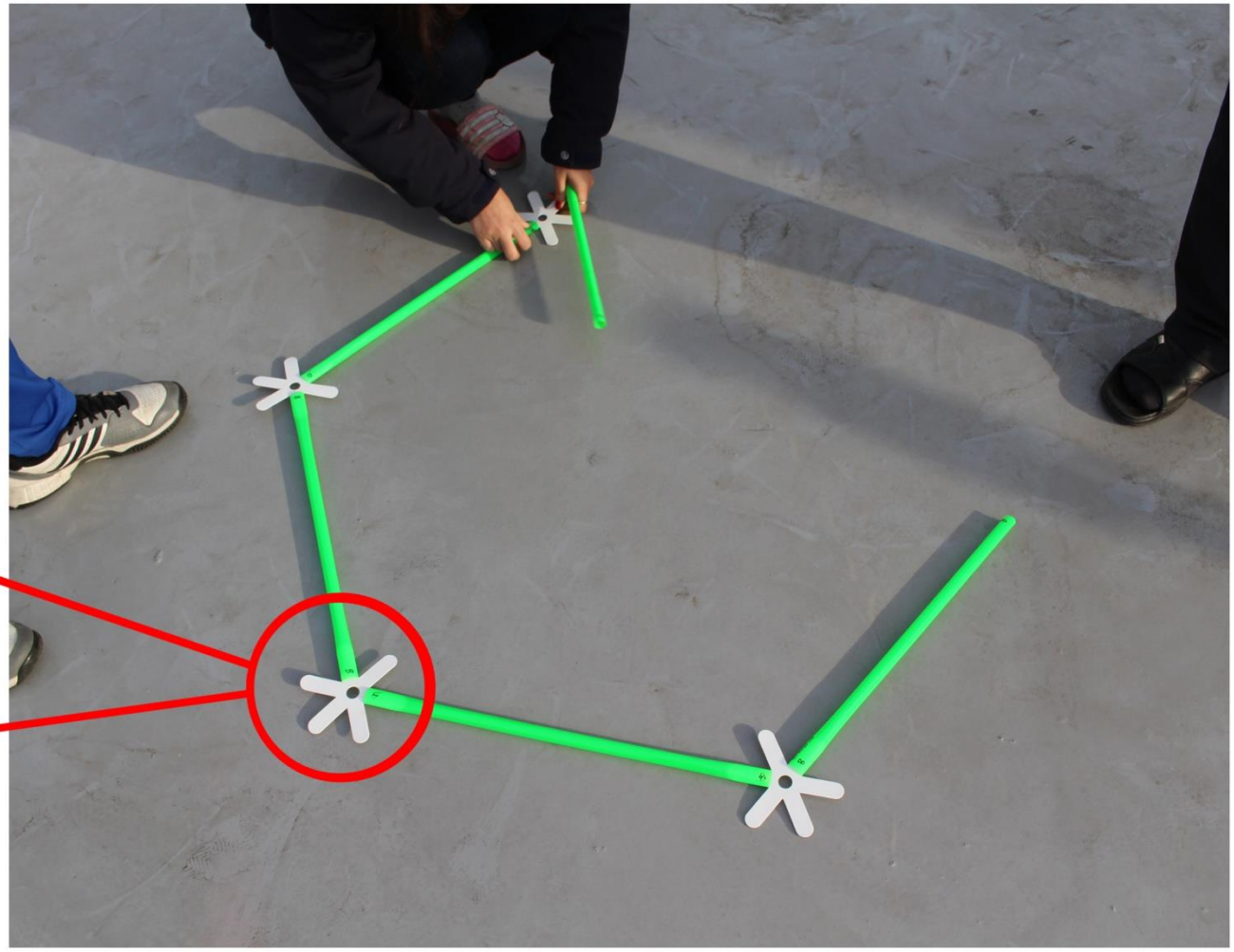


- Top part pentagon

Top part pentagon

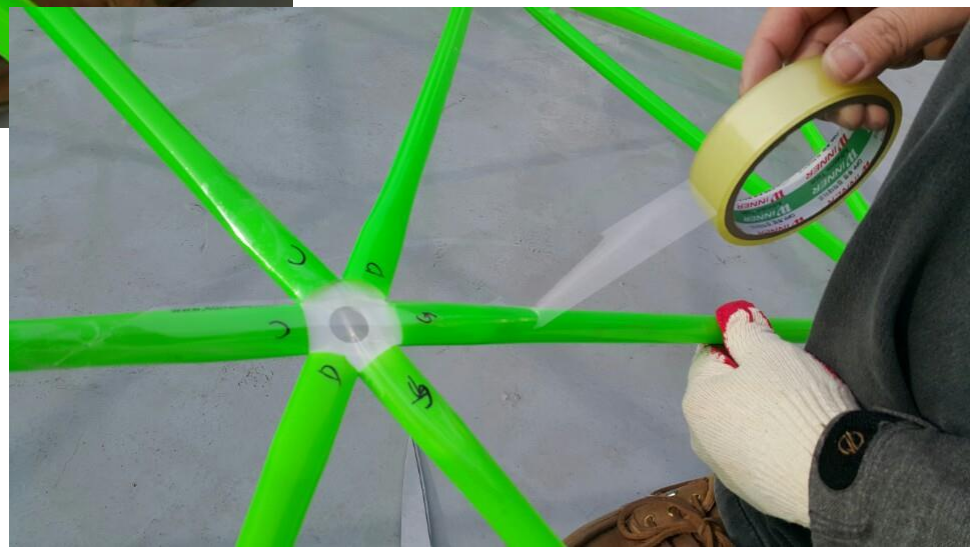






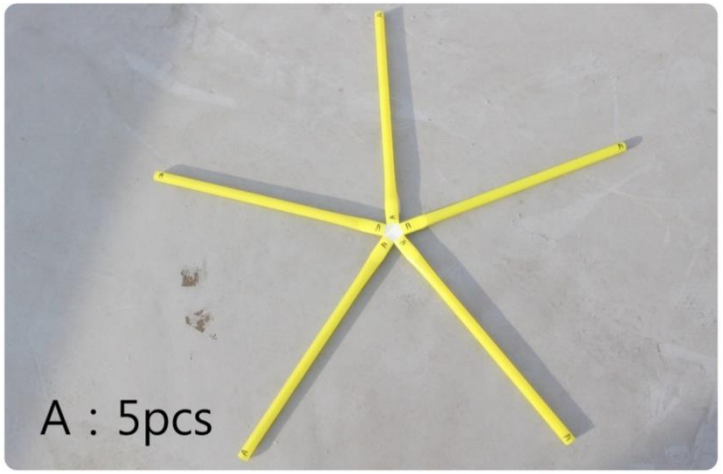
This is top part pentagon building. As you see, the red part shows **two-pieces folding in connecting**. Depending on the number of connecting frame over each vertex, way-connectors should be determined as shown in the suggested figure beforehand.

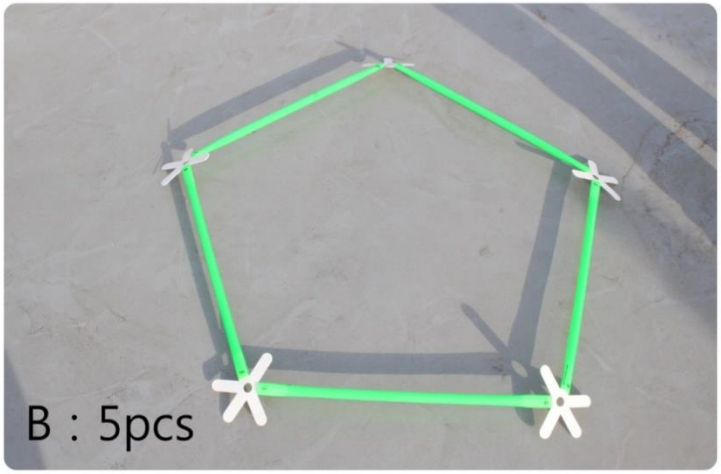
Taping method at each vertex

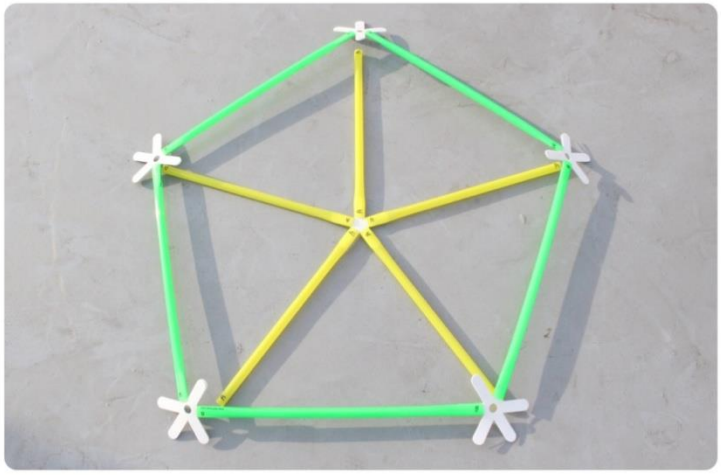


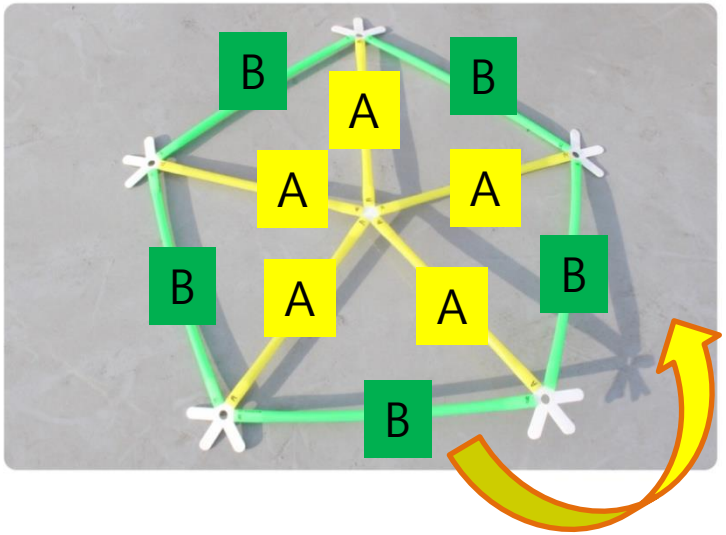
* You should use duct tapes each connector

Process of connecting

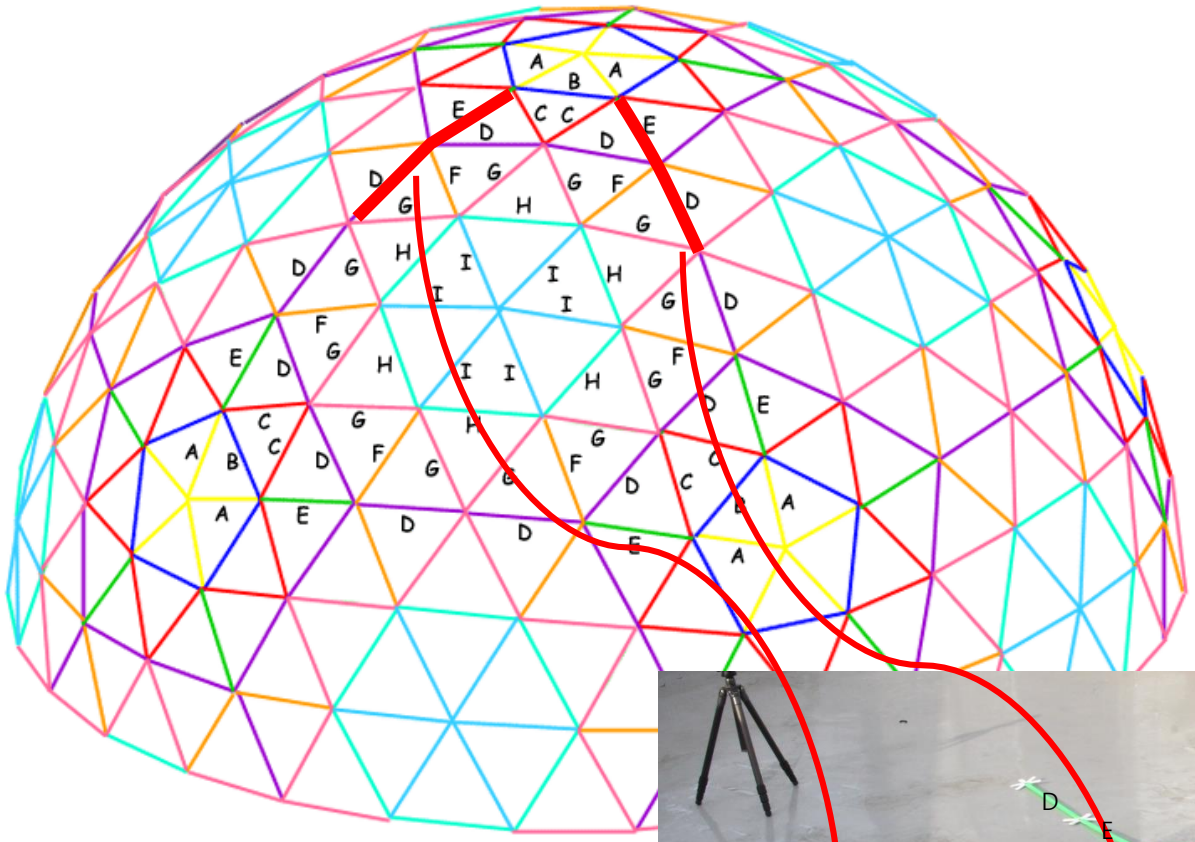


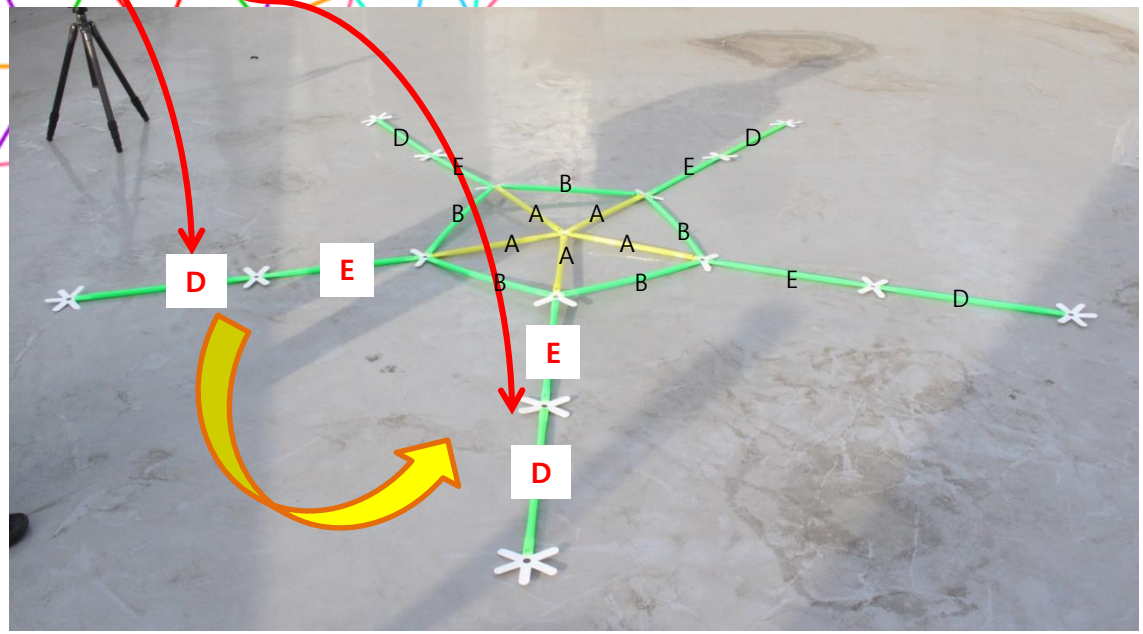




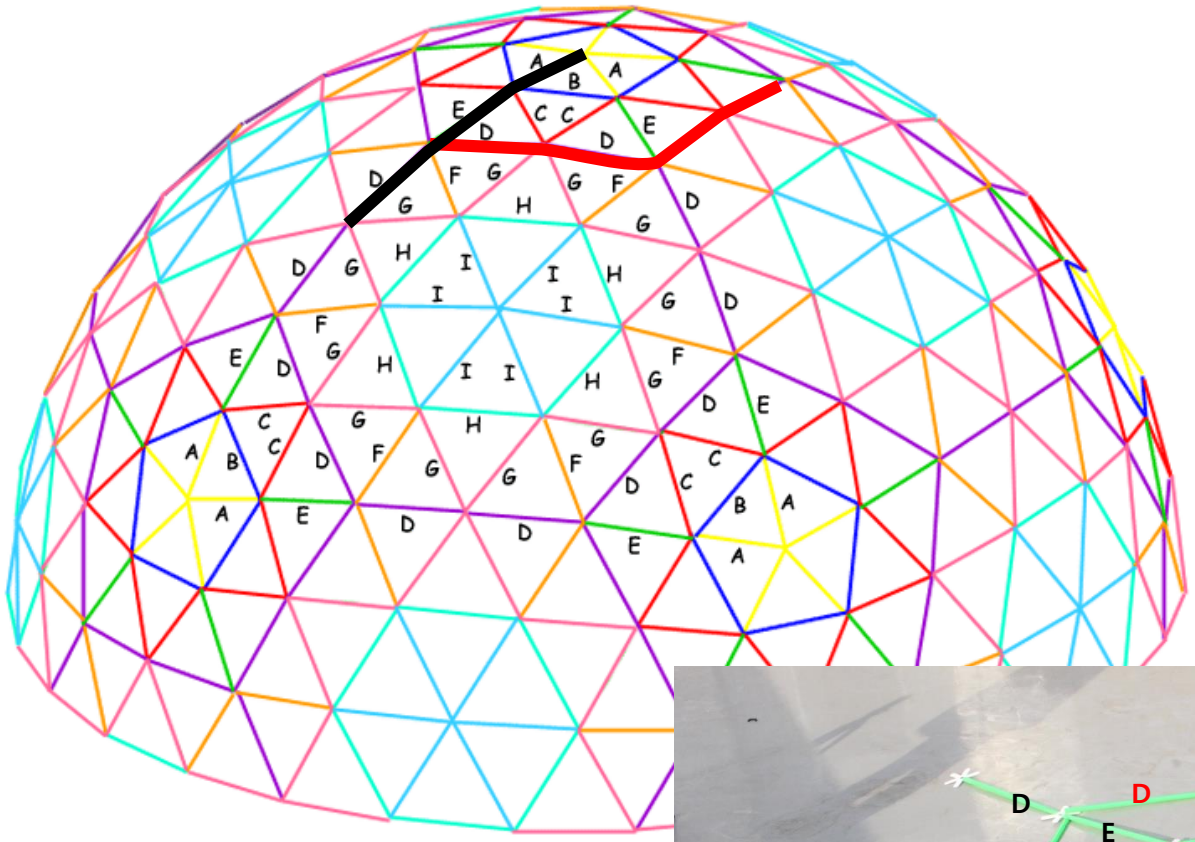


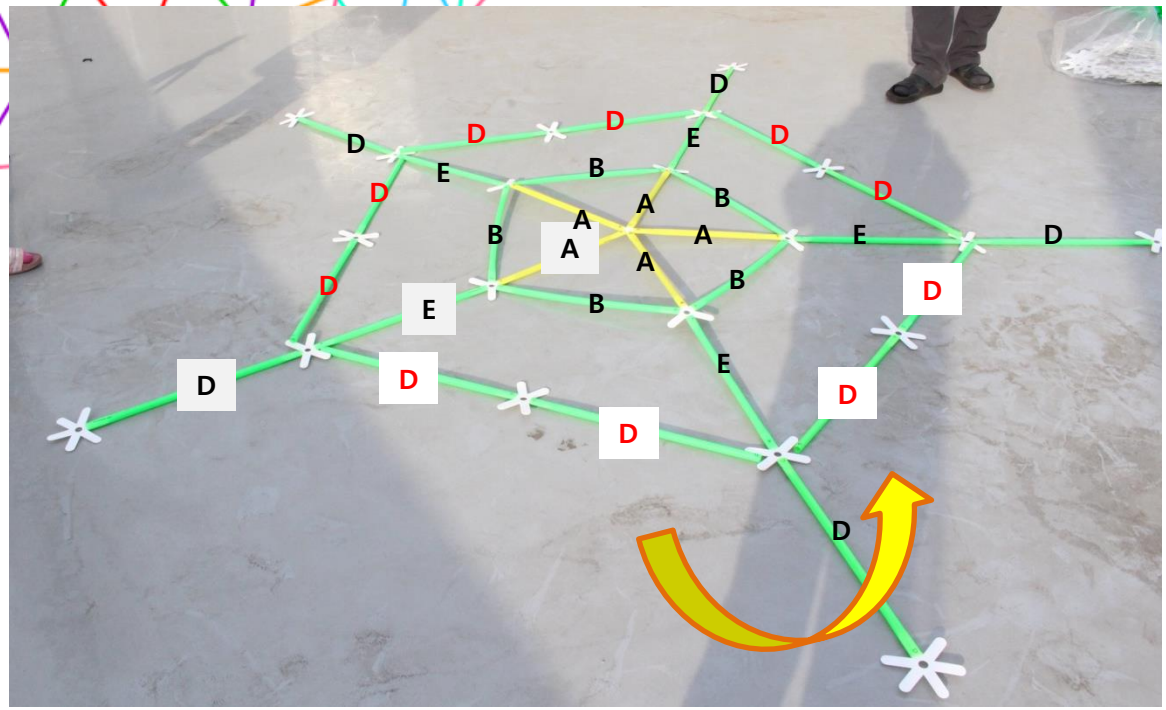
This is top part pentagon building. Inside 5 way connector is used and 6-way connectors has been Used on the 5 sides-boundary. Please use two times-taping in center of pentagon.

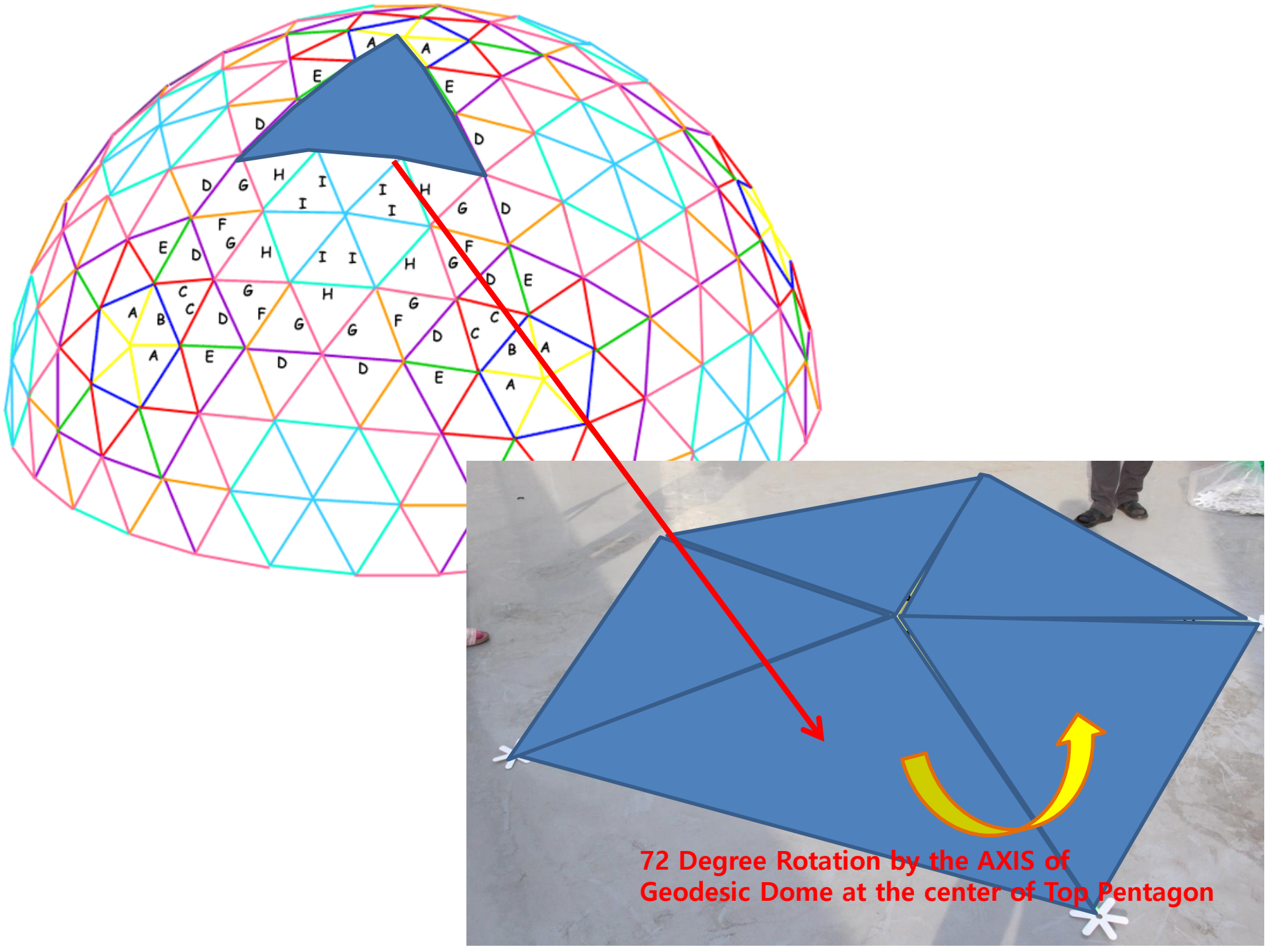




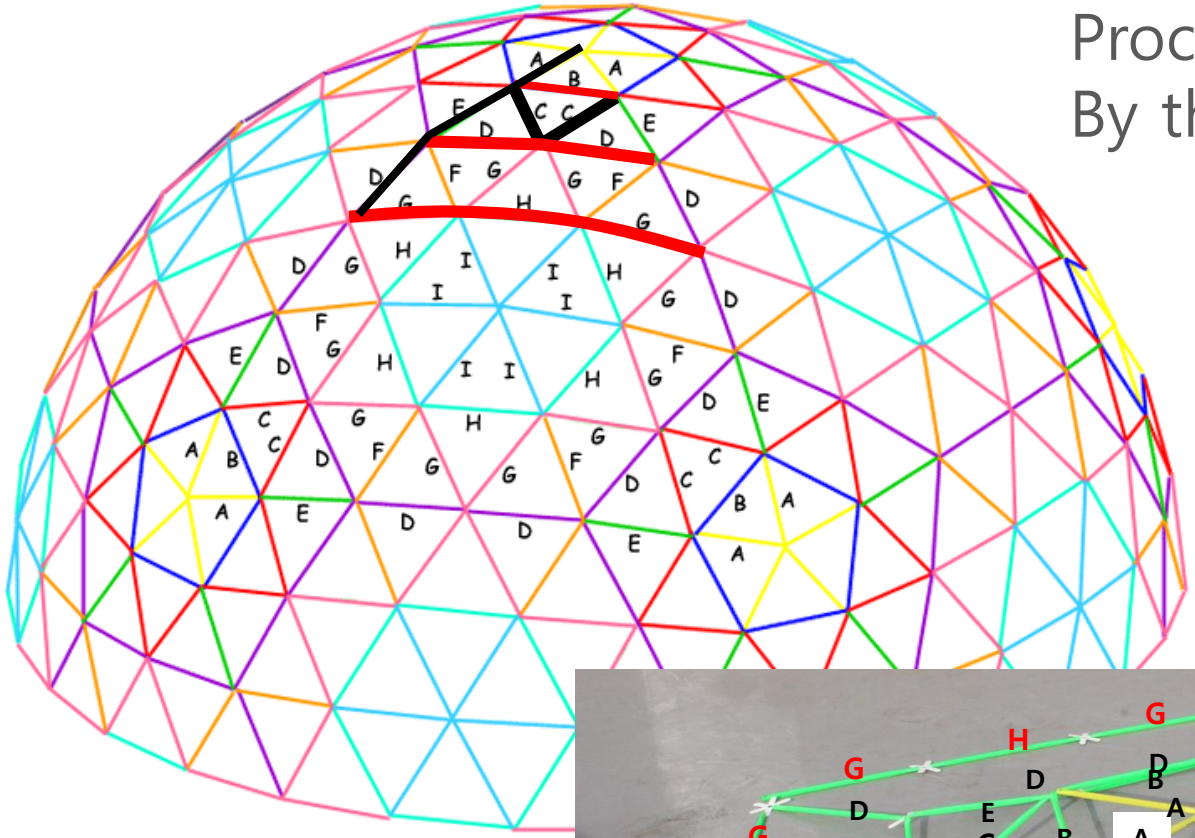
Each side parts have the 5 symmetric shapes
congruent to the letter-wise symbolized
figure part on the above figure.
It means that if you understand
the connecting structure on the forepart,
then the remaining part for connecting
can be done similarly.

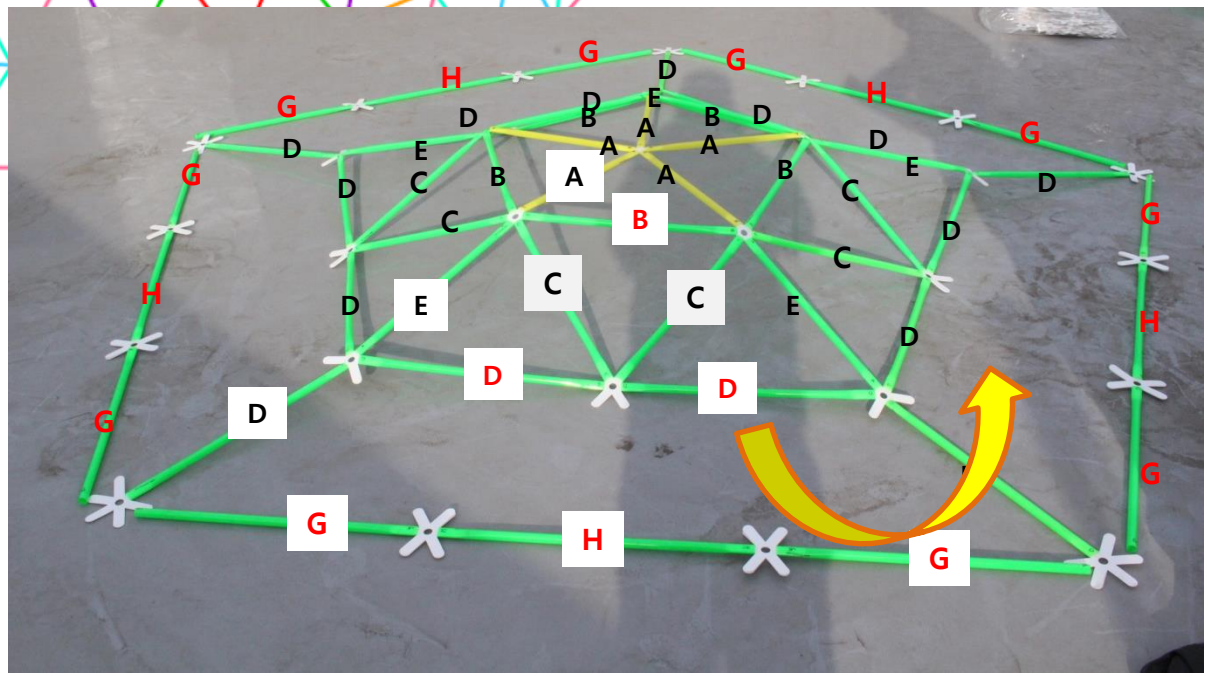


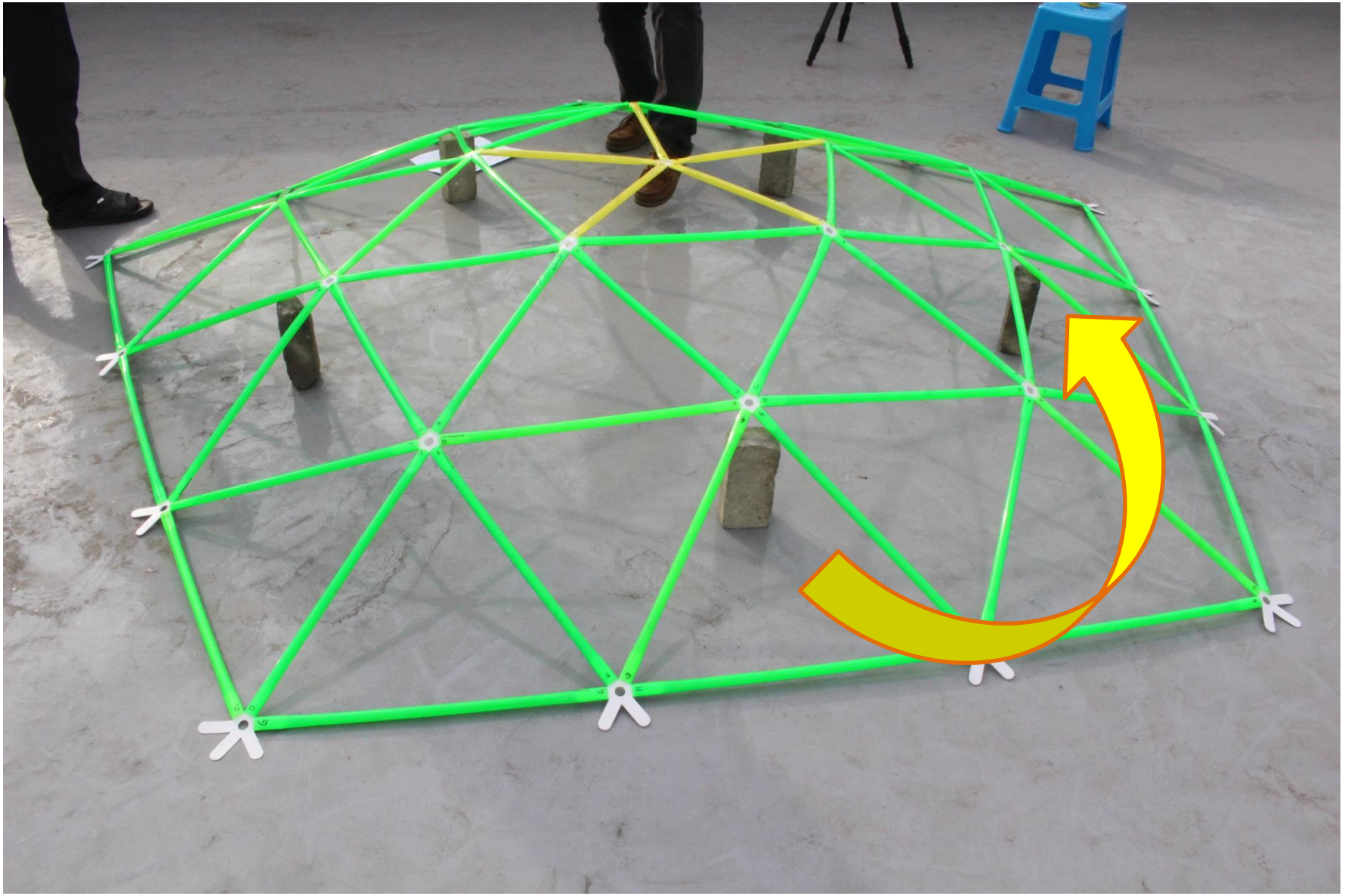

D
D
D
D
E
D
E
B
D
A
B
A
A
B
A
A
E
D
A
D
B
D
E
B
D
D
E
D
D
D
D

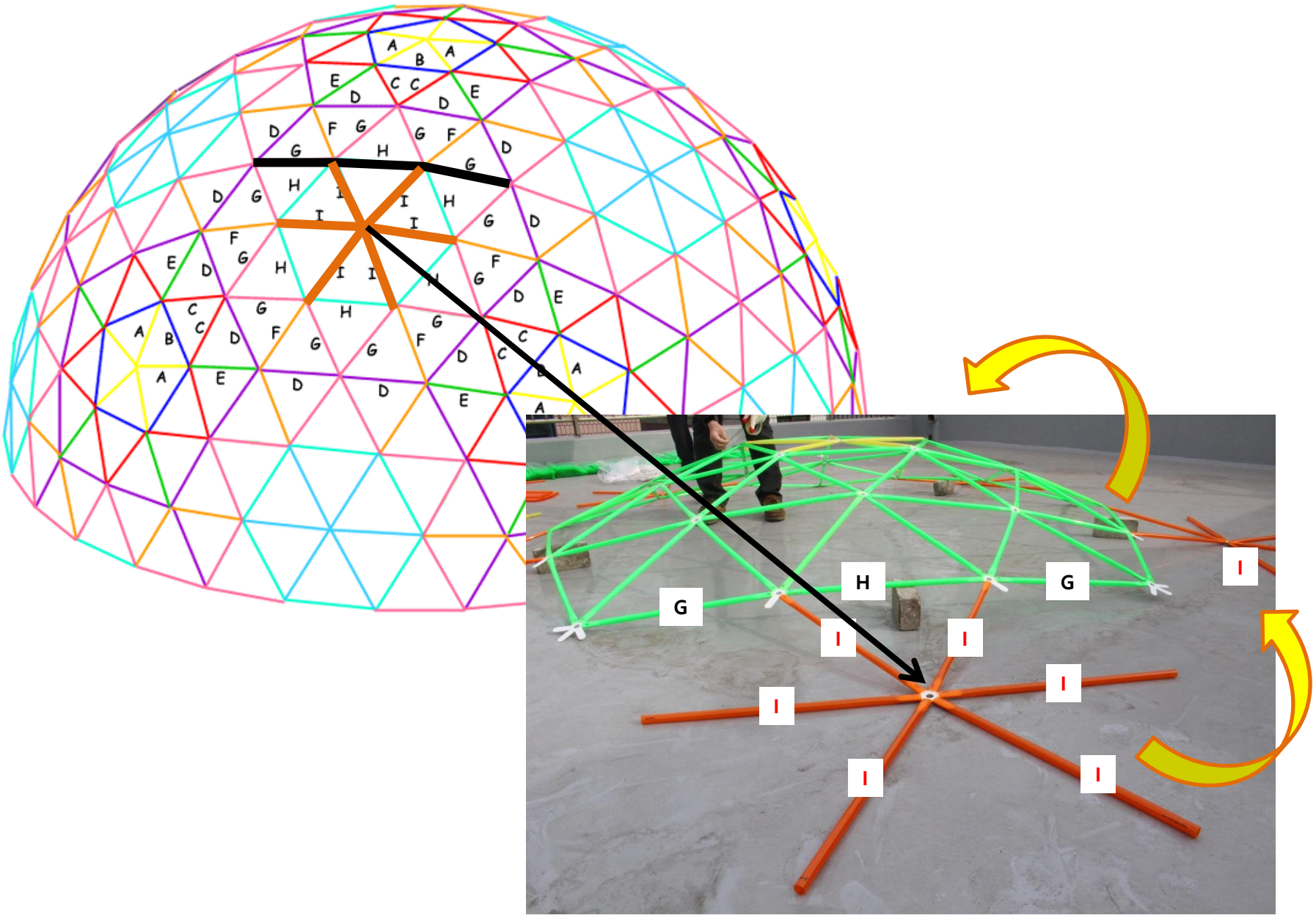

72 Degree Rotation by the AXIS of
Geodesic Dome at the center of Top Pentagon

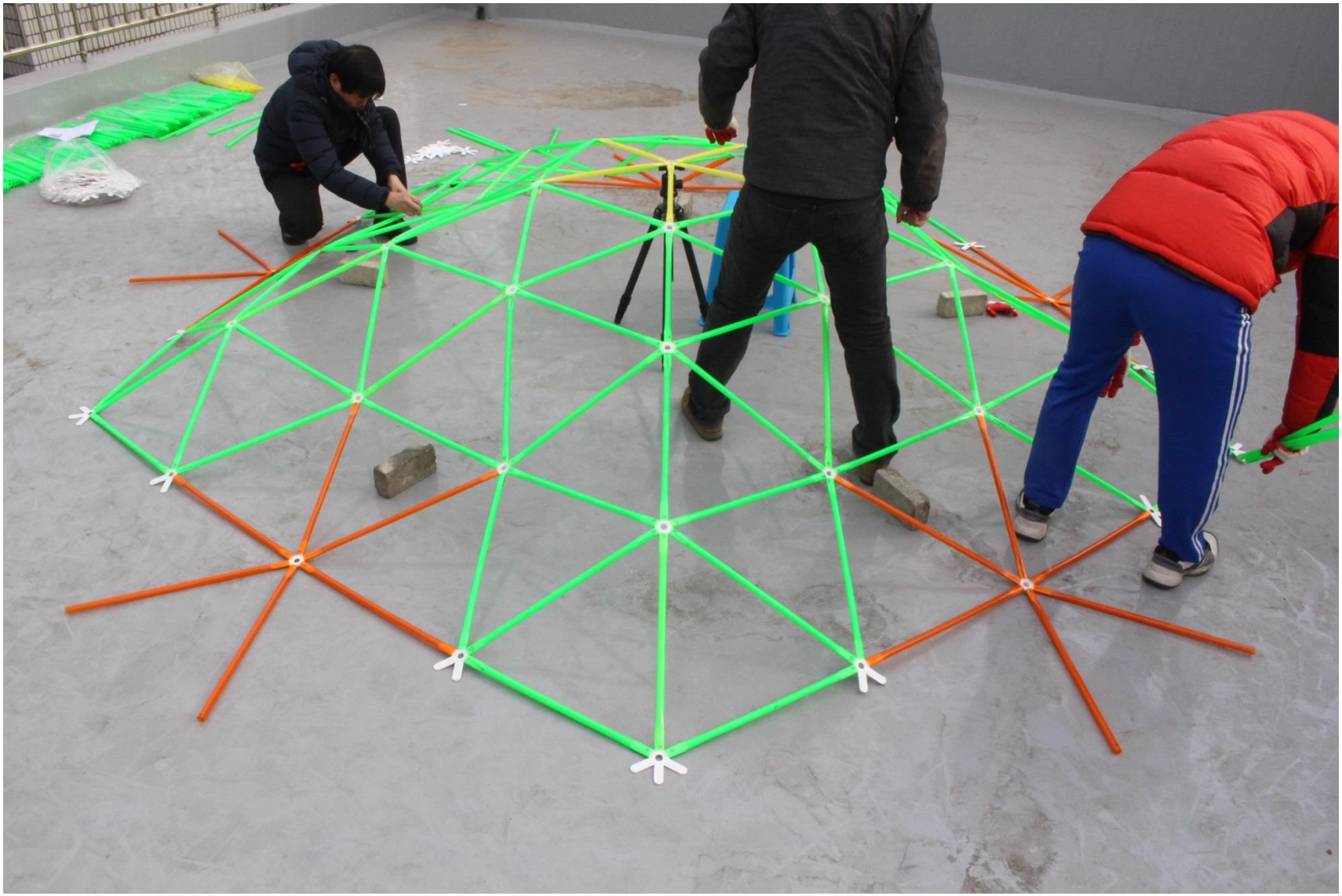
Proceed to connect
By this method

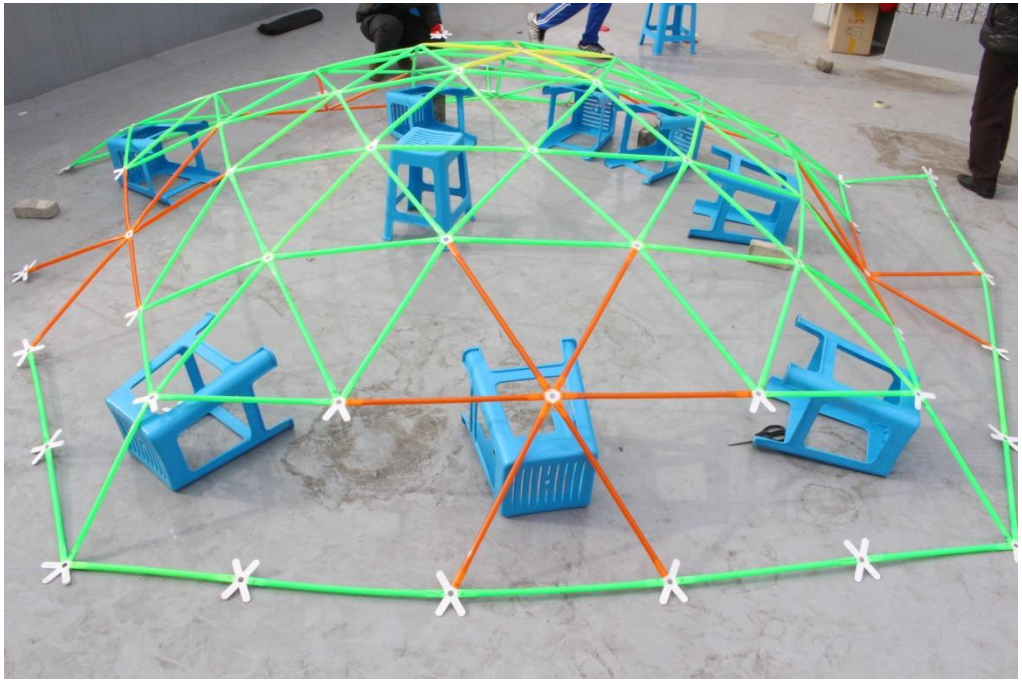


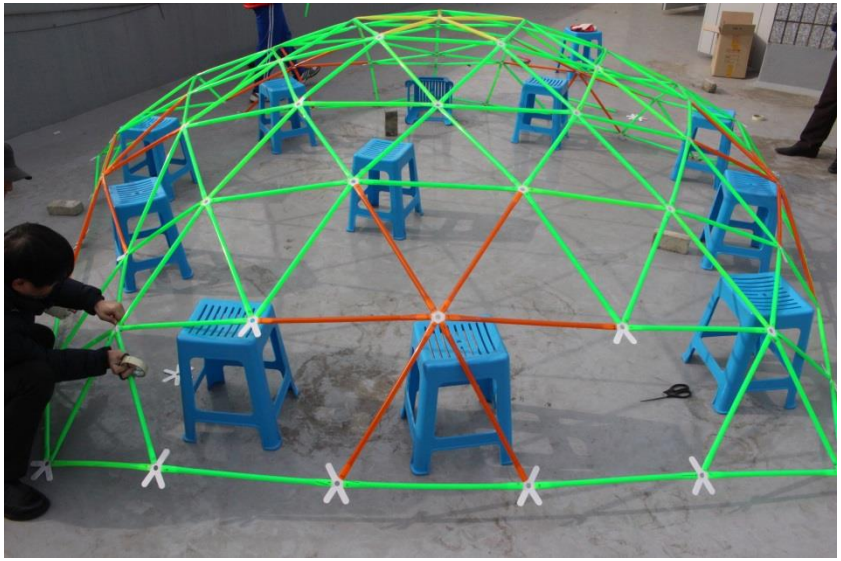


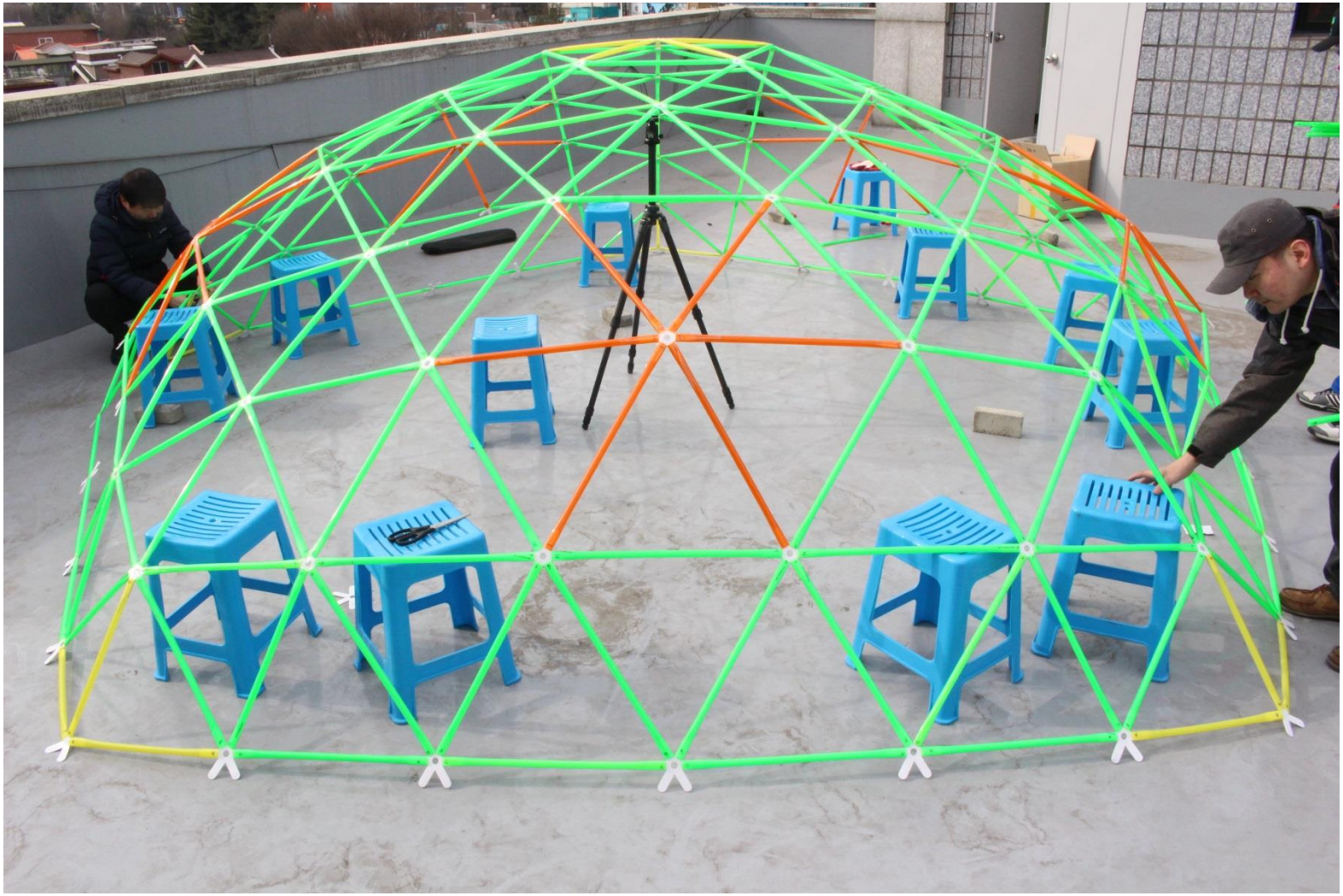


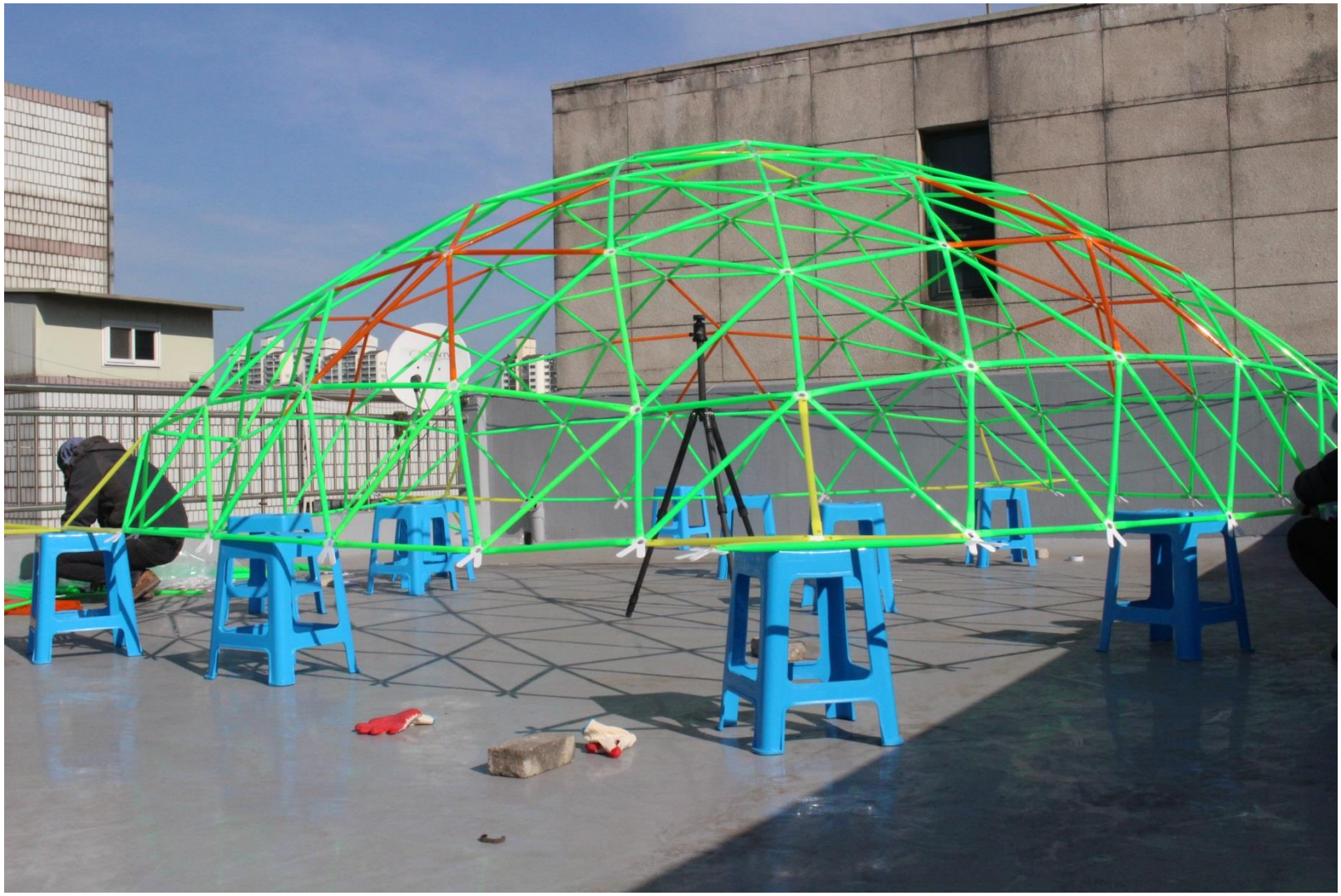

A
B
A
E
D
C C
D
E
D
F G
G F
D
G
H
G
D G
H
I
I I
H
I
I
G
D
F
E
D
G
H
I I
I
G
F
D
E
C
G
H
G
A
B
C
D
F
G
G
F
D
C
C
B
A
A
E
D
D
E
A
H
G
G
I
I
I
I
I
I

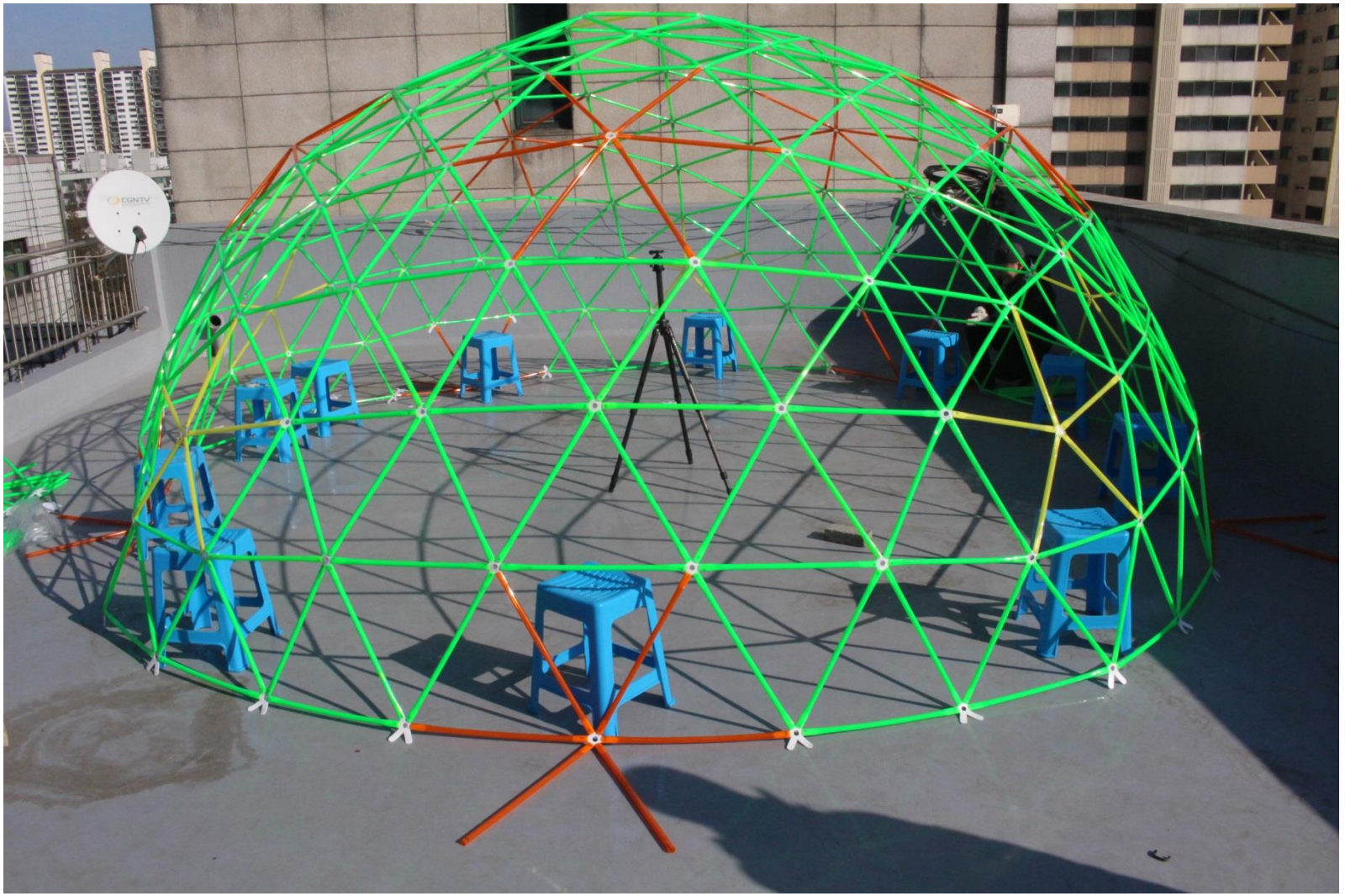


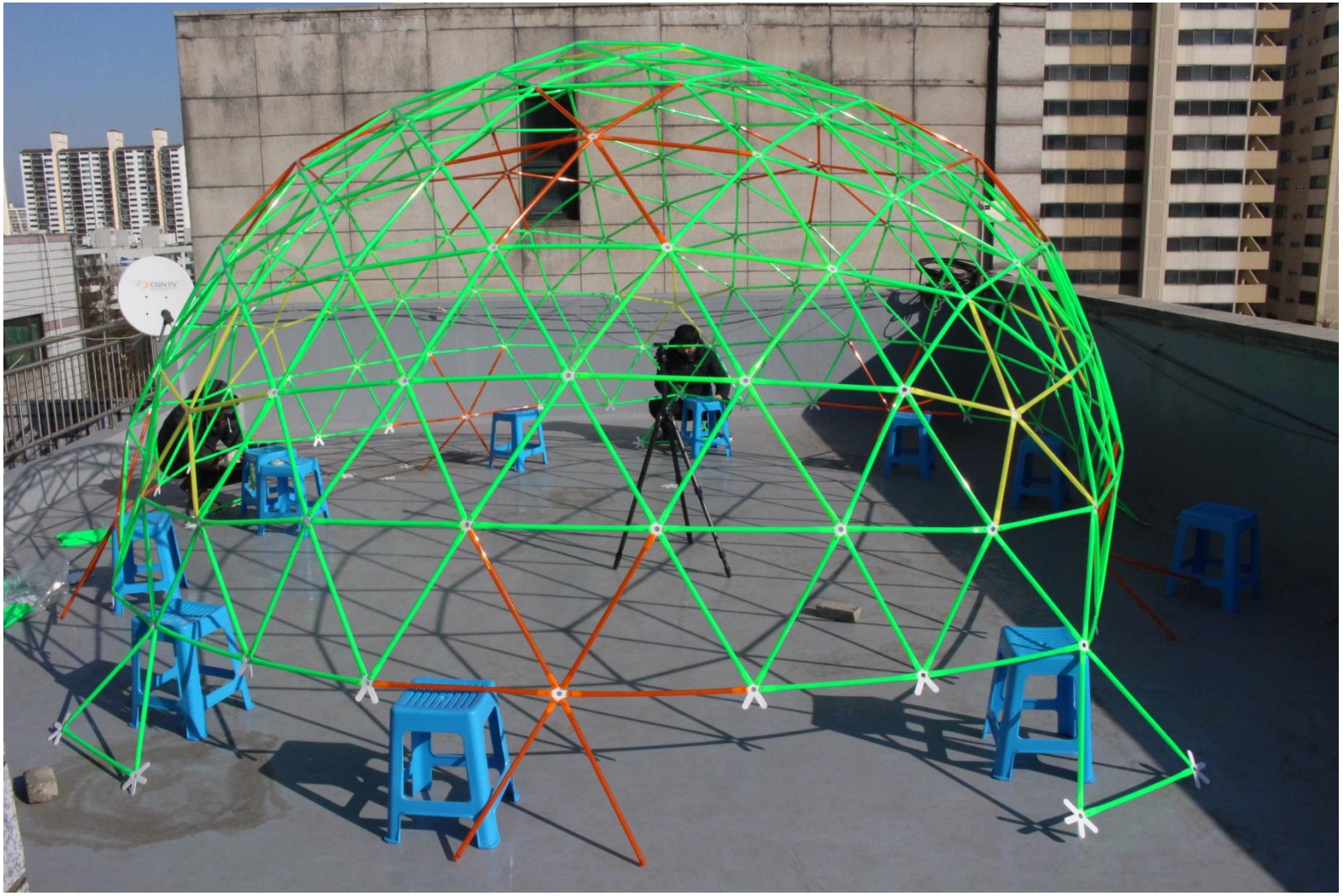




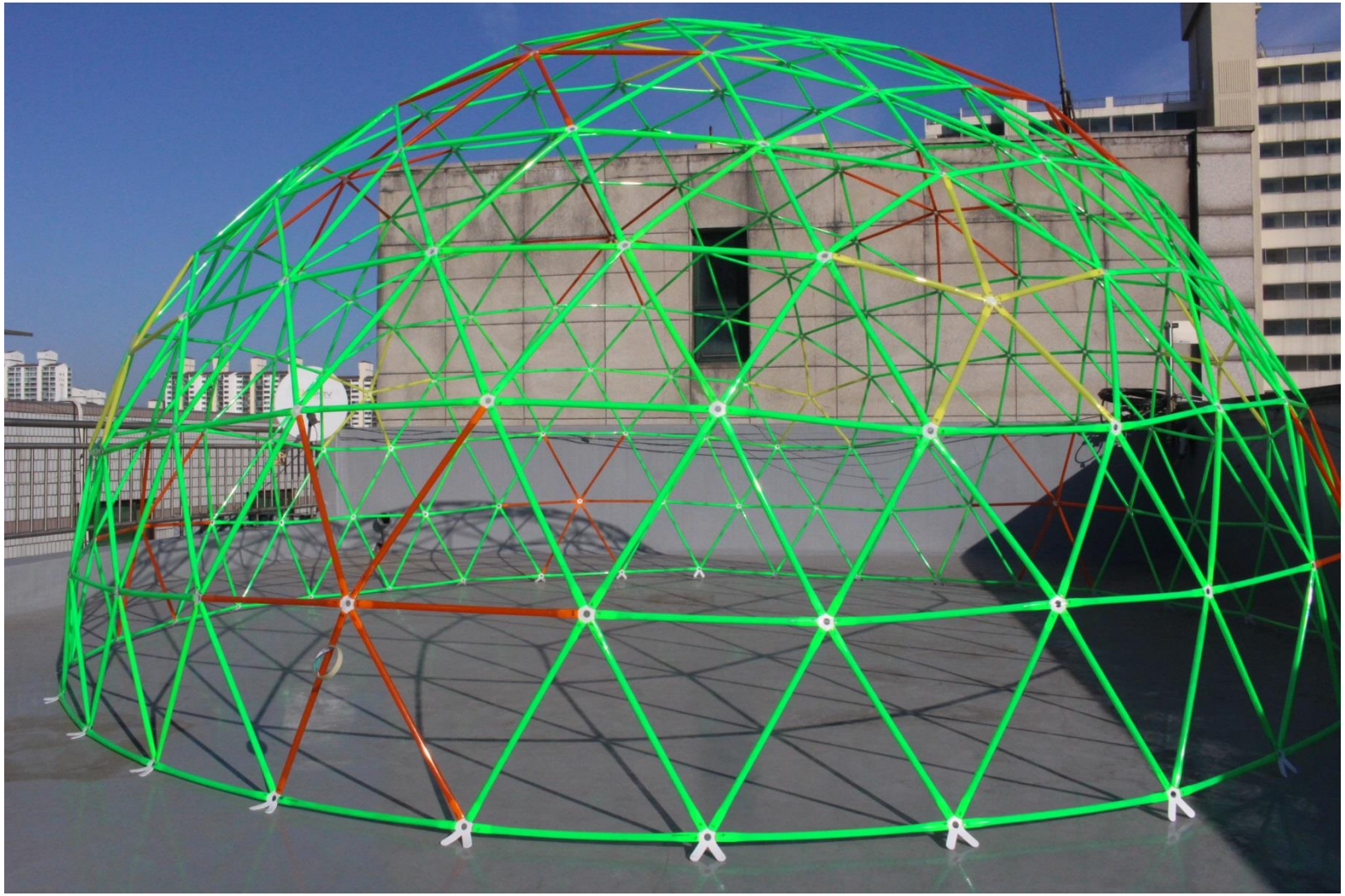


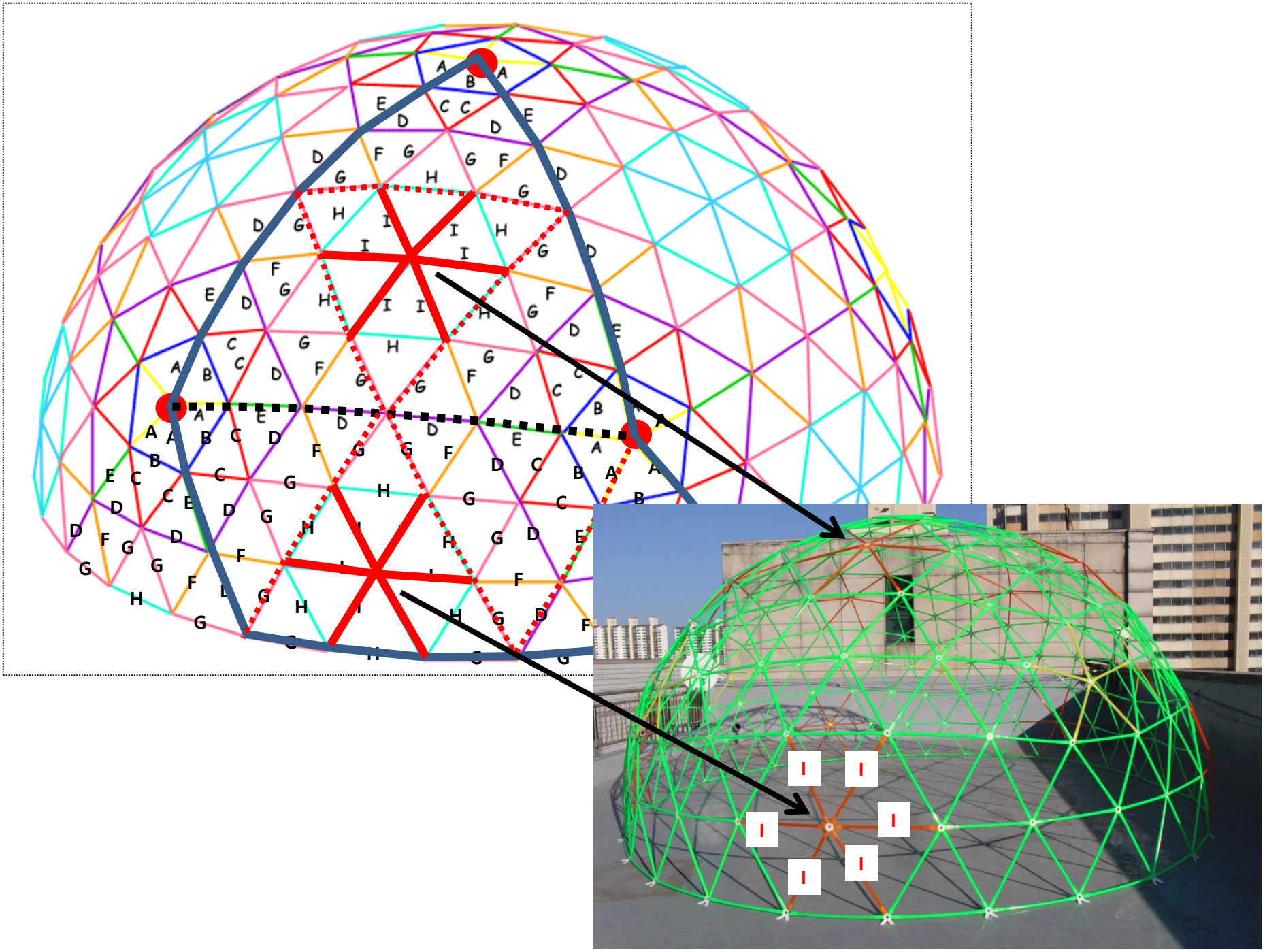



CGNTV


CGNTV

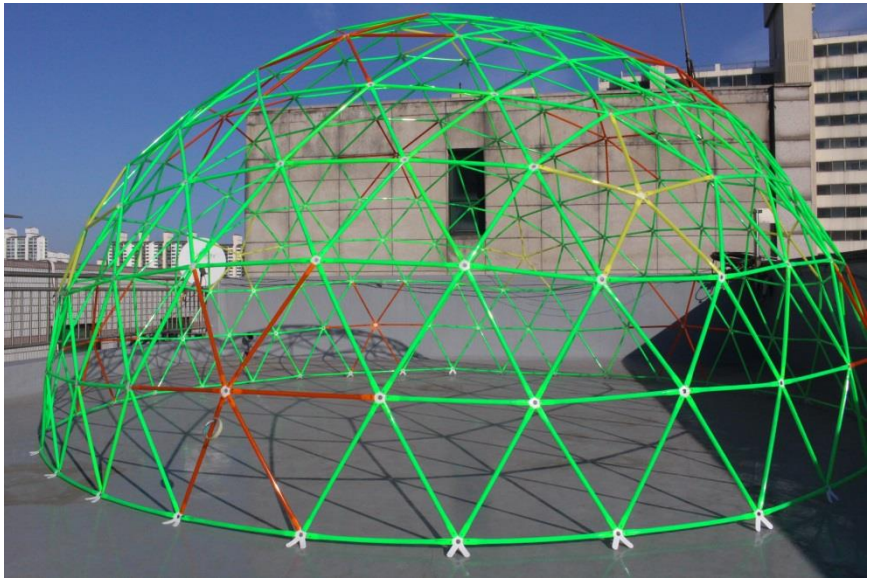
CONCLUSION

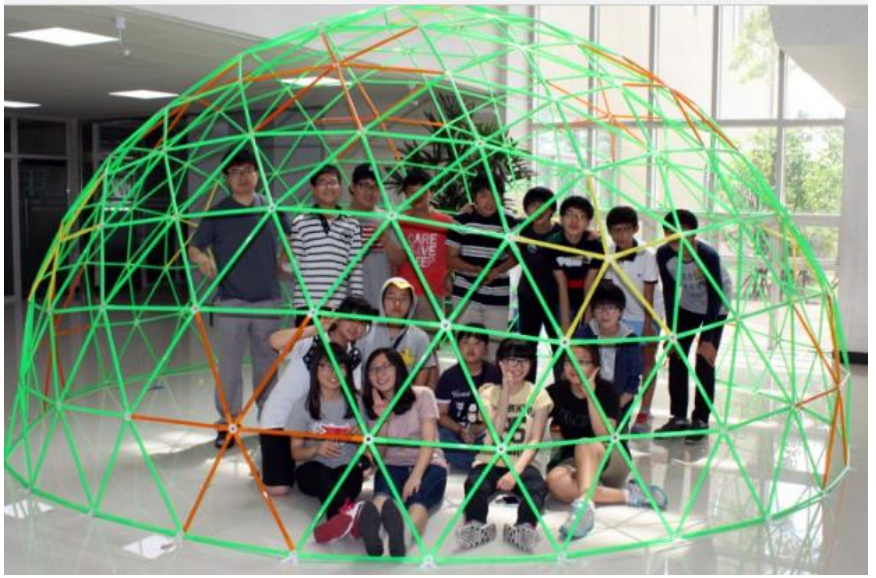



I
I
I
I
I
I

Further process

For extra activities inside of dome, please MAKE some small entrance ROOM after eliminating some part of frames under environment.





EXPERIENCE WORKSHOP

THE EXPERIENCE-CENTERED
MATH/ART MOVEMENT

www.experienceworkshop.hu

EXPERIENCE WORKSHOP

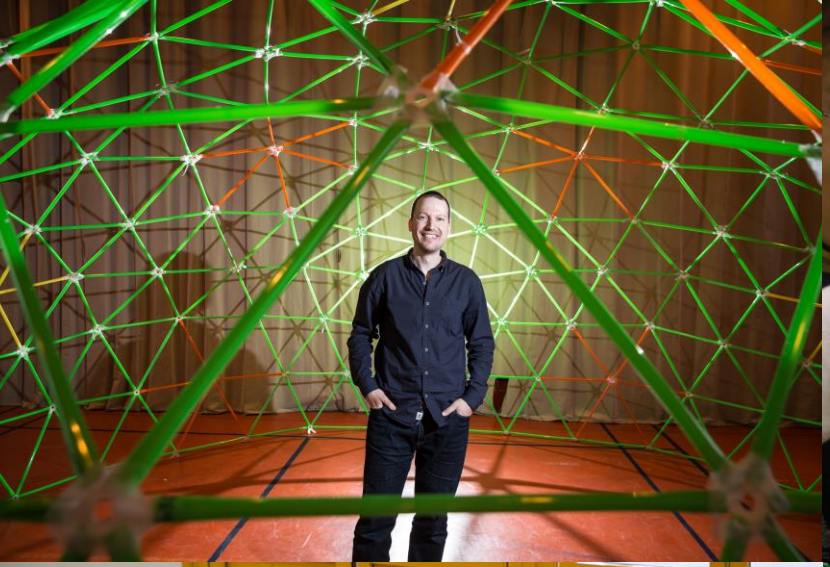
THE EXPERIENCE-CENTERED
MATH/ART MOVEMENT

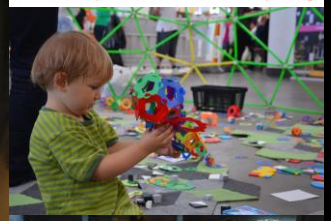
www.experienceworkshop.hu

Work in pairs or in small groups! Work as a team of engineers!

You need to solve a given problem within a given amount of time, based on a given amount of resources:

- Set goals
- Make plans
- Do tests
- Record the thinking / design process
- Do more with less





EXPERIENCE WORKSHOP

THE EXPERIENCE-CENTERED MATH/ART MOVEMENT

www.experienceworkshop.org

Interested in STEAM? Looking for support in connecting mathematics & art in education? Do you have a good idea?

Contact us: info@experienceworkshop.org

Website: www.experienceworkshop.org

Facebook: www.facebook.com/experienceworkshop.math.art