Uniform 3-D Meshes with Cutting Surfaces

Facilitated by Polyhedral Finite Elements

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1. Objective

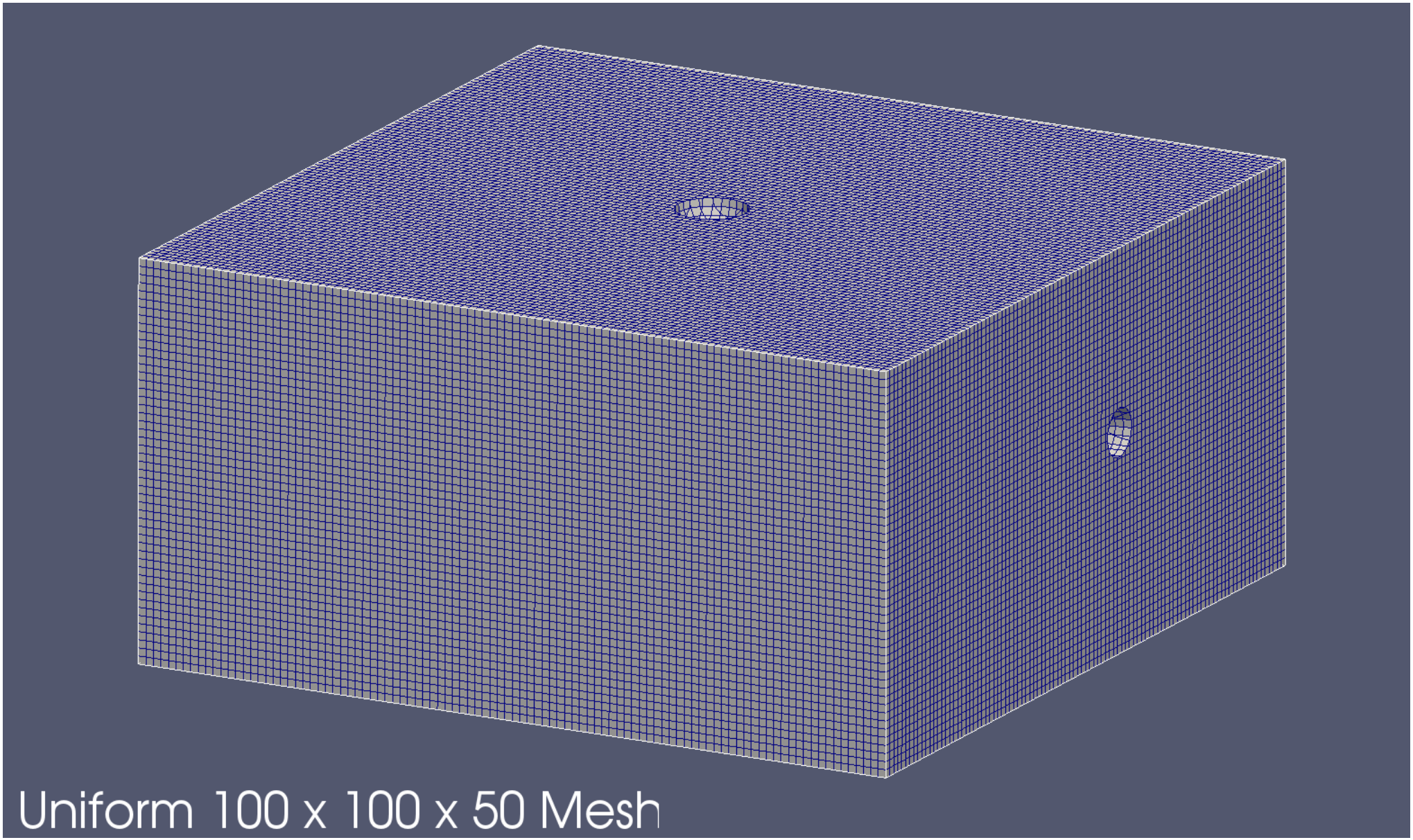
This is a brief presentation with the objective of showing how large uniform, three-dimensional finite element meshes can be modified with cutting surfaces, facilitated by polyhedral finite elements, to become high fidelity models of cast and machined equipment components.

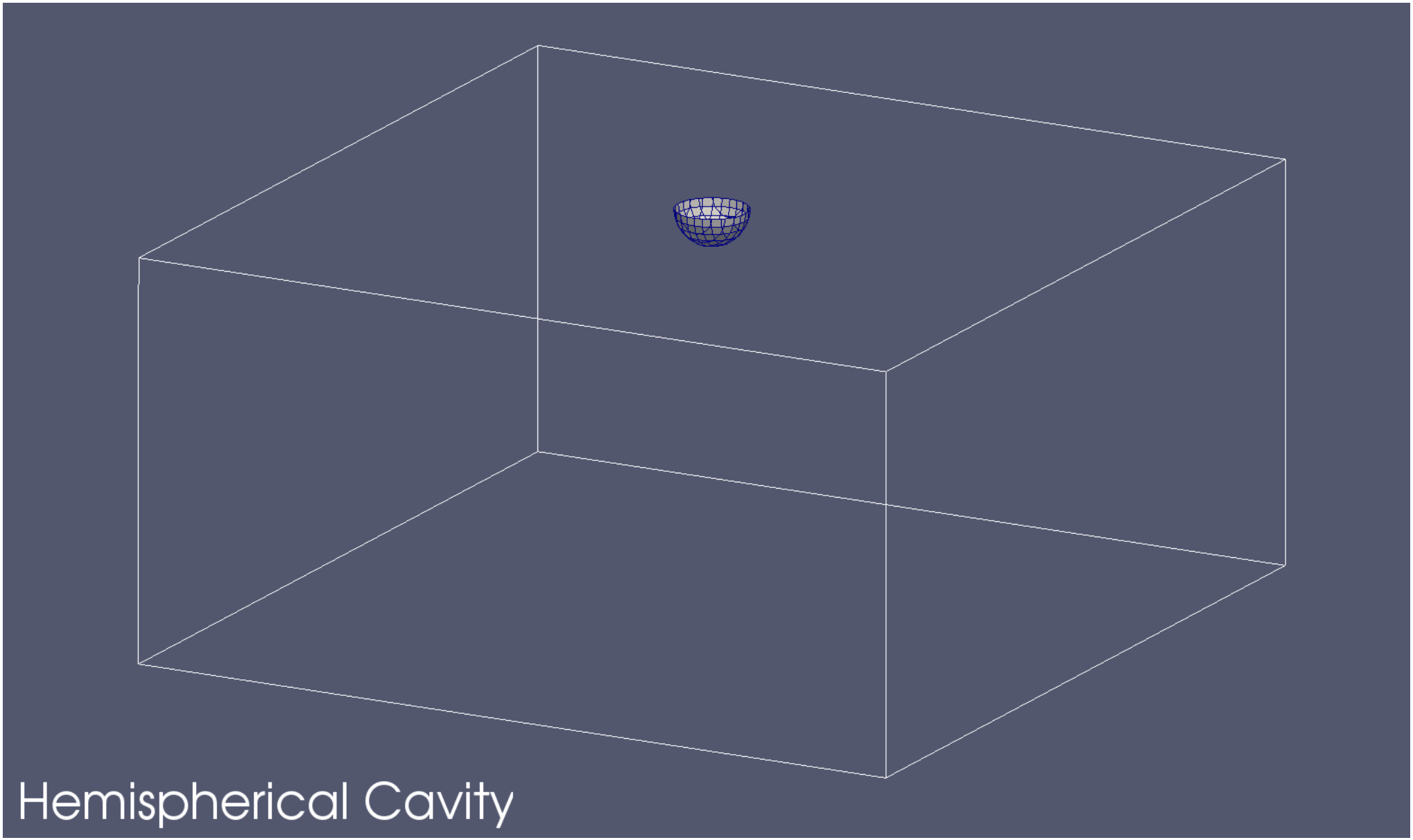
A distinctive feature of this approach to model building is the speed with which a finite element model can be constructed once a geometry model is available. The final mesh shown here, albeit quite elementary, only required 60 seconds of computer time.

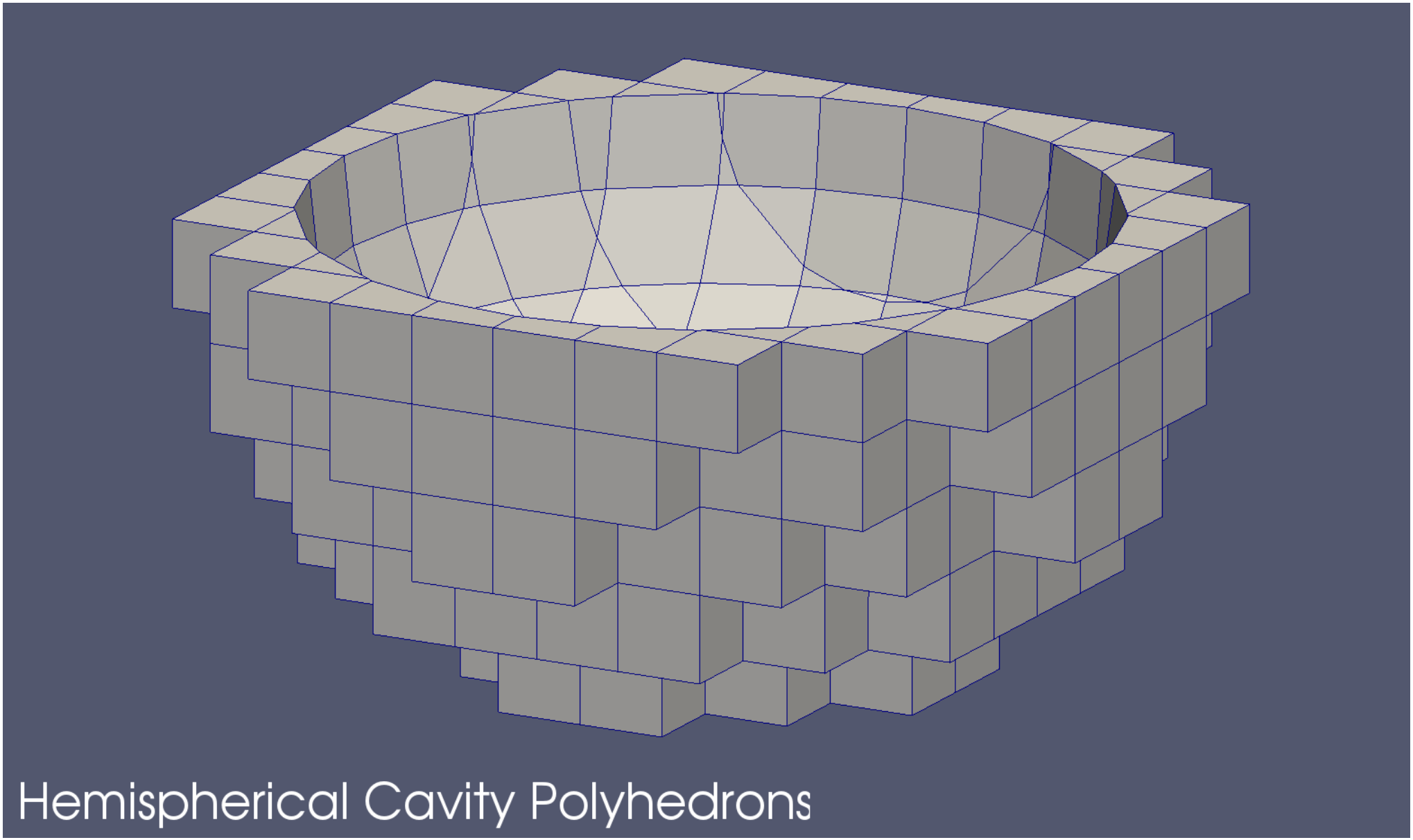
2. Cutting Surfaces

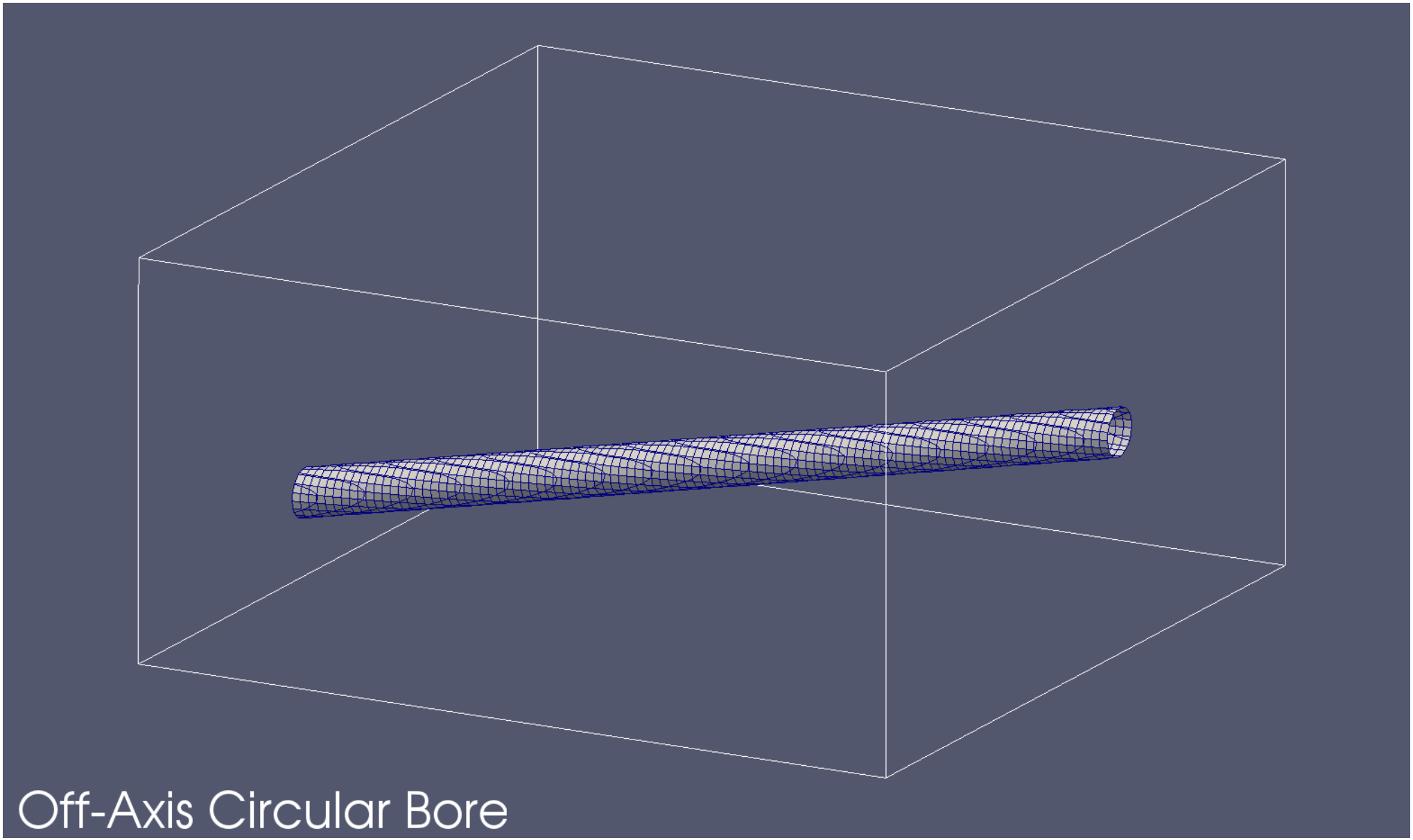
The use of three different geometric cutting surfaces are demonstrated to show the "re-sculpting" of a uniform mesh to produce quality representations for

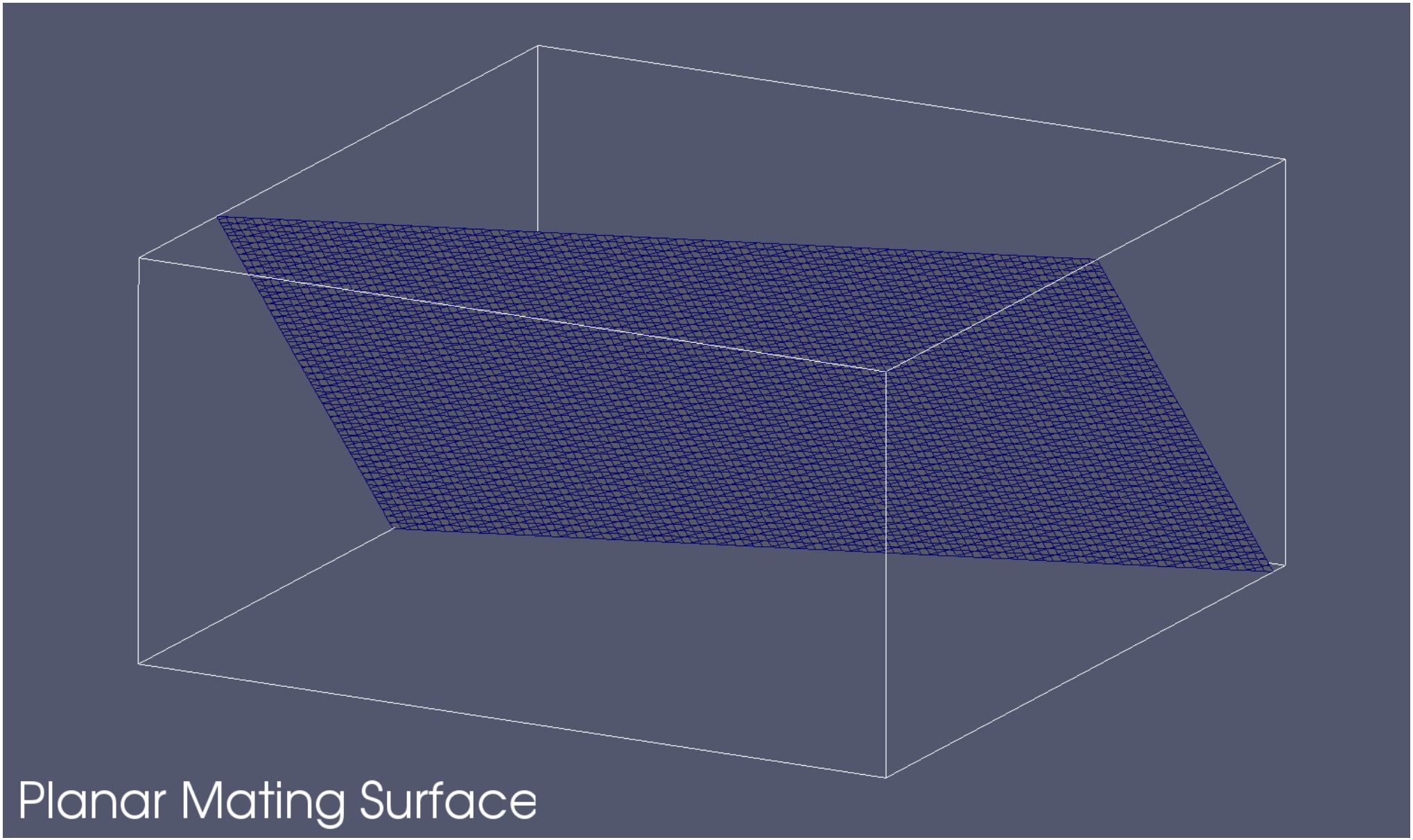
- A hemispherical cavity,
- An arbitrarily oriented cylindrical bore, and
- An oblique mating surface.


Uniform 100 x 100 x 50 Mesh


Hemispherical Cavity


Hemispherical Cavity Polyhedrons


Off-Axis Circular Bore


Planar Mating Surface

3. Cutting Process

Initially, when a cutting surface transects a hexahedral finite element in the uniform mesh, two sibling polyhedral finite elements are created.

In the case of a cylindrical cutting surface used to create a bore hole, the "interior" polyhedrons and hexahedrons are discarded.

In the case of a planar cutting surface used to create mating surfaces between two parts, all of the polyhedrons are retained and side-sets from the opposing surfaces are generated to be used later in defining contact between the two parts.