

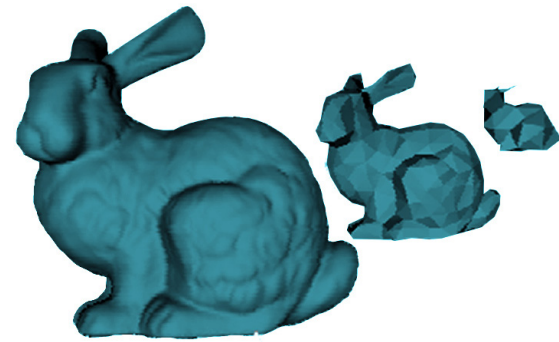
# TRIANGULAR MESH

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## Abstract

Our project consists in the fabrication of an **arbitrary toroidal surface** using a **triangular mesh**, meaning the surface should be solved with triangles. We optimized those triangles to get the least singularities possible, getting a second mesh, where worked with the size of the triangles to get an approximate surface. After this, we used Kangaroo to push the mesh, to the original with the most **equilateral triangles** possible, to finish with the fabrication process. We first chose the most efficient and longest **“paths”** to unroll in order to easy the cutting and subsequent assembly.

## 3. Implementation

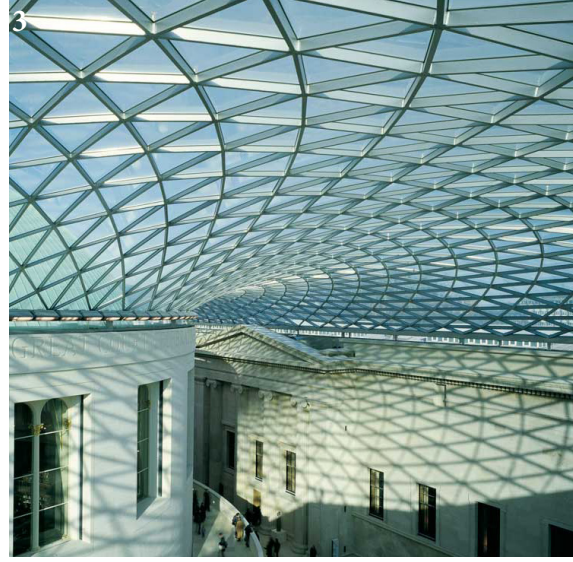


4. Dynamic level of detail (LOD). distant objects (*small*) are simplified by adopting less triangles.  
Rabbit: 69451-->621-->76 triangles

## 1. Introduction

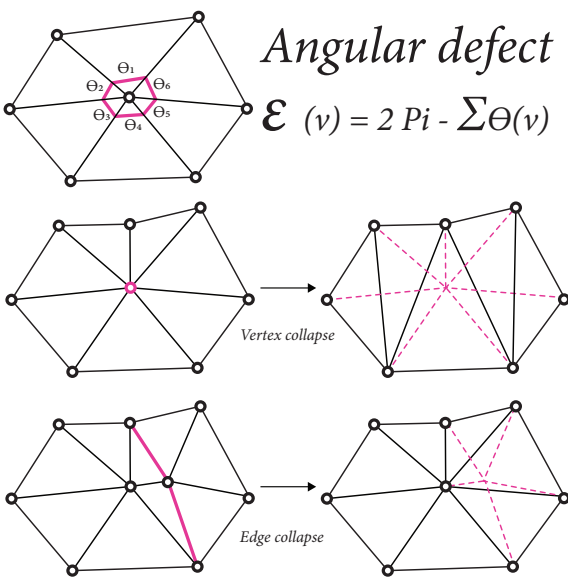
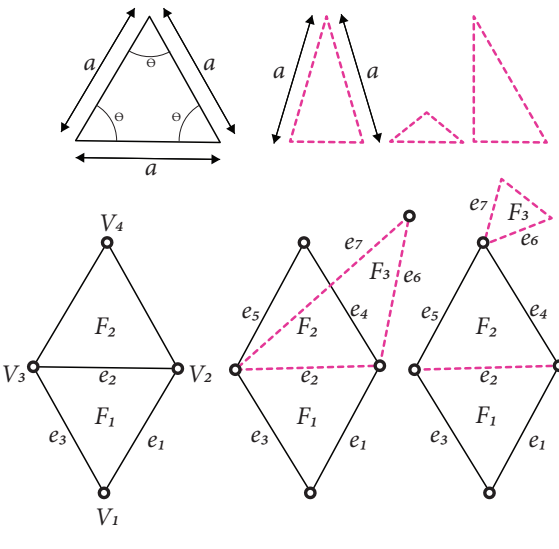
Starting from a surface that represents only the exterior shell, we are able to discretize it with plane polygons, triangles, obtaining an approximation to the original surface. The number of triangles is called **“Tessellation Level”** and has a direct influence in the level of detail we want to reach with the approximation **“Dynamic level of detail” (LOD)**. Not only the number of triangles count, but their distribution depending on the curvature of the surface. The almost **equilateral triangles** mean an optimized tessellation (= *maximization of the surface per unit of triangle*) useful for a quick visual verification of the mesh.

## 2. Background



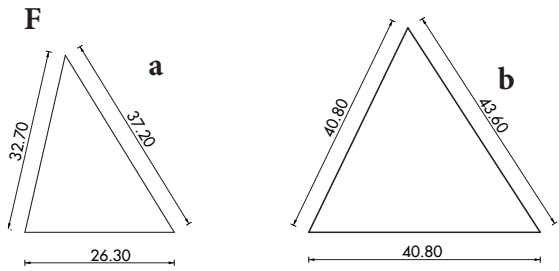
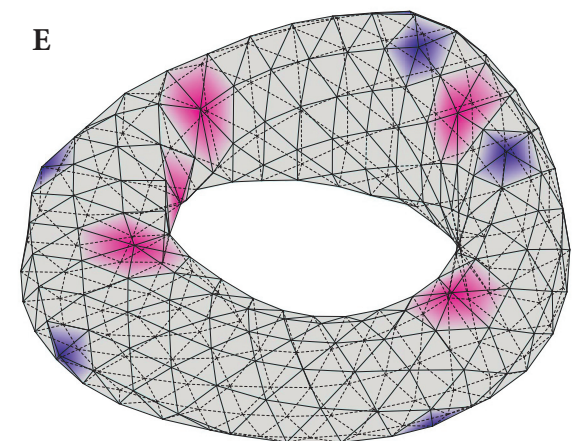
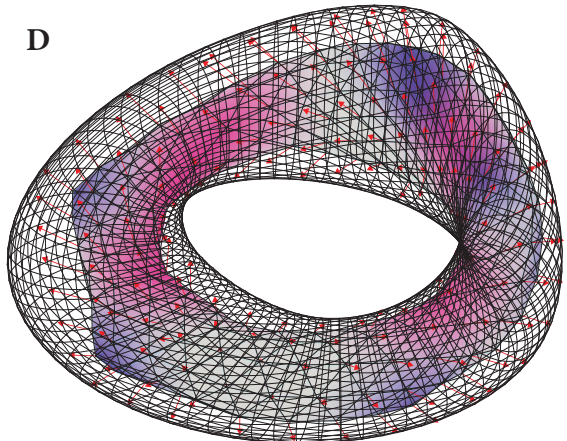
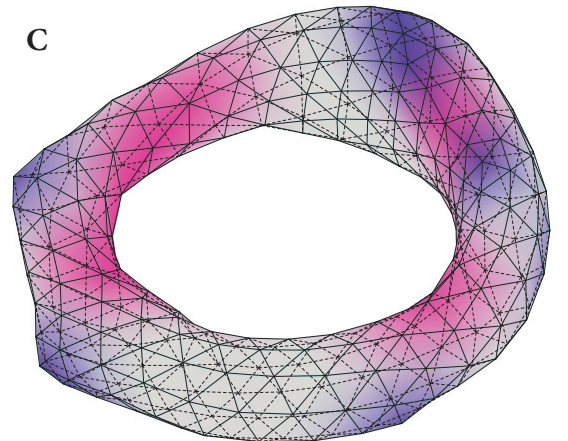
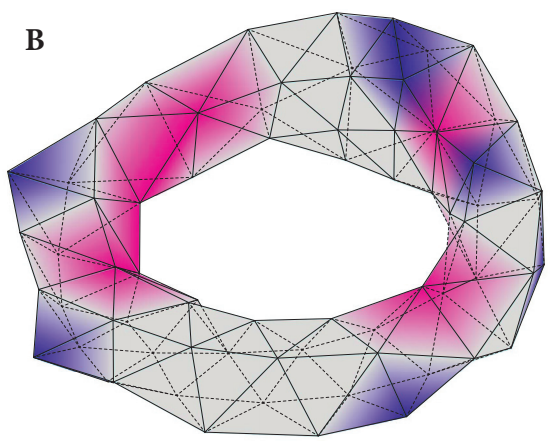
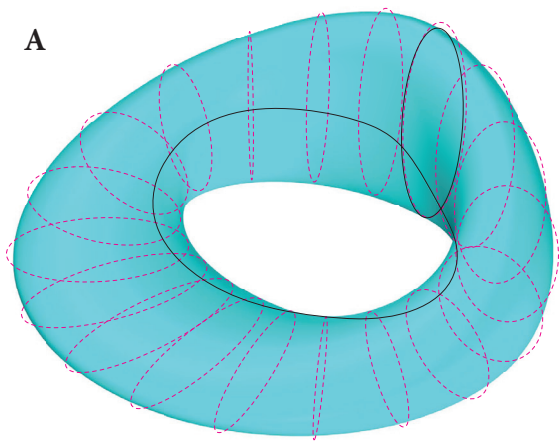
1,2.MyZeil Shopping Mall. Frankfurt - M. Fuksas

3.British Museum Hall, London - C. Williams



-A edge belongs as much as two faces  
-If two faces collide at the same vertex, they both must belong to the closing of that portion of the surface, the faces shall share a colliding edge to the mentioned vertex.  
-The colliding faces in a vertex must conform a **“fan”**  
-For each vertex is associated with a number equal to 2 Pi minus the sum of the angles of all triangles incident on the point. We see that the vertices with zero angles are essentially **“useless”** and proceed to the **Vertex Removal**, or the **Edge Removal**, according to a determined dimension.

Starting from a mesh of **hexagonal** polygons, we identify the **singularities**. then we reduce the account to a limited number of singularity and more controllable composed of **pentagons** and **heptagons**.

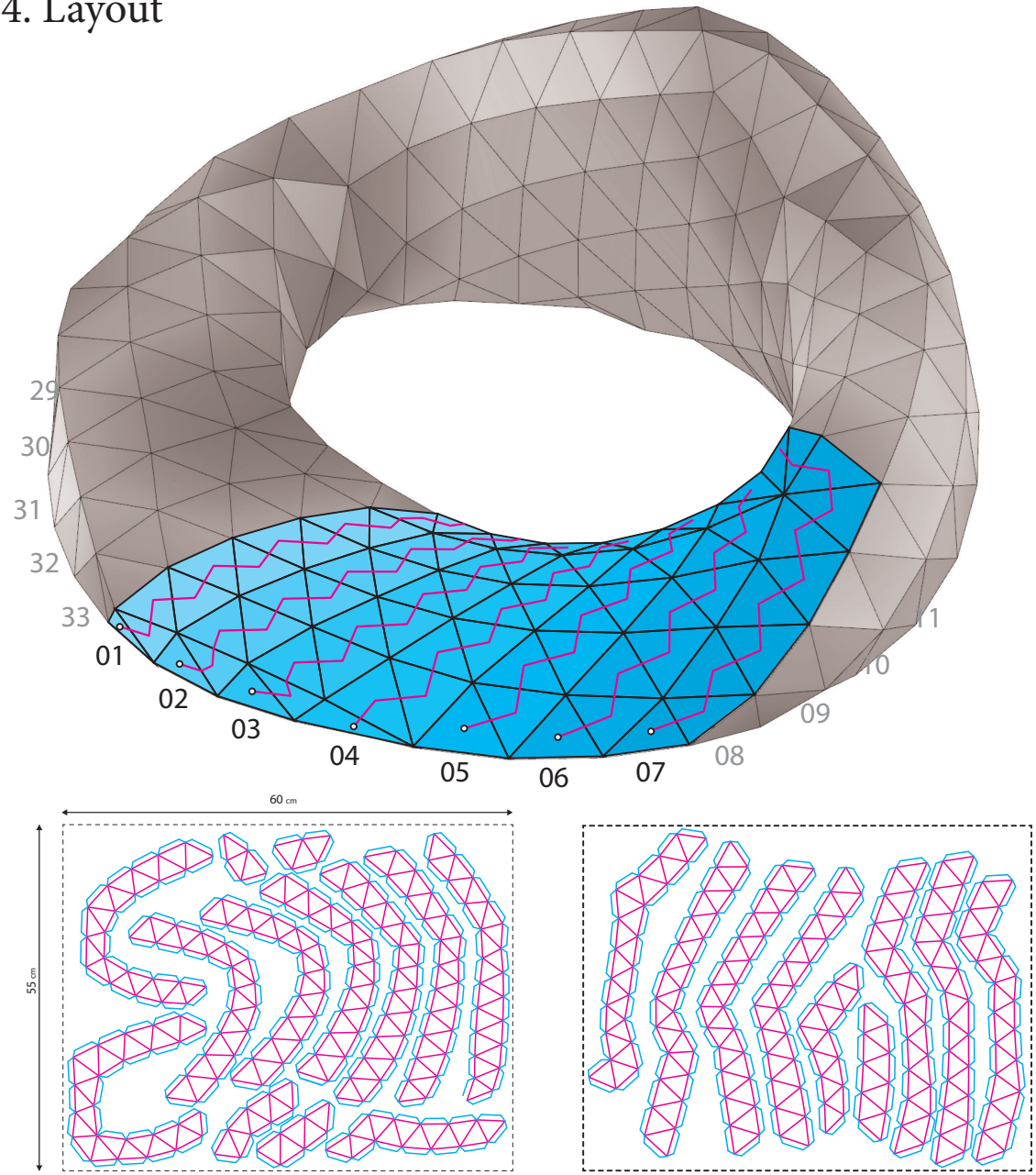


A Original "arbitrary toroidal surface"  
B Reducing amount of singularities and approximation with triangles

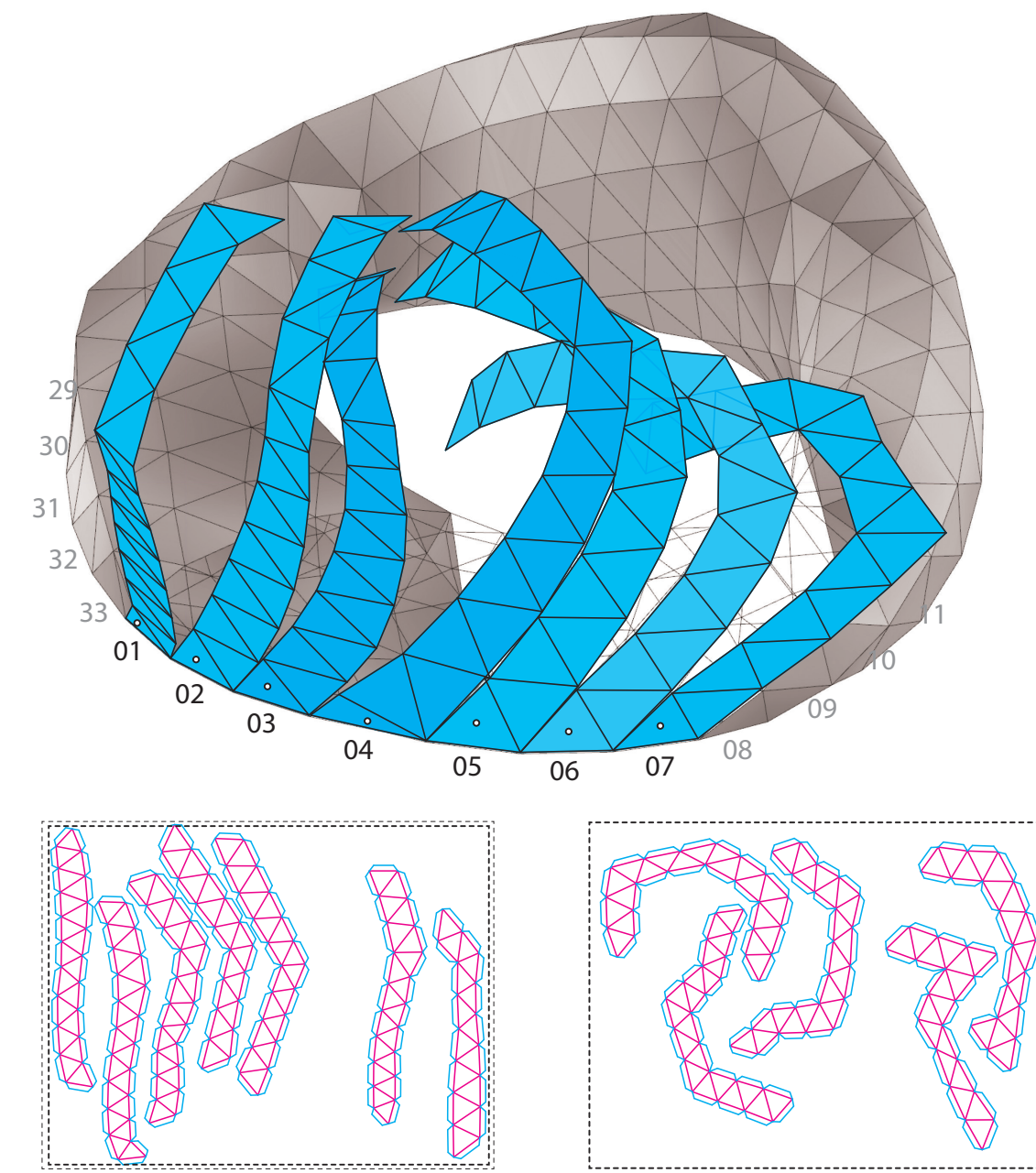
C Increasing the mesh of triangles to achieve a more accurate approximation of the original surface  
D Pushing each vertex, towards its original position corresponding to the starting surface.

E Final optimized Mesh  
F The obtained mesh is composed of **irregular triangles (a)**, we want to obtain a mesh of **equilateral triangles (b)**, as much as possible.

## 4. Layout



**Unrolling**  
After the remeshing and equalizing of the triangles, the goal was to find the best and most optimized path to unroll the stripes. We need to keep the stripes as straight as possible and keep them in the most efficient length possible for fabrication.



**Final Layout**  
To prepare the stripes for production it is necessary to add the flaps and define layer to cut, the engraving layer and the numbering. Then we layout the stripes as efficiently as possible to reduce the waste of material

## 5. Conclusions

The triangular stripes technic was an adequate and efficient method to fabricate the arbitrary toroidal surface. The previous analysis of the surface was indispensable to understand its topology and singularities for the following steps which included the implementation of algorithms to remesh the surface so that the final mesh would be optimized. Another important step was the equalizing of the triangles before implementing algorithms to find the best possible paths to unroll the stripes. Each path combination gives us different layouts that might not be the most adequate for the fabrication process. Finding the best path combinations was mandatory to make the fabrication process more smooth and efficient.

## 6. References

1. H. Pottmann, A. Asperl, M. Hofer and A. Kilian, *Architectural Geometry*, Bentley Institute Press, 2007