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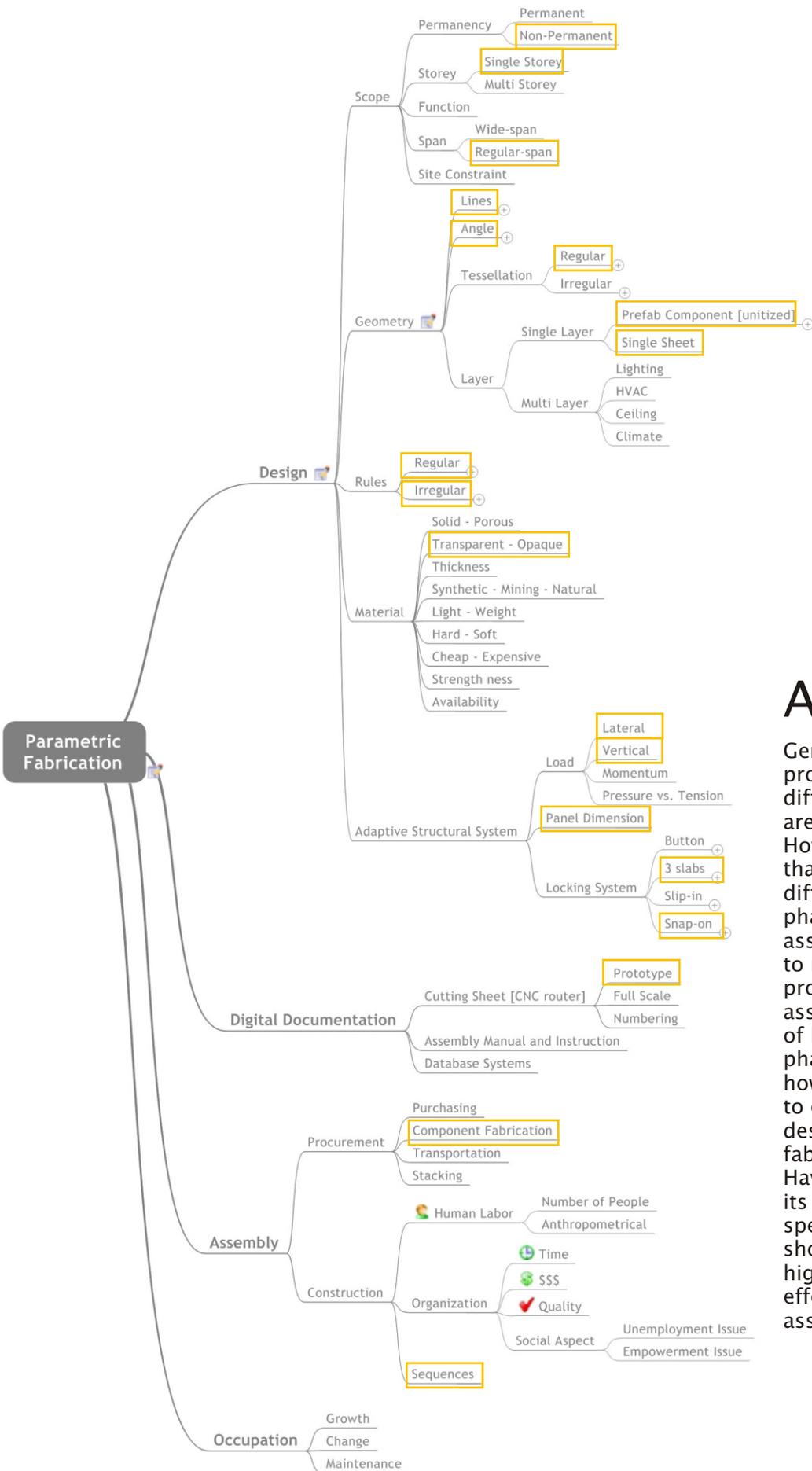
4.510 Digital Design Fabrication
Fall 2008

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Digital Design Fabrication Final Project

Professor : Larry Sass

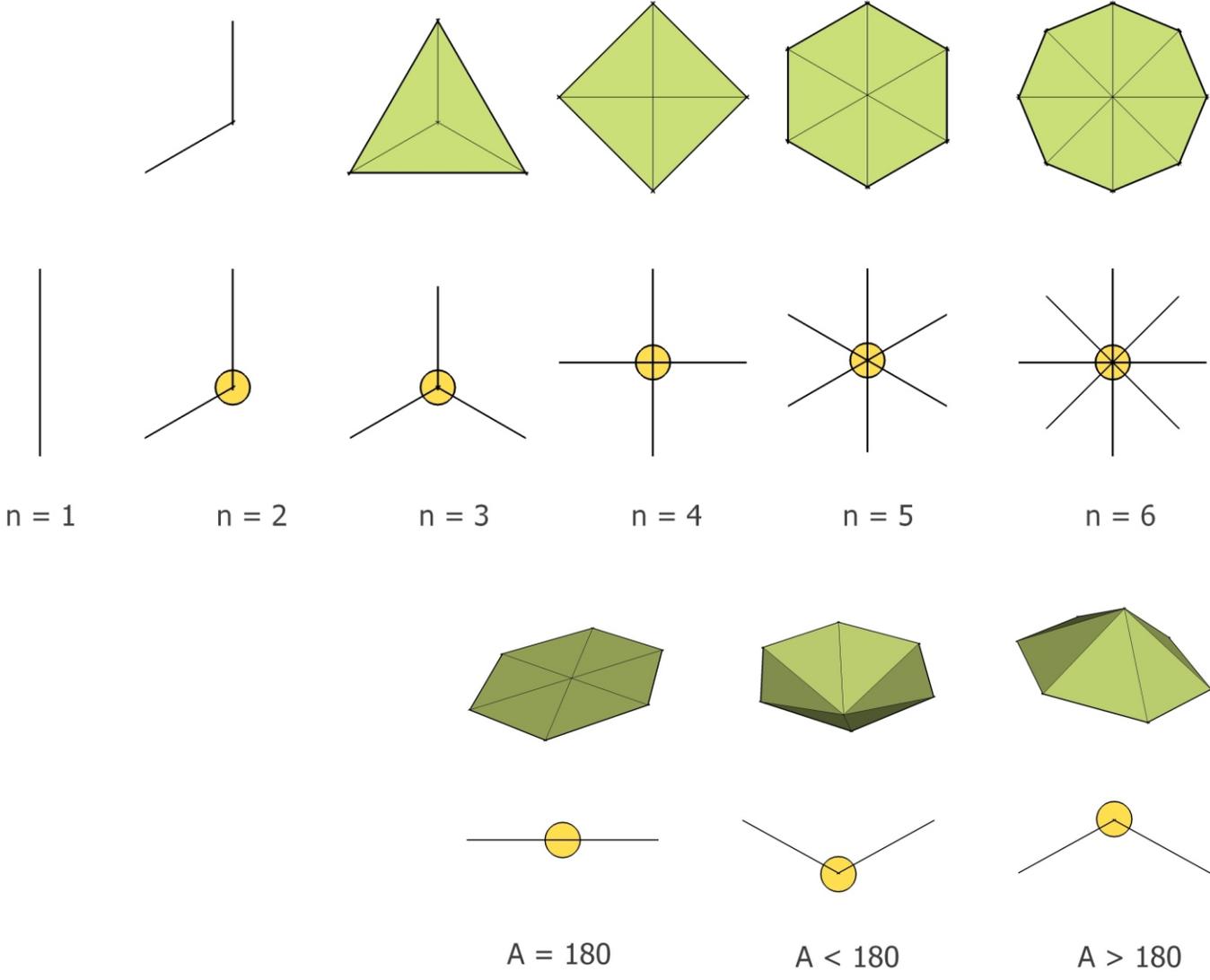


Abstract

Generally, every architectural project is designed based on different needs and desires, which are affected by different situations. However, there are similar phases that involves different groups with different specialization. These main phases are: design, documentation, assembly and occupation. In order to maintain the integration of the project, each phases should be assessed with a critical evaluation of how it will affect the other phases. In this project, we exercise how the role of fabrication related to each phase, and how particular design will define the role of fabrication in architectural project. Having evaluate these phases and its complexity, we end up with a specific goal: design components should be as simple as possible, yet highly flexible, versatile and effective to cover all aspect in assembly and occupation period.

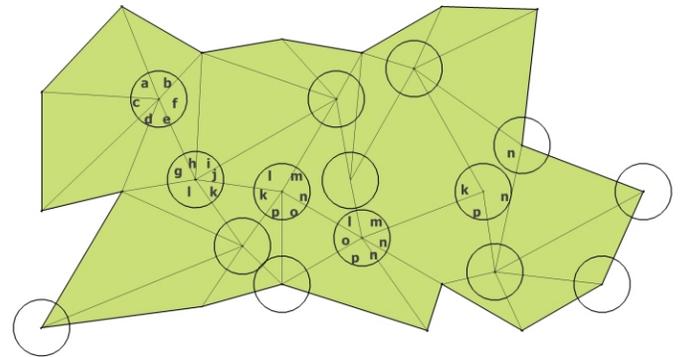
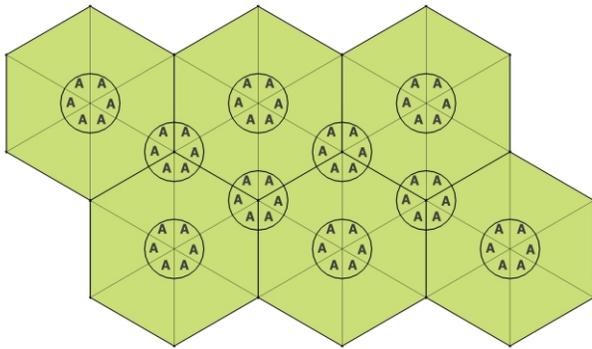
Line and Angle

The position of any connection joint on the triangular divisions surfaces can be categorized by how its angles related to the other. They can be 180° , less than 180° or more than 180° . Also, all of these joints may have different number of surfaces that connected to each other.

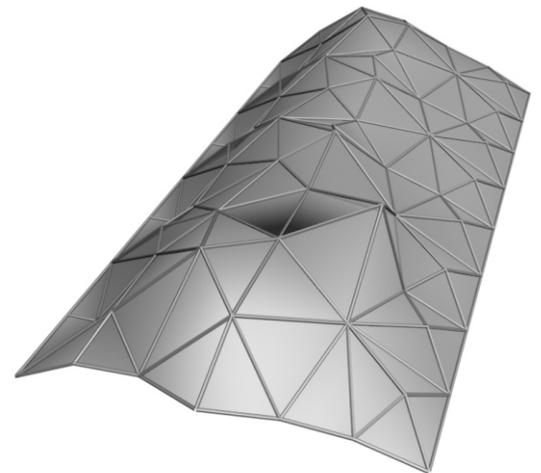
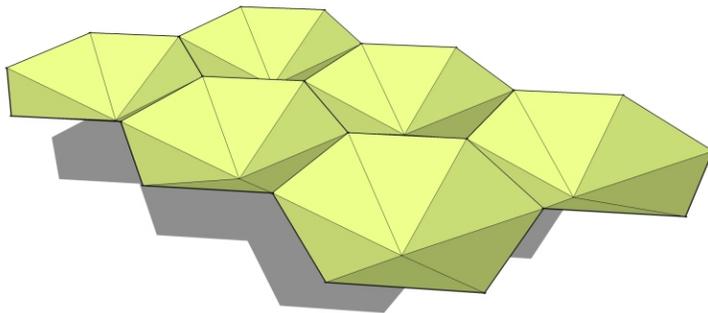


Tessellation

Whether its a symmetrical or asymmetrical surfaces, members with different angles can be connected to a single point. This angles are adopted by allocating their position relatively to the other surface (180° , $<180^\circ$, $>180^\circ$). In symmetrical surfaces, members are placed with the same distance and the same angle to each other. In contrast, asymmetrical patterns have different distance and different angle among each members.

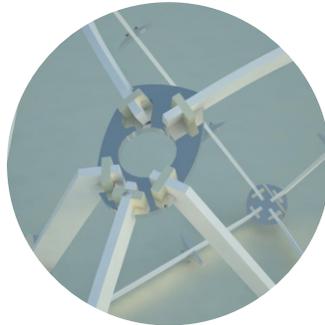
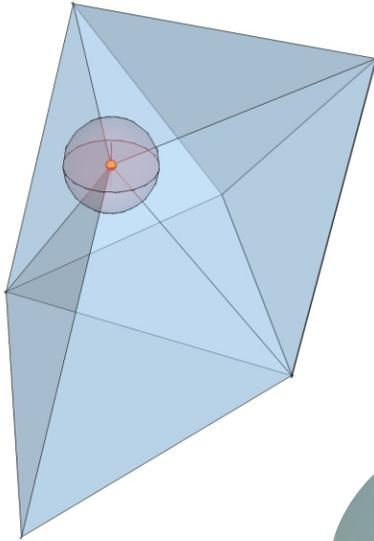


1 . Surface with symmetrical tessellation .

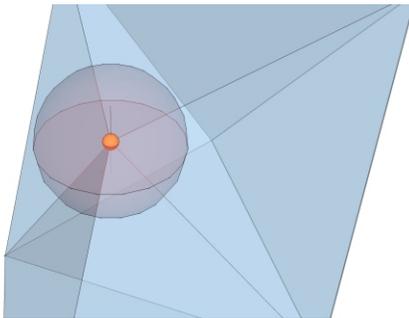


2 . Surface with asymmetrical tessellation

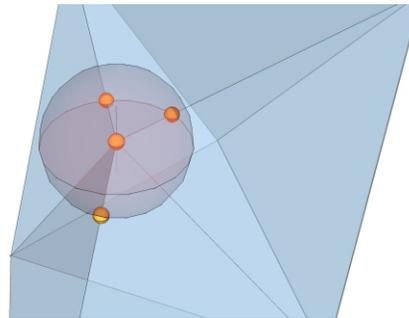
Rules : Regular Form



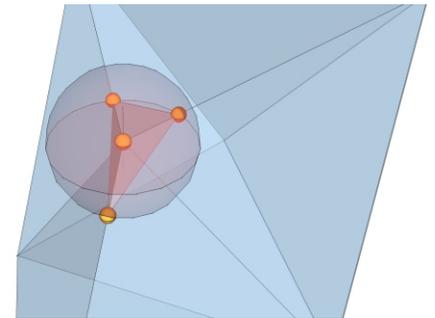
In order to design proper joint for each node, different methods may be used. For instance, to find the surface for base joint element in symmetrical joints, we may cross a sphere centered on all members intersection point with a radius based on elements length. Then from the intersection of the sphere and the members of surface, a surface will be created. This surface lies in the exact location of joint base part. After finding the best position for base part, which is following the angle between each members, we can find suitable angle between supporting members and base joint.



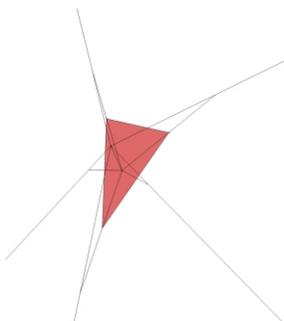
1. Draw a sphere with radius R centered on joint



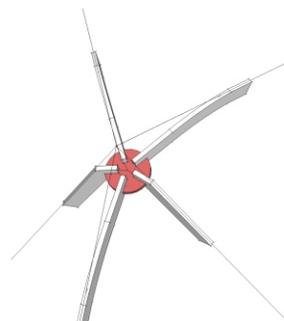
2. Find sphere intersection with lines



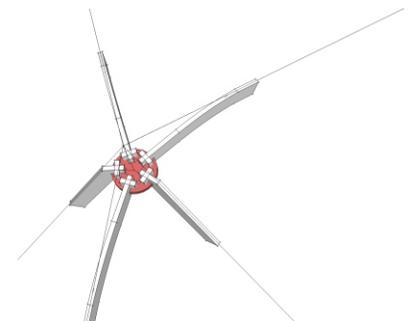
3. Find the surface crossing from these nodes



4. Find the polygon for joint base connecting part

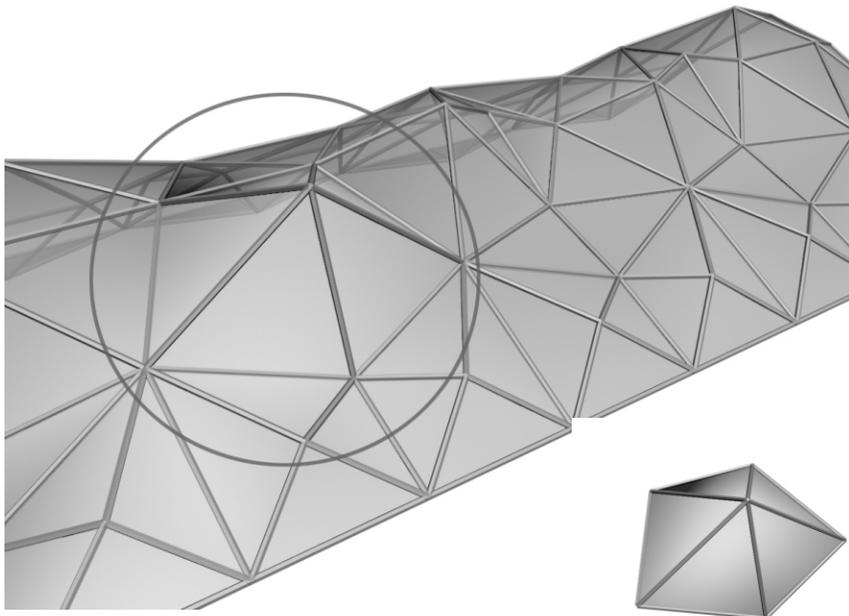


5. Create supporting elements to joints base

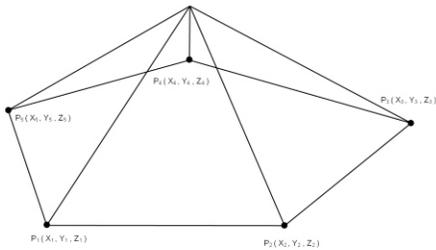


6. Lock the parts to stabilize the whole parts.

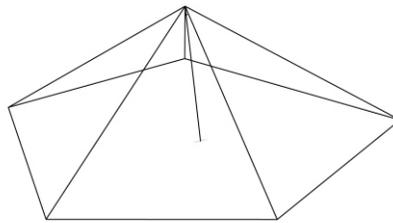
Rules : Irregular Form



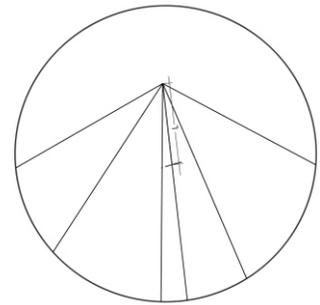
In designing joints in asymmetrical surfaces, it is not possible to use sphere method, because the intersection nodes may no longer exist on one flat surface. In order to find a line normal to the surface for our base joint part, we may find a point by average point position of all other corner points of this set of connected triangular surfaces. The line which connects this new point and center point of joint maybe used as normal line to the surface on which we can set or base joint element.



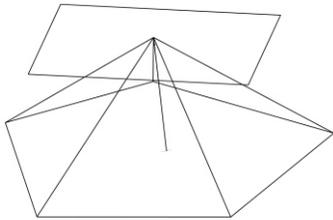
1. Find the corner points x, y and z position in space



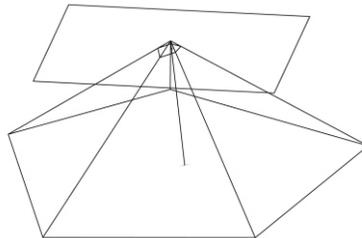
2. Find point B position with average of x, y and z position



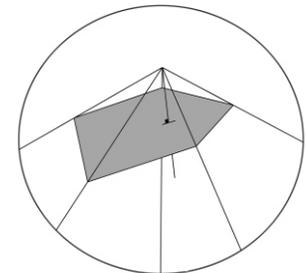
3. Divide length L from line AB .



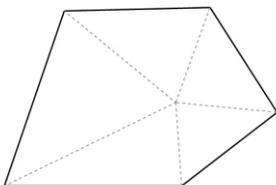
4. Draw a surface normal to line AB from length L



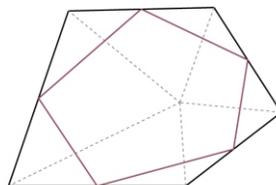
5. Intersect the surface with all other joint's lines



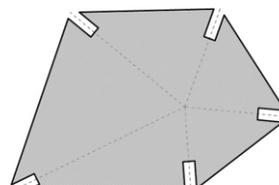
6. Draw a polygon with intersection points



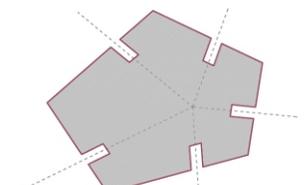
7. This polygon can be used as joint base element



8. Make notches at corners. For having notches at sides instead of corners draw a polygon by connecting center point on all sides of existing polygon.



9. Finally, make notches on sides



Connection Hub

Each connection hub in the design is consisted of three fundamental parts: base connection joint, supporting members and locking parts. The base part is shaped base on number of equilateral triangles surfaces joining together. Also, angle of supporting members with base parts is derived from angle between surfaces.

As our design was base on tetrahedron and octahedron shapes, we tried to design joints with different number of surfaces to each node.



1 . Connection hub with three supporting member



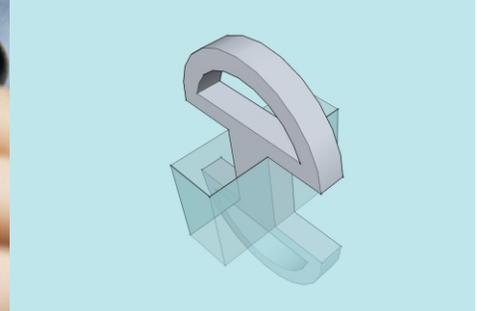
2 . Connection hub with four supporting member



3 .Connection hub with five supporting member

Locking System

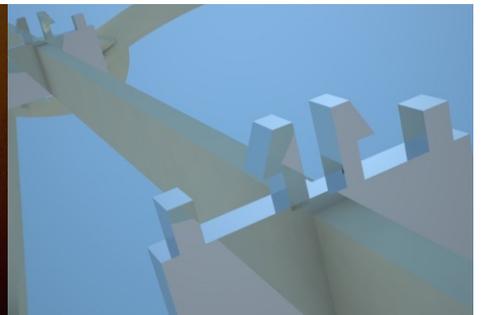
A variety of locking methods may be acquired with different shapes and in different positions. According to the materials qualities and combination of different material in a single joint, locking systems may vary. Here are some different locking systems:



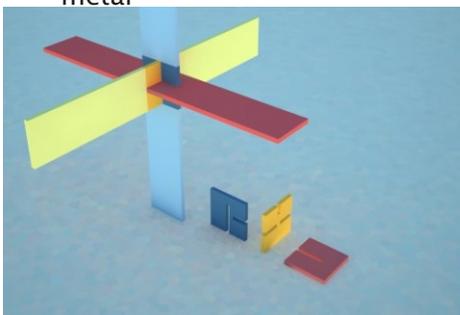
1. Button system which only uses one piece for holding panel



2. Lock system which uses 2 pieces for holding panels and can be used to hold several panels at the same time

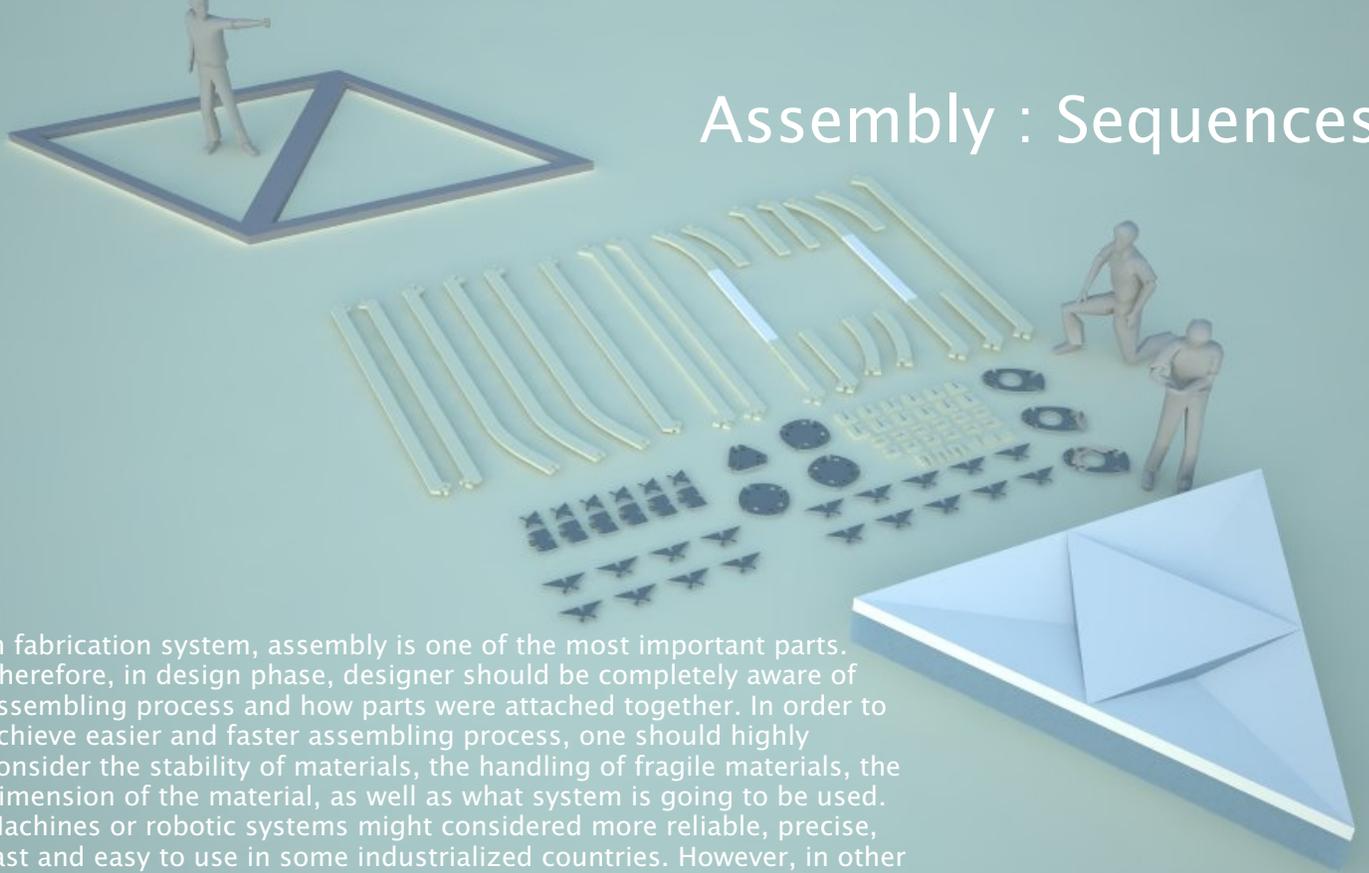


3. Spring joint system which works with flexible materials such as metal

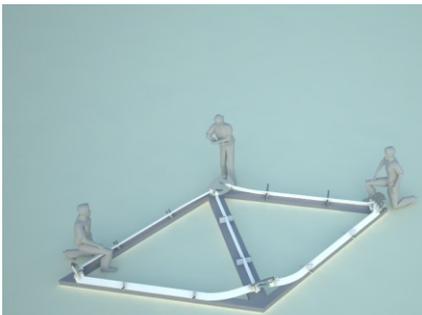


4. Interlocking system which consists of three different piece with three different axes (X,Y,Z) that hold each other in place

Assembly : Sequences



In fabrication system, assembly is one of the most important parts. Therefore, in design phase, designer should be completely aware of assembling process and how parts were attached together. In order to achieve easier and faster assembling process, one should highly consider the stability of materials, the handling of fragile materials, the dimension of the material, as well as what system is going to be used. Machines or robotic systems might considered more reliable, precise, fast and easy to use in some industrialized countries. However, in other countries, labor cost might more reasonable and preferred comparing to machines.



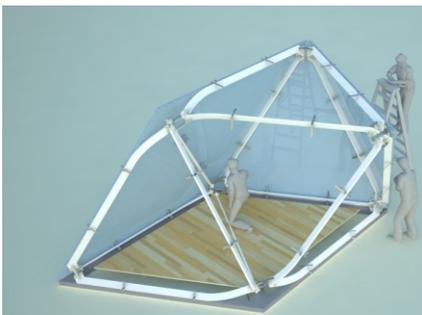
1. First, lower members will be assembled together which make a base for the rest of structure.



2. Vertical members are connected to the base.



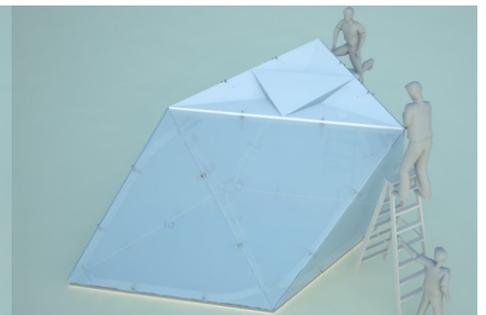
3. Top member complete the whole structure and hold all parts together.



4. Attach the façade, floor and ceiling panels to the main structure



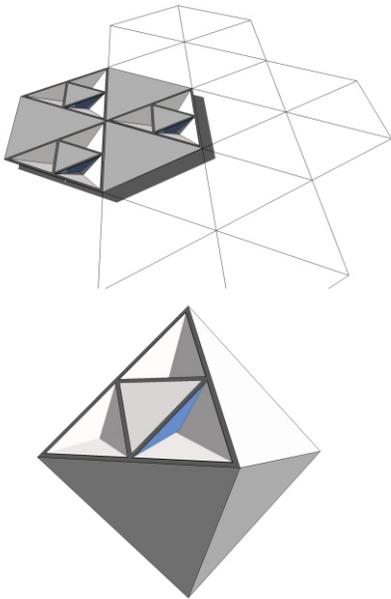
5. Panels are attached using spring joint system



6. These panels can be consisted of simple or complex panel

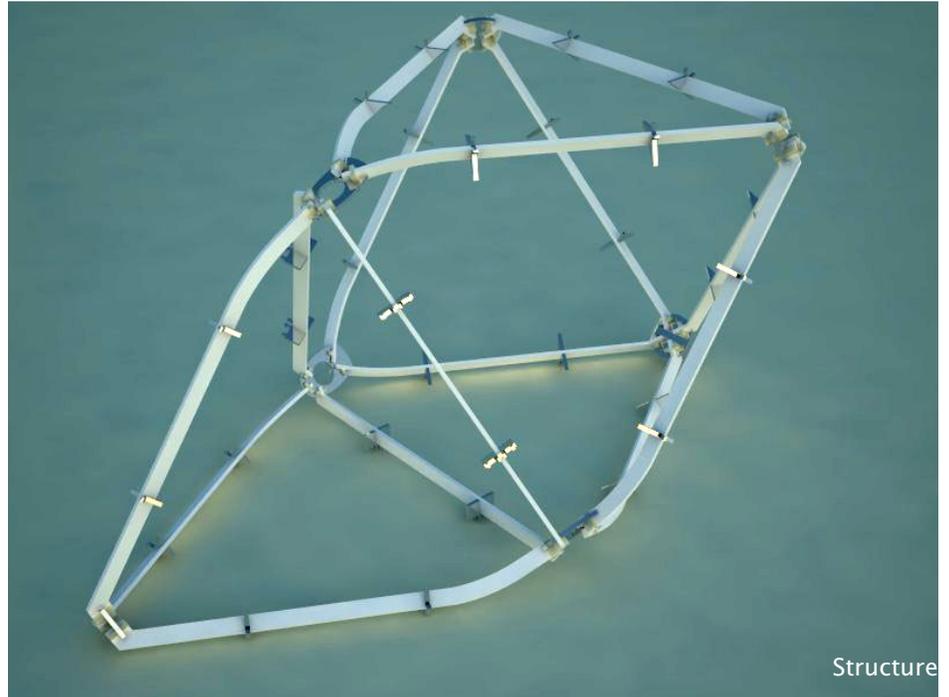
Structure + Skin

Structural element should be designed in a way it support special kind of skin material with specific weight, size and flexibility. Also it should be considered whether this building is going to be permanent or non-permanent. In non-permanent buildings practicability and speed of assembly /disassembly process is highly important, while in permanent buildings, stability and rigidity are more important.

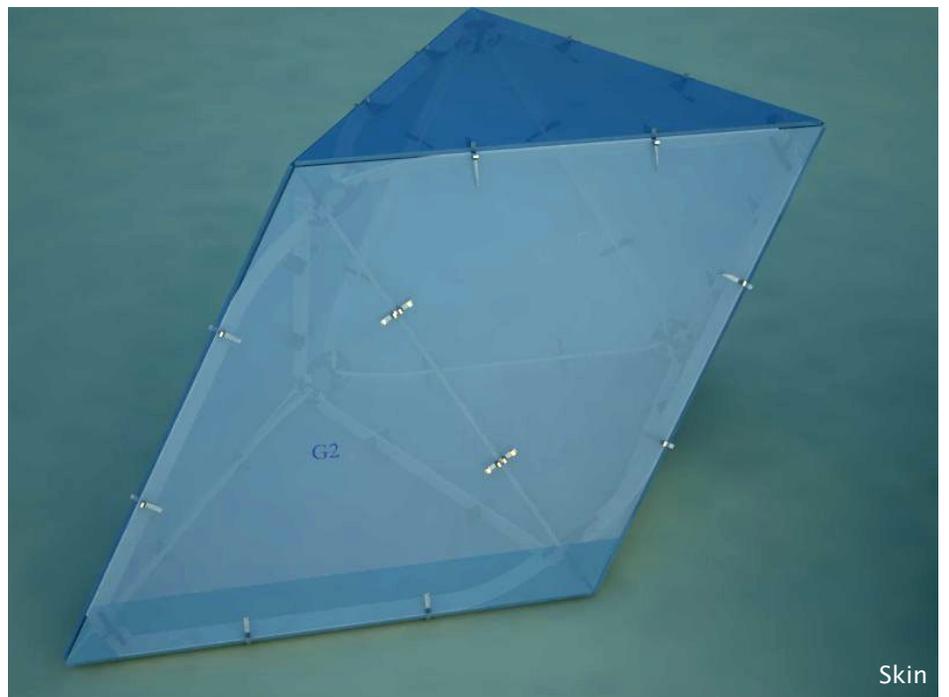


Complex Surface

Based on architect design, each of these surface panels can be simple or complex according to the combination of different materials and shapes. It may act as a single layer (unitized system) or multi-layered panel with more movable parts within them.



Structure



Skin

