LASER CUTTING ASSIGNMENT –TRUNCATED ICOSAHEDRON

Introduction:

A truncated icosahedron is a convex polyhedron obtained by truncating (cutting off) the 12 vertices of a regular icosahedron. It consists of 12 regular pentagonal faces, 20 regular hexagonal faces, 60 vertices, and 90 edges

The objective of this project was to design a hollow truncated icosahedron sphere with a 50mm outer diameter using MDF (2mm thickness) for laser cutting and assembly.

Design Specifications:

- Outer Sphere Diameter: 50mm
- Material Thickness: 2mm MDF
- Composition: 12 Pentagons + 20 Hexagons
- Edge Length: 19.5mm

Design Procedure:

Step 1: Start a New Sketch

- Open **Fusion 360** and create a new design.
- Start a new **2D Sketch** on the XY plane.

Step 2: Construct the Base Polyhedron

- Create a pentagon and define the edge length as 19.5mm.
- Draw a centreline from the middle of the pentagon along the Z-axis.
- Add a circle and constrain it to match the pentagon.
- Convert some construction lines for reference.
- Draw connecting lines between the pentagon and reference points to form a base shape.

Step 3: Define Additional Layers

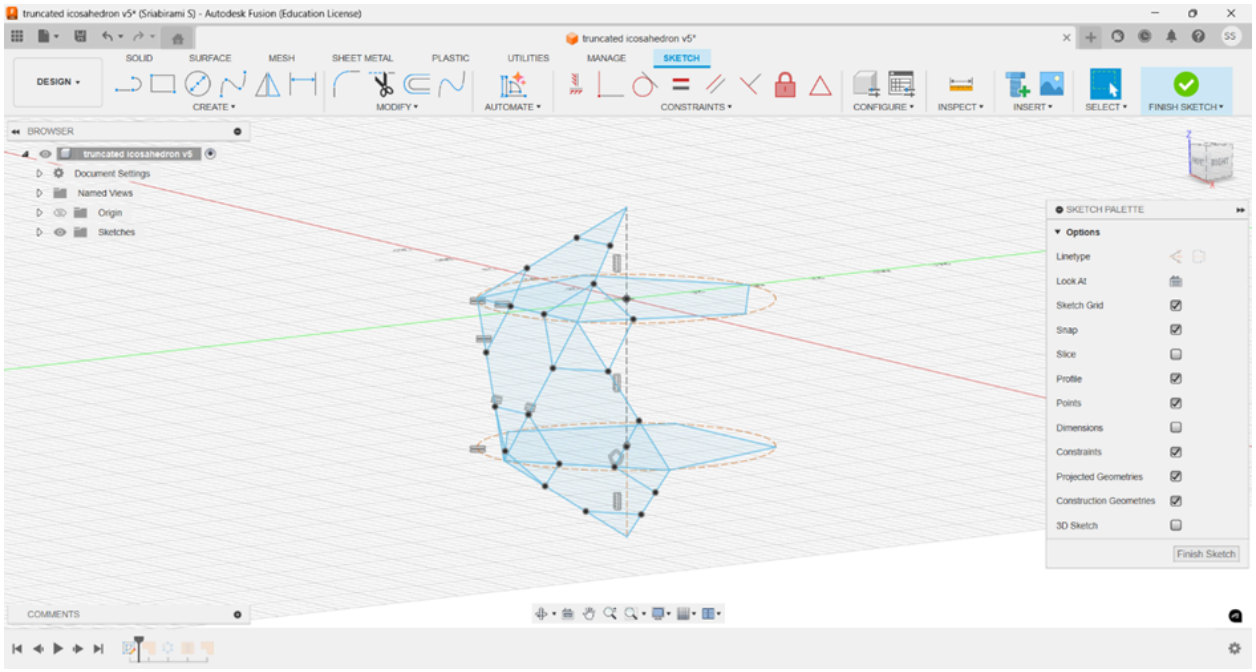
- Identify the top, middle, and bottom layers in the polyhedron.
- Use symmetry and equal constraints to ensure all edges match.
- Create a construction line for alignment along the Z-axis.
- Add another pentagon to form the next level of the shape.

Step 4: Subdivide Edges for Truncation

- Insert midpoints on each edge by splitting each line into three equal segments.
- Apply equal constraints to keep all divisions uniform.

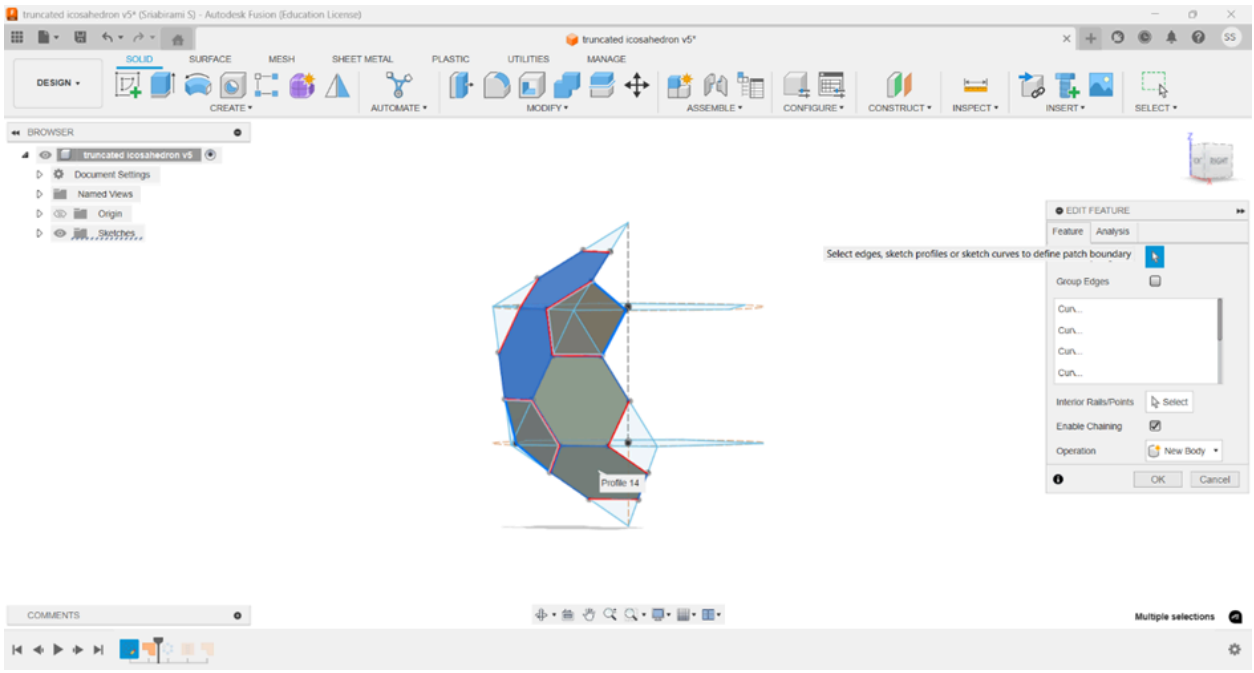
Step 5: Create the Truncated Faces

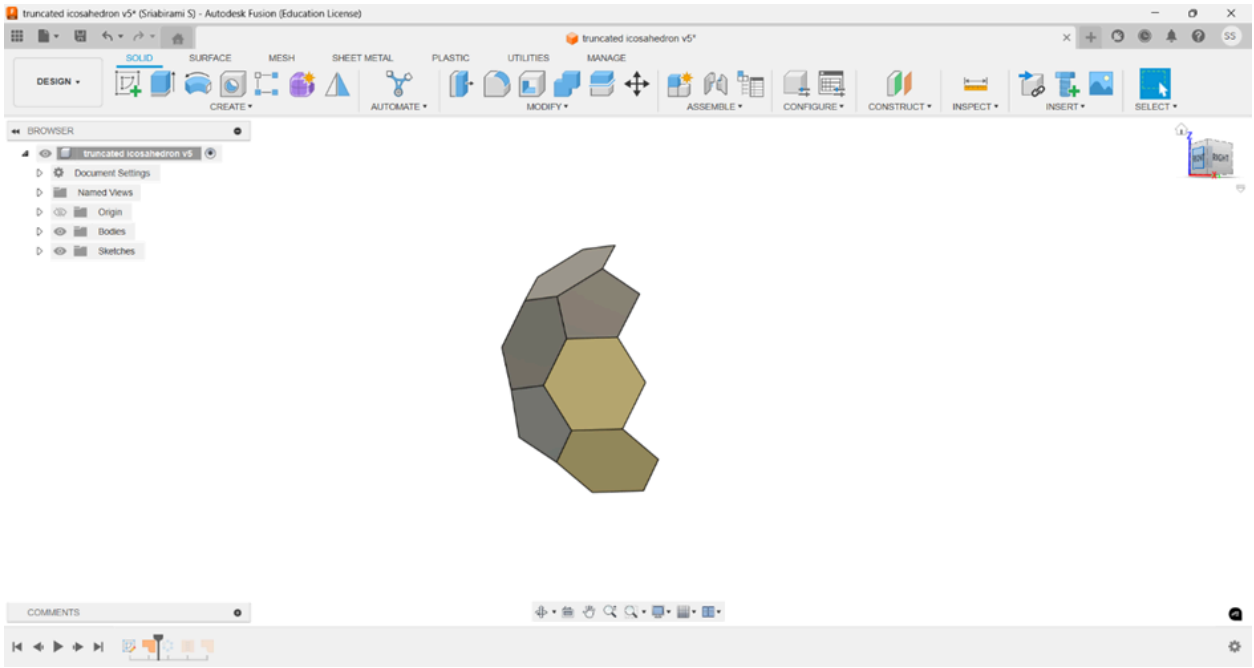
- Connect the new split points to create hexagonal and pentagonal faces.
- Ensure all faces are symmetrical and constrained correctly.
- Complete the subdivision for all necessary edges.

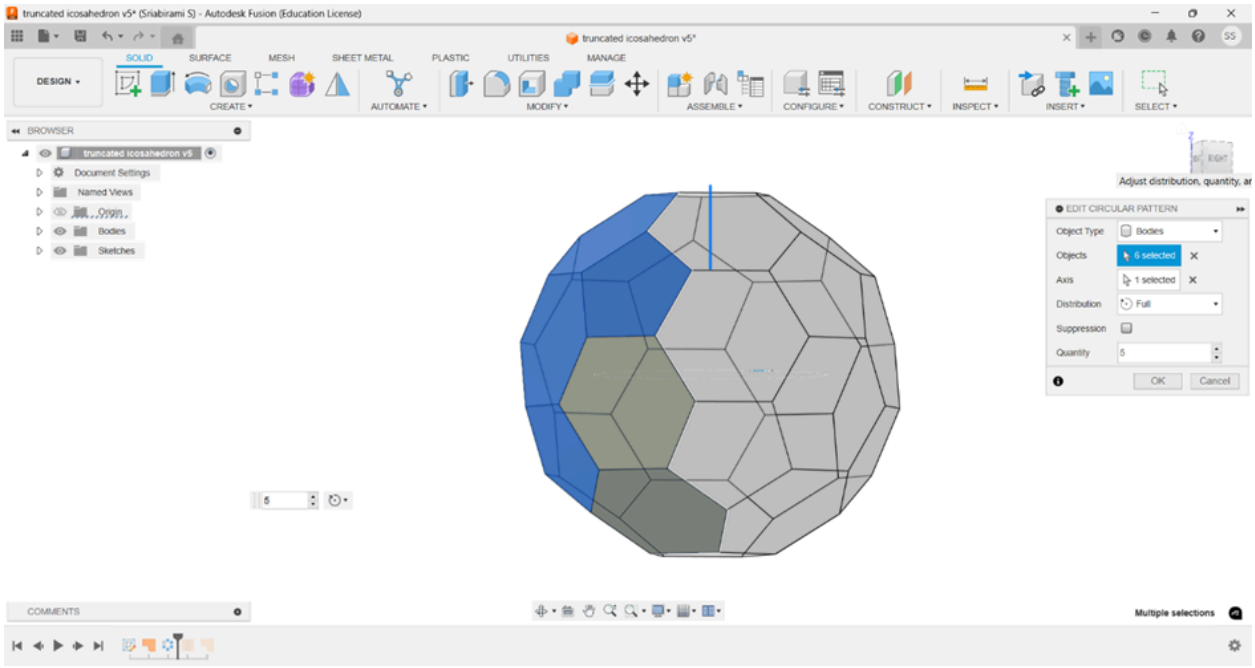


Step 6: Create the Surface Model

- Switch to **Surface Tab** and use the **Patch Tool**: Patch all hexagonal and pentagonal faces.
- Apply a **circular pattern** using the Z-axis for symmetry.
- Stitch all faces together using **Stitch** Command to merge them into a continuous surface.






truncated icosahedron v5* (Sriabirami S) - Autodesk Fusion (Education License)
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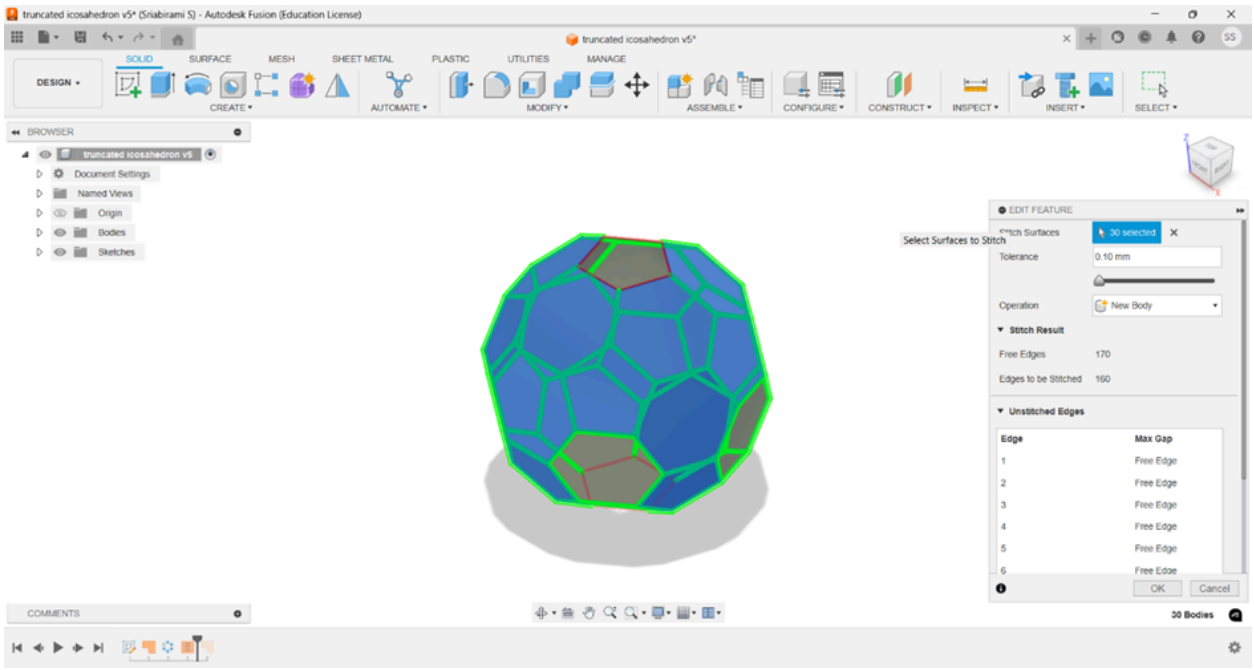
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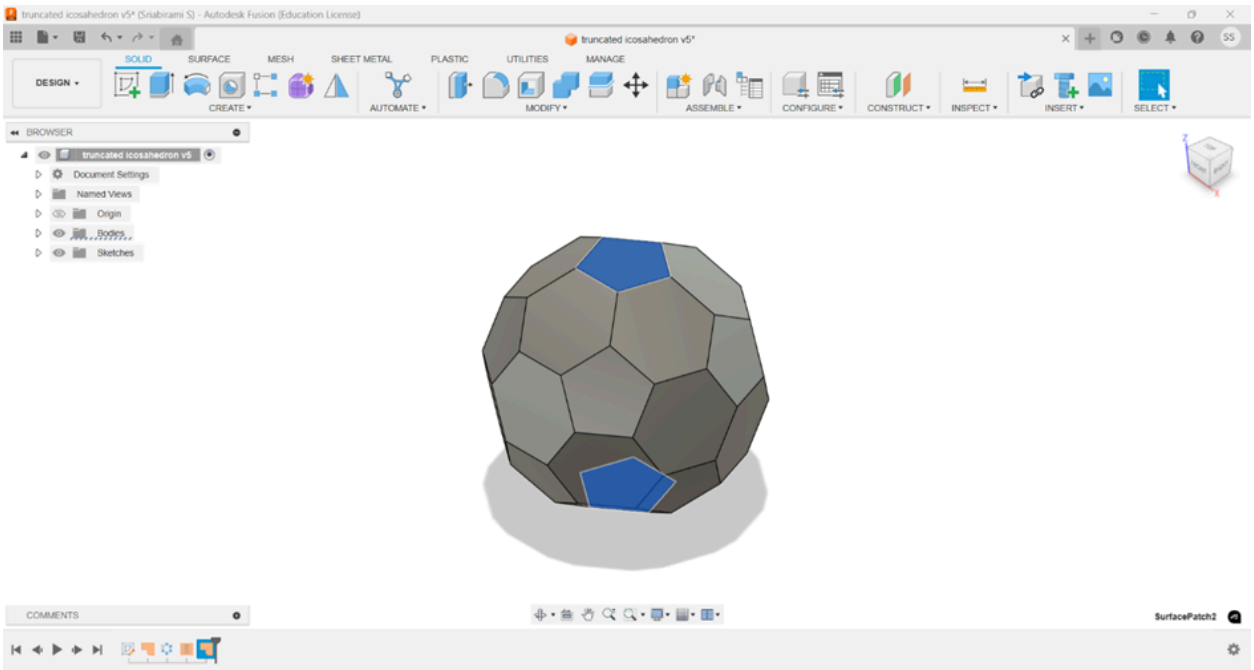
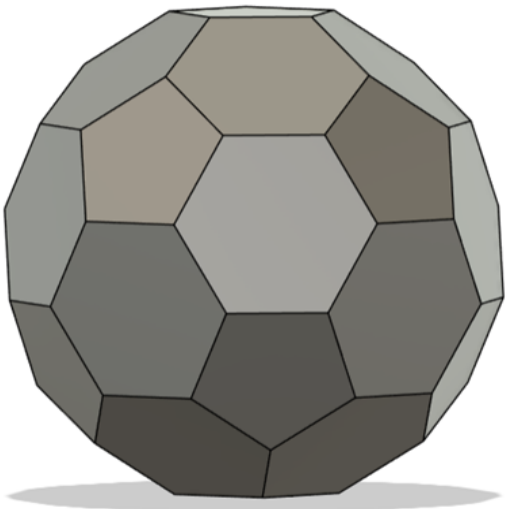
Step 7: Convert to Solid Body

- Use the **Patch Tool** again to close the **top and bottom** holes.
- Apply the **Stitch Tool** to convert the surface model into a **solid body**
- Finally, save the file



Final Design:



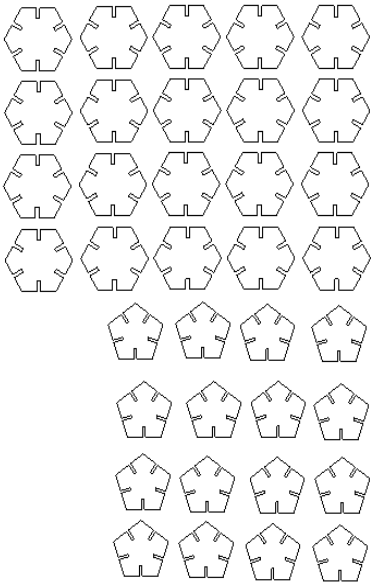
LaserCAD Procedure:

Step 1: Exporting from Fusion 360

- Create New Sketch and draw a pentagon and a hexagon of edge length 19.5mm using the edge polygon tool.
- Duplicate the pentagon 11 times and the hexagon 19 times
- Export the drawing as a **DXF file**.

Step 2: Preparing for Cutting

- Import the **DXF file** into **LaserCAD**.
- Adjust the **scale and alignment** if necessary.
- Set **cutting layers** and define speed/power settings.
- Send the file to the **Laser Cutter** and begin the cutting process.



Assembly Process

Step 1: Building the Base Layer:

- Placed a **pentagon** as the starting point.
- Attached **six hexagons** around it using **connectors**, ensuring stability.
- Added additional connectors on the adjacent sides of the hexagons for reinforcement.

Step 2: Forming One Half:

- Filled the gaps by placing **five pentagons** in the available spaces.
- Added the remaining **hexagons** to complete the first half.

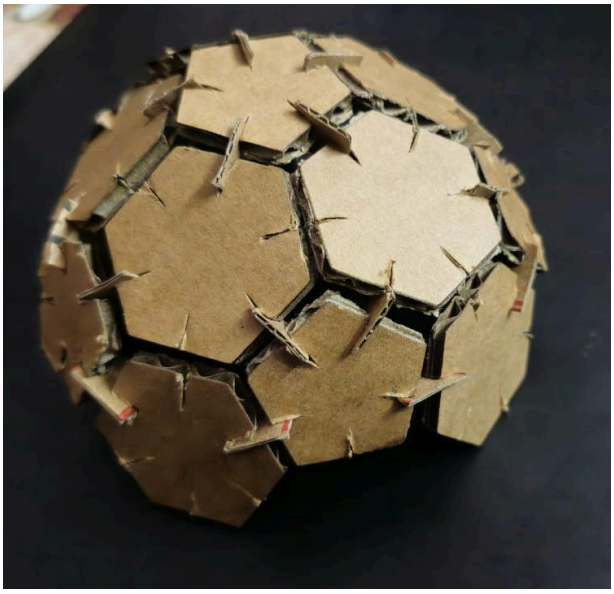
Step 3: Creating the Second Half:

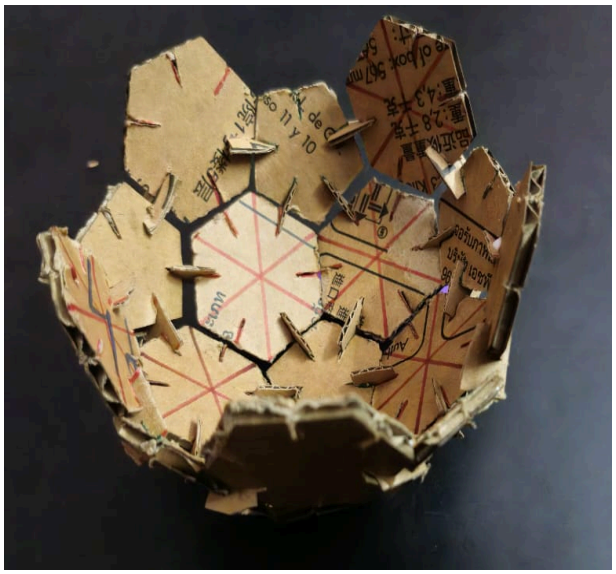
- Repeated the same process to construct the **second half** of the structure.

Step 4: Final Assembly:

- Carefully **aligned and adjusted** both halves.
- Used a small amount of **glue** to secure the connection and ensure stability.

Assembled Structure:





Challenges Faced:

- **Tight Fit in Slits:** Cardboard pieces were difficult to insert, requiring precise adjustments.
- **Loose Connectors:** Some connectors loosened when working on other sections, causing instability.
- **Misalignment of Halves:** Joining two separately made halves led to slight misalignment.
- **Selective Connector Usage:** Using connectors for every slit caused shifting, so only essential ones were used.

Learning Outcomes:

This project provided valuable hands-on experience in:

- Geometric modeling and sphere design in Fusion 360
- DXF file generation and precision laser cutting.
- Proper assembly techniques using connectors.

Reference Image:

Reference Image link:
https://www.polyhedra.net/photo/extra-large-truncated-icosahedron-01.jpg

Fusion 360 file link: https://a360.co/41KdDIy