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INGENIERIA COMPUTACIONAL

The Meccano Method for Mesh Generation and Solid Parameterization

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**XVIII Spanish-French School Jacques-Louis Lions about Numerical Simulation in Physics and Engineering
Las Palmas de Gran Canaria, Spain, 25-29 June 2018**



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CONACYT-SENER Project, Fondo Sectorial, contract: 163723

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Integración de Nuevas Metodologías en Simulación de Campos de Viento, Radiación Solar y Calidad del Aire



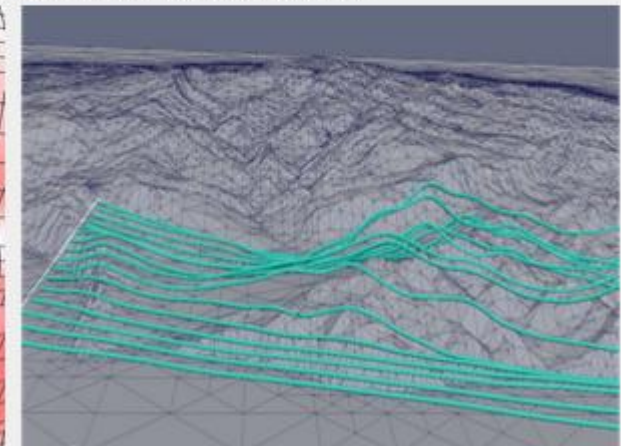
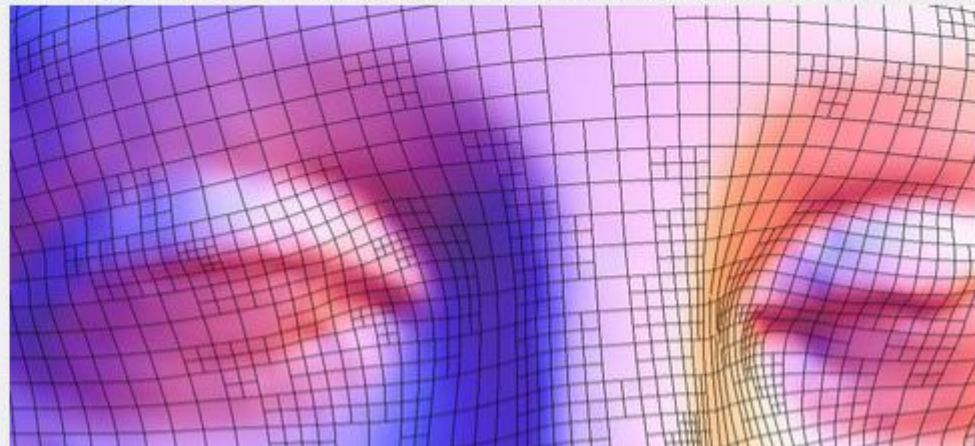
Proyecto
Descripción
Objetivos
Investigadores
Resultados
Links de interés

Ministerio de Economía y Competitividad y FEDER
Referencia: CTM2014-55014-C3-3R
Plazo de Ejecución: 01/01/2015 - 31/12/2017

Descripción del proyecto



Este Subproyecto de Investigación de la Universidad de Las Palmas de Gran Canaria, titulado “Integración de nuevas metodologías en simulación de campos de viento, radiación solar y calidad del aire”, con referencia 604155032-55032-45-514, se enmarca dentro del Proyecto Coordinado: “Integración de nuevas metodologías para gestión medioambiental”, con referencia CTM2014-55014-C3-1-R, financiado por el Ministerio de Economía y Competitividad y FEDER a través de la convocatoria 2014 de proyectos I+D+i del programa estatal de Investigación, desarrollo e innovación orientada a los retos de de la sociedad. Adjudicado para el periodo 2015-2017.



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UNIVERSIDAD POLITECNICA DE CANARIAS
ESCUELA TECNICA SUPERIOR DE INGENIEROS INDUSTRIALES
Departamento de Matemática Aplicada

Tesis Doctoral

APLICACION
DE
METODOS DE ELEMENTOS FINITOS ADAPTATIVOS
A PROBLEMAS DE CONVECCION-DIFUSION

AUTOR: Rafael A. Montenegro Armas

DIRECTOR: Dr. Luis Ferragut Canals

Las Palmas de Gran Canaria, Marzo de 1999

En la figura 1.1.1 se expone a modo de resumen el organigrama general de un código de cálculo adaptativo combinado con el método de los elementos finitos:

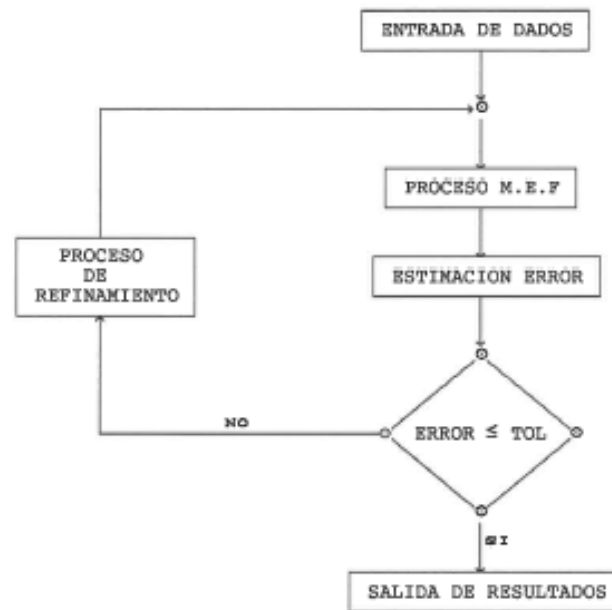
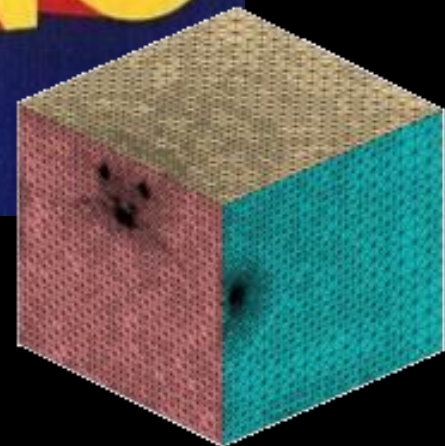
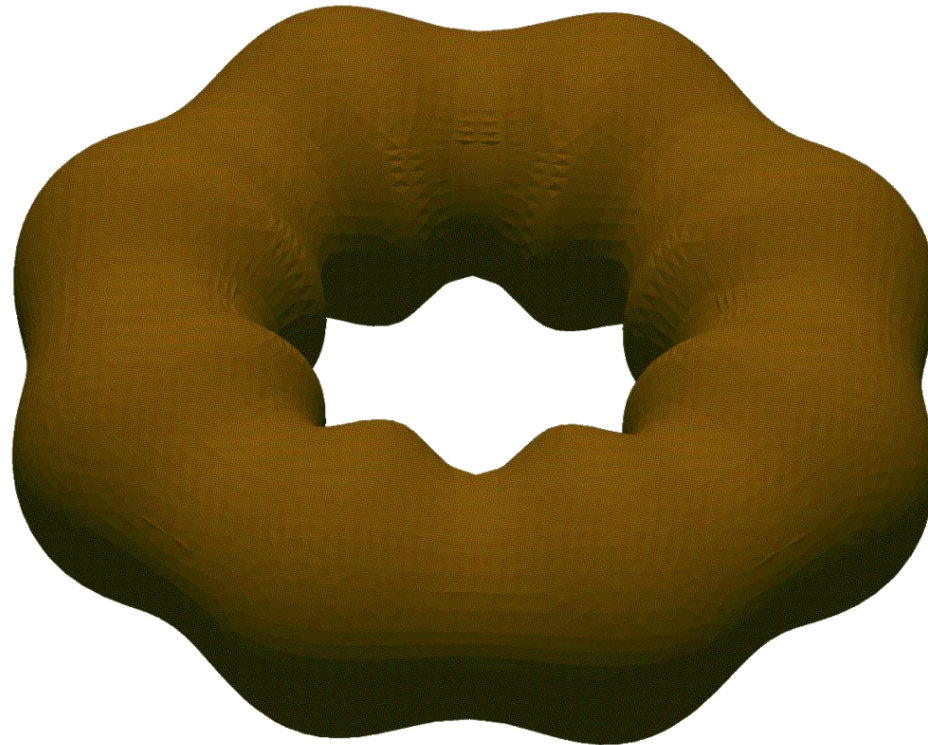


Figura 1.1.1.- Organigrama general de un código adaptativo.



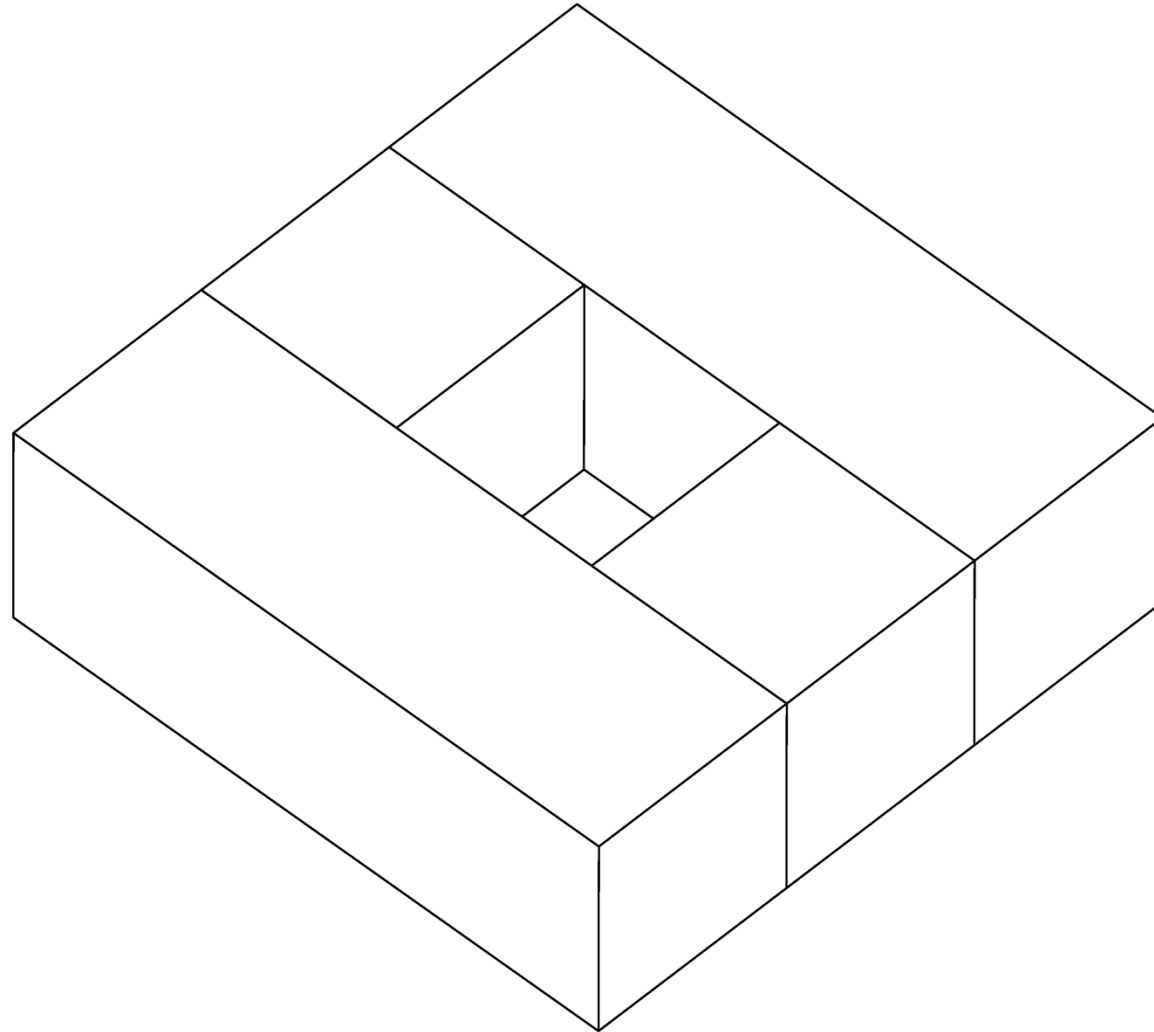
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Surface of the solid as input data



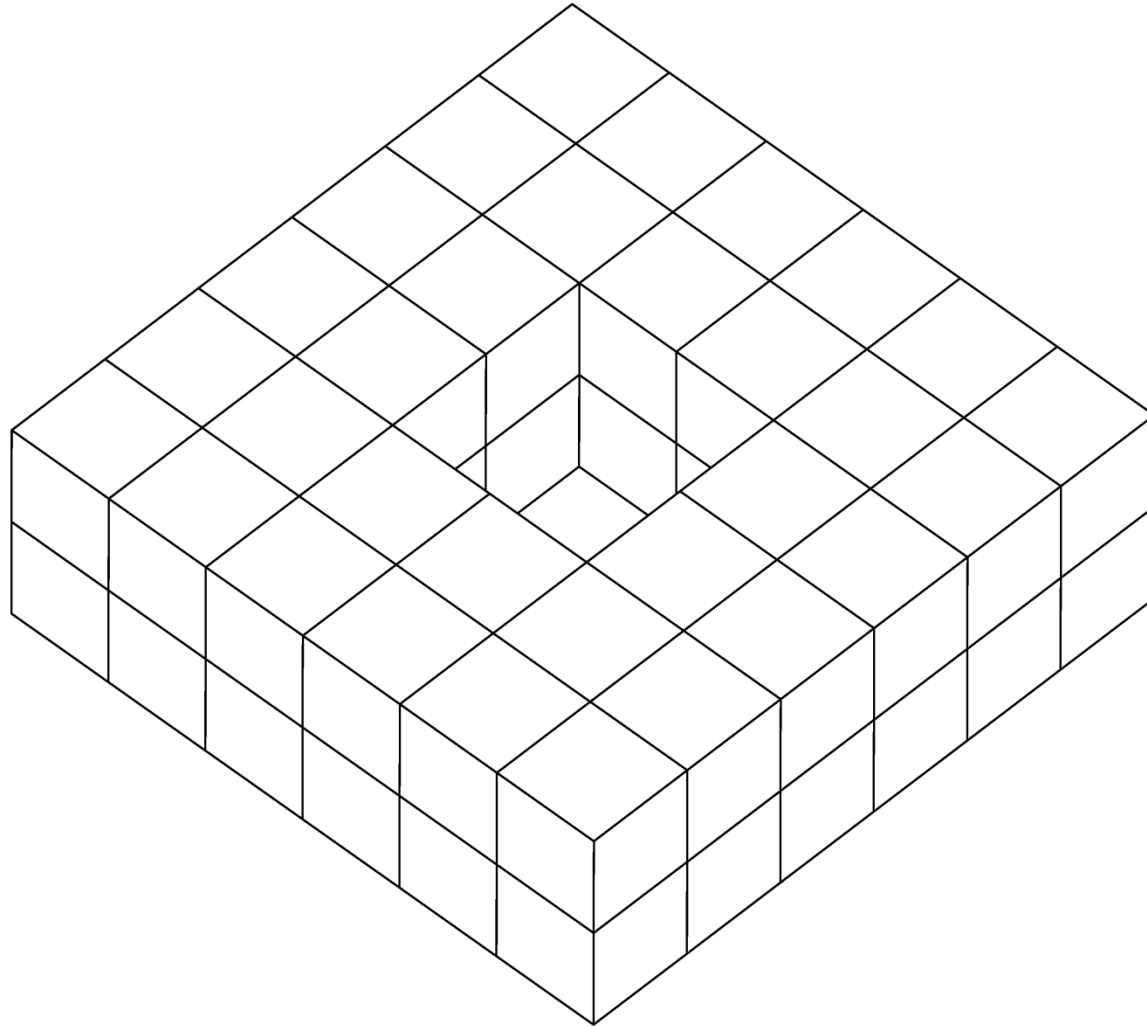
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: The meccano construction and surface mapping



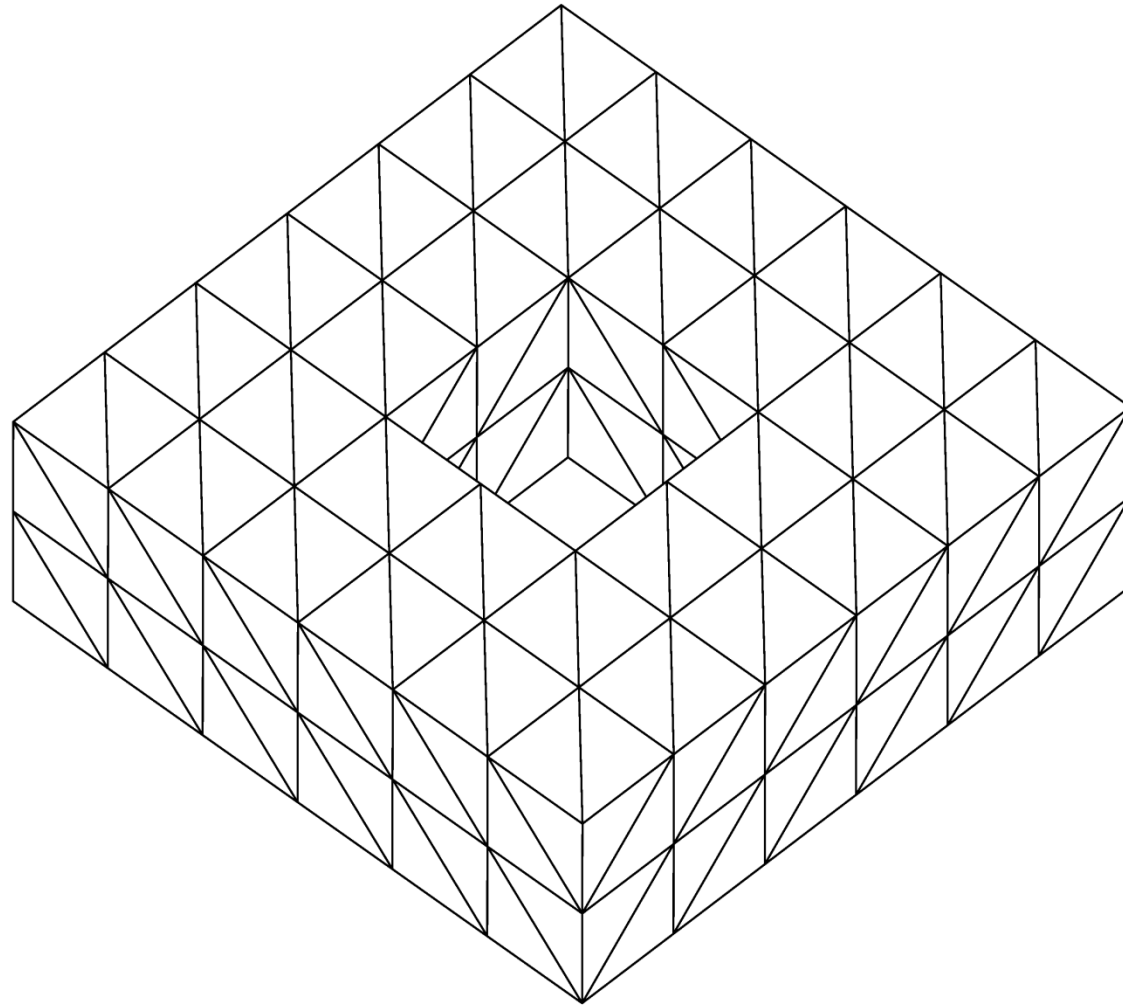
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Polycube



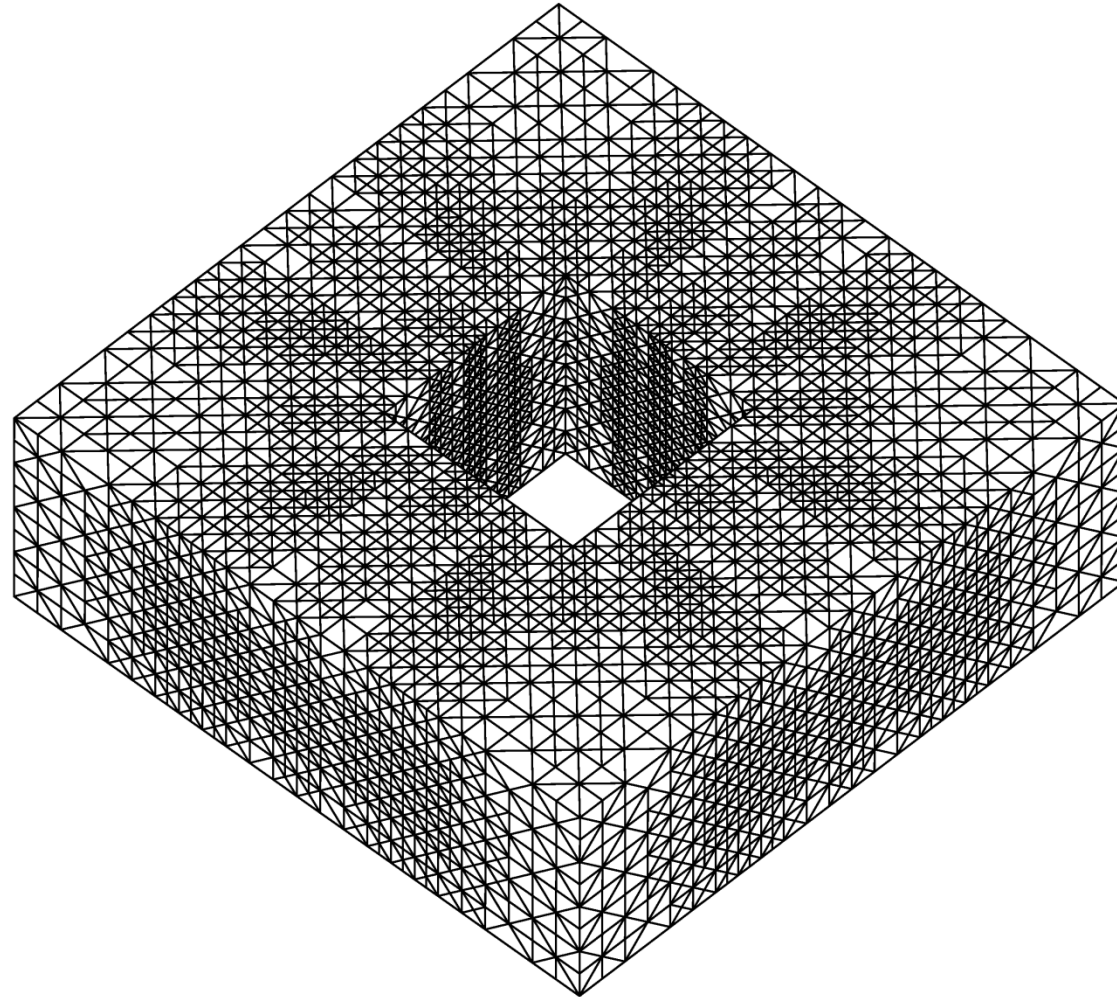
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Coarse tetrahedral mesh



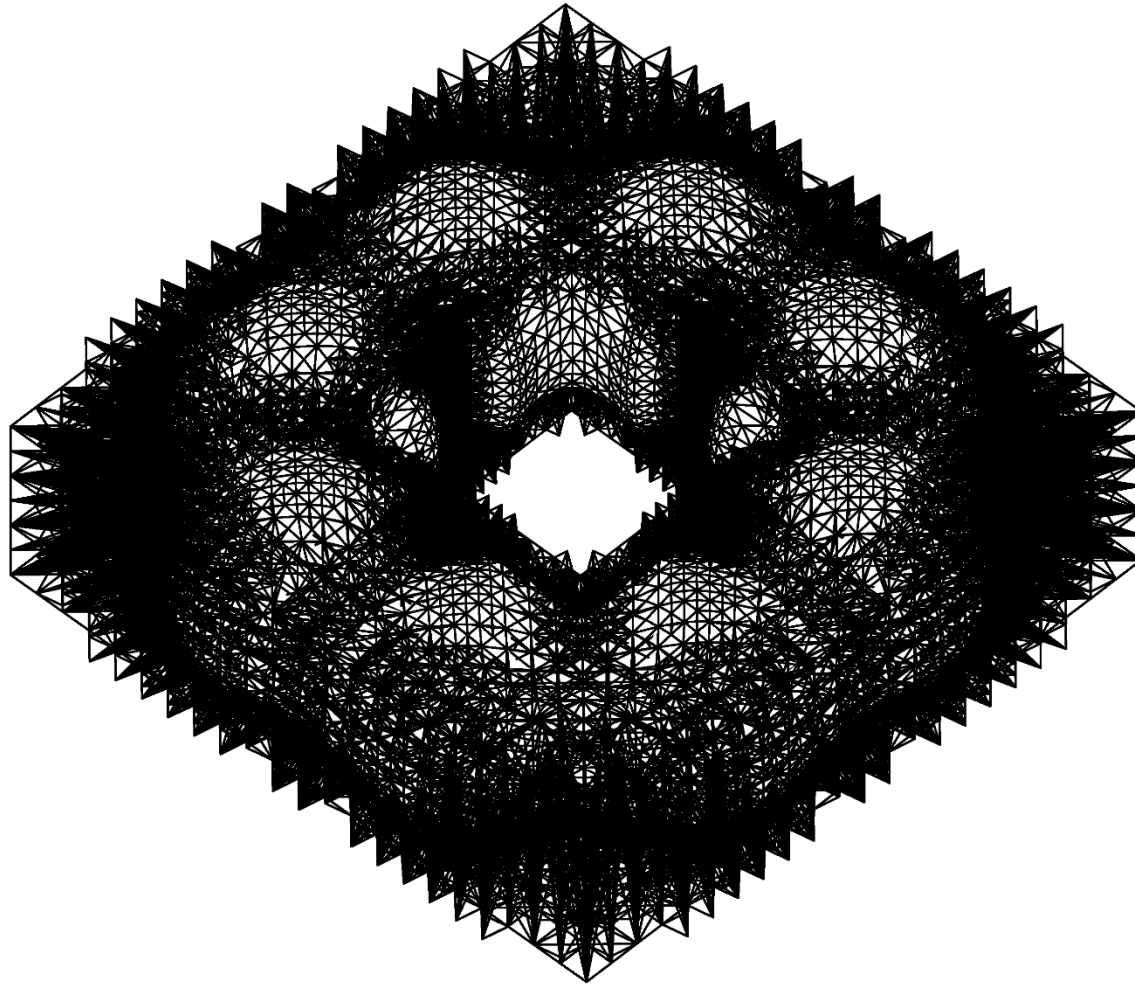
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Local refined mesh



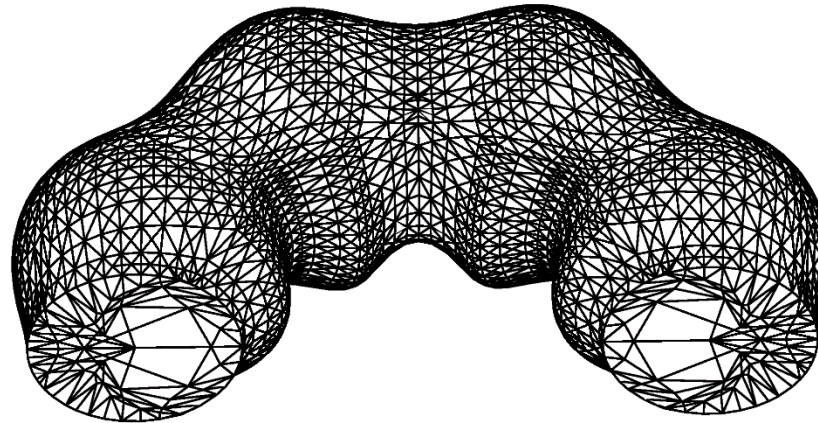
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Move the meccano boundary nodes to the solid surface



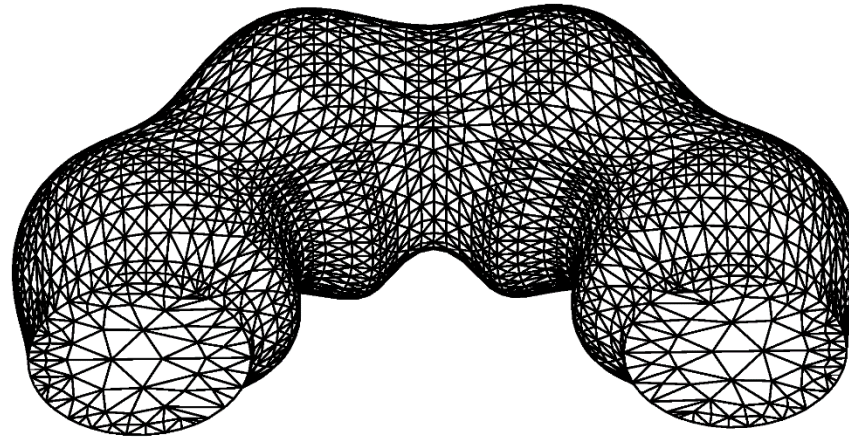
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Relocate the inner nodes of the meccano



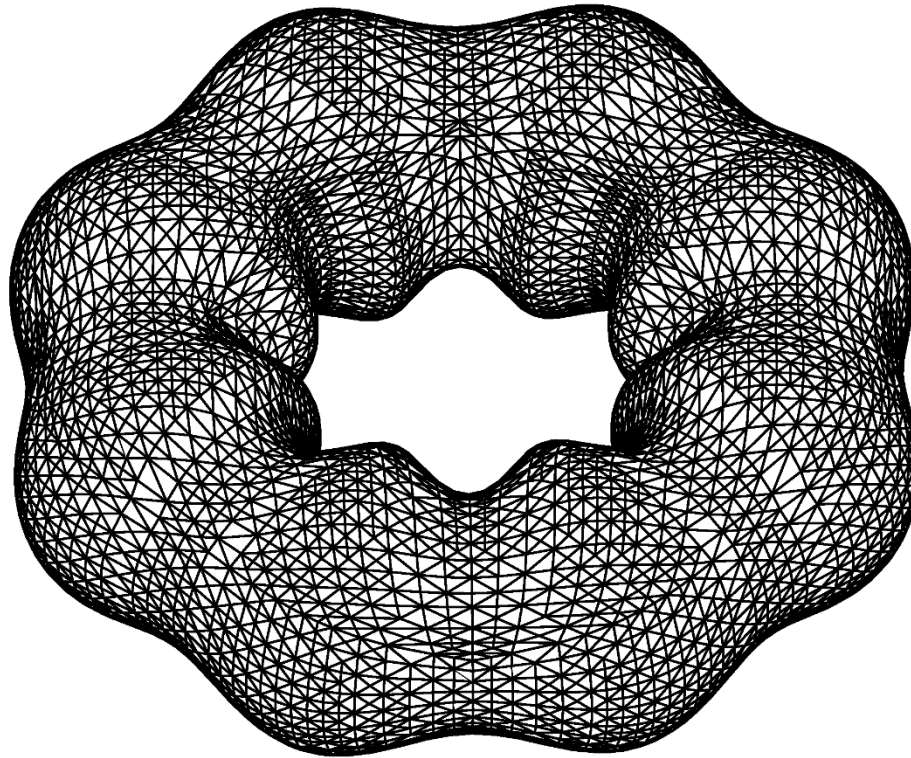
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Simultaneous mesh untangling and smoothing



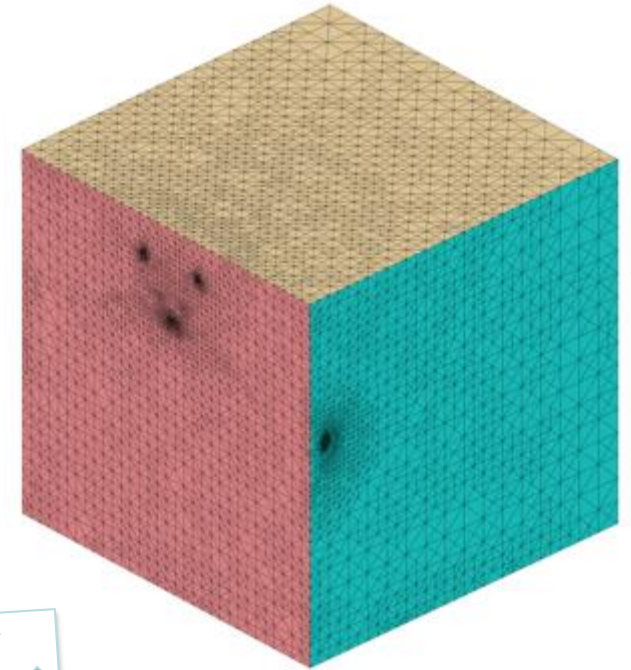
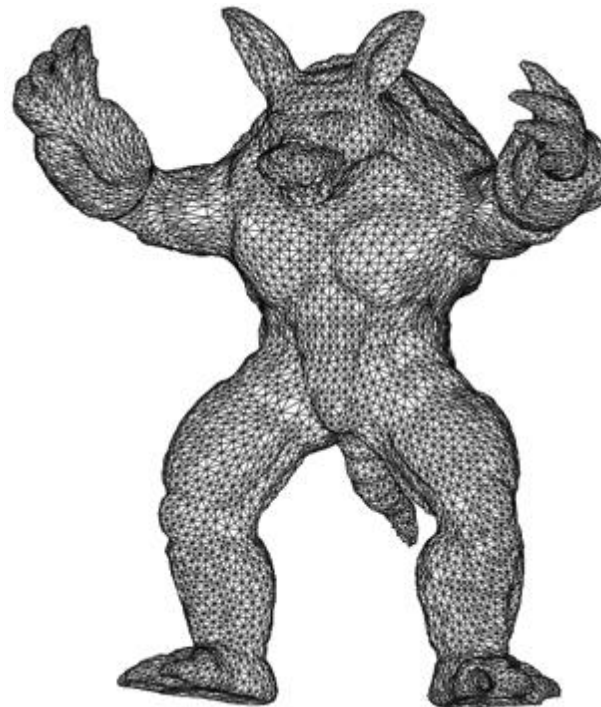
The Meccano Method for 3-D Mesh Generation

Algorithm Steps: Final tetrahedral mesh



Meccano Method

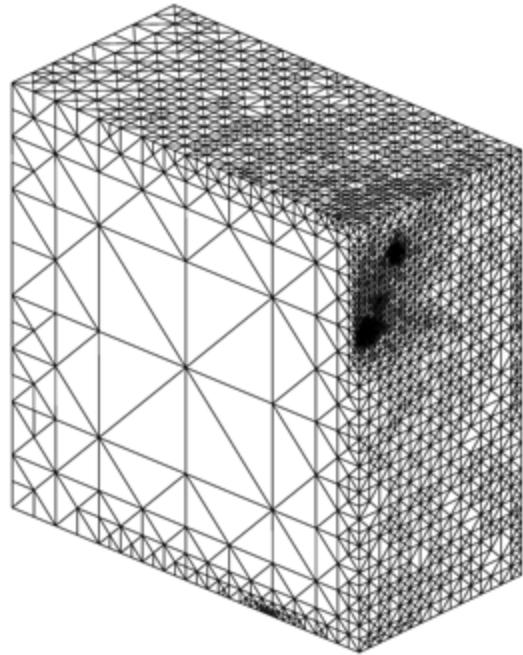
Simultaneous mesh generation and volumetric parameterization



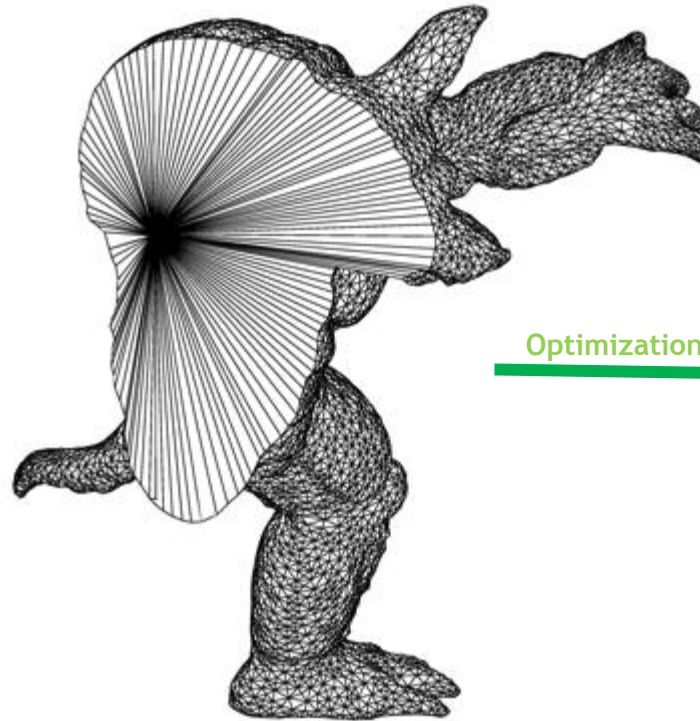
- **Parameterization**
- **Refinement**
- **Untangling & Smoothing**

Meccano Method

Key of the method: SUS of tetrahedral meshes

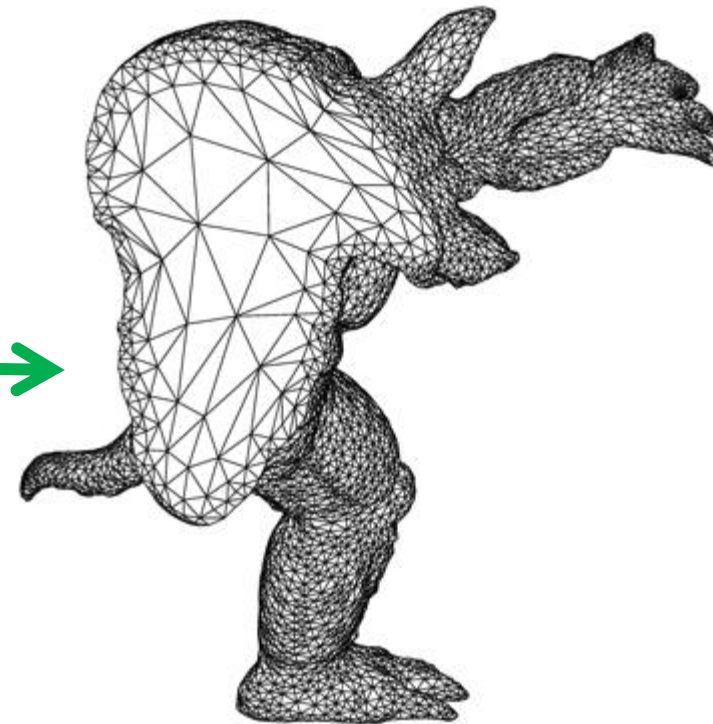


Parameter space
(meccano mesh)



Physical space
(tangled mesh)

Optimization →



Physical space
(optimized mesh)

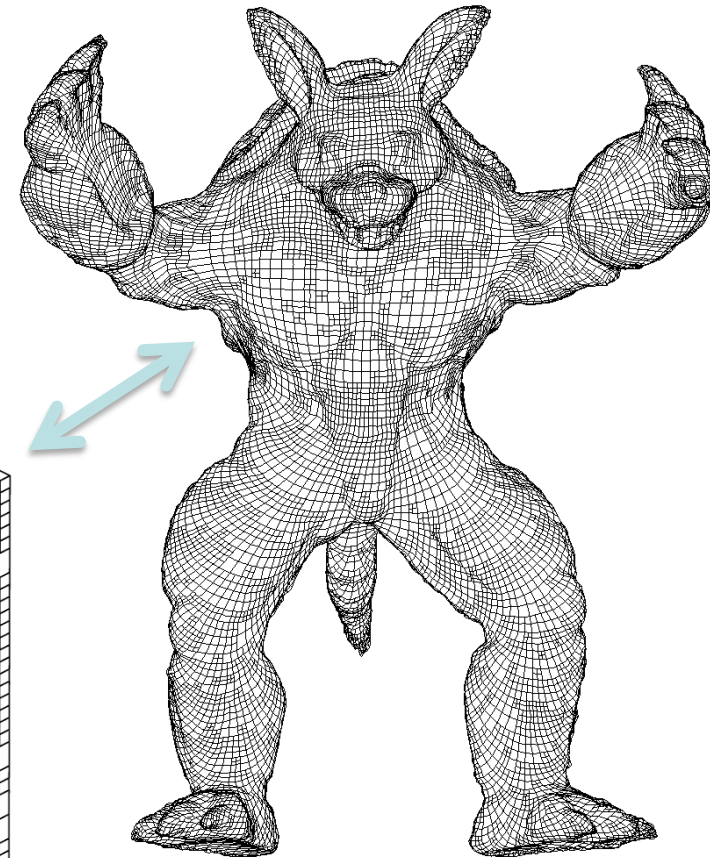
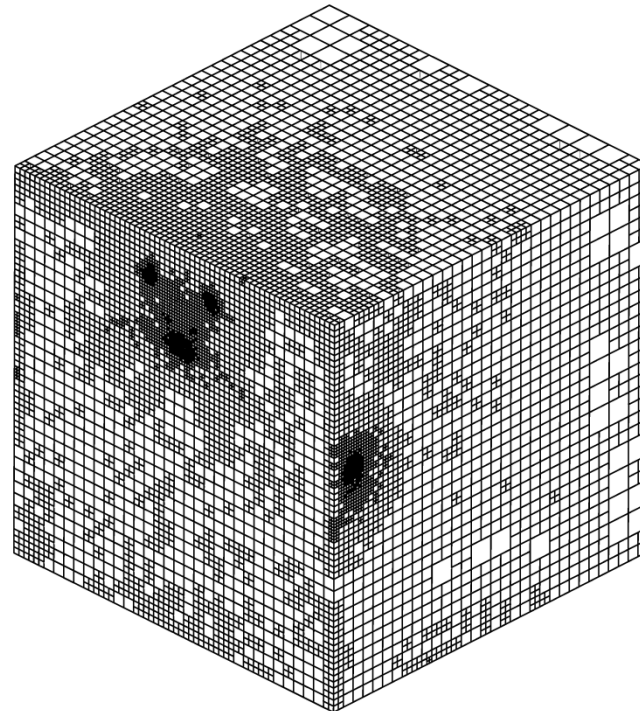
The Meccano Method for Isogeometric Solid Modeling

Solid Modeling with Trivariate T-splines



• INPUT: Surface Triangulation

• 3-D T-Mesh of the Meccano



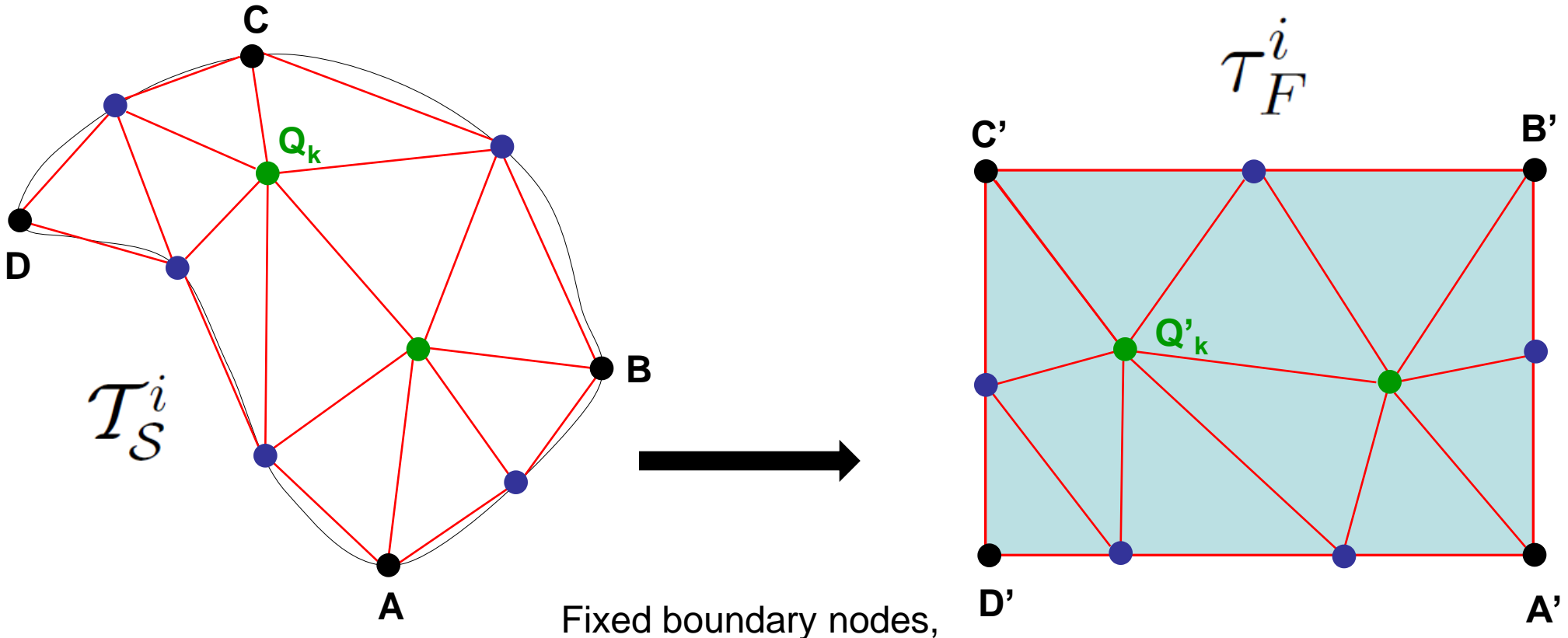
• OUTPUT: Trivariate T-spline

Meccano Method

Surface Parameterization of M.S. Floater (CAGD 1997)



From the i -th solid surface triangulation patch to the i -th meccano face



Physical Space

Fixed boundary nodes,

$$Q'_k = \sum_j \lambda_{j,k} Q'_j$$

Parametric Space

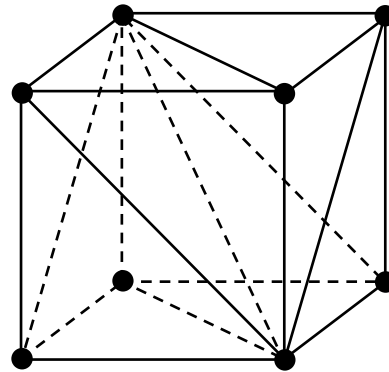
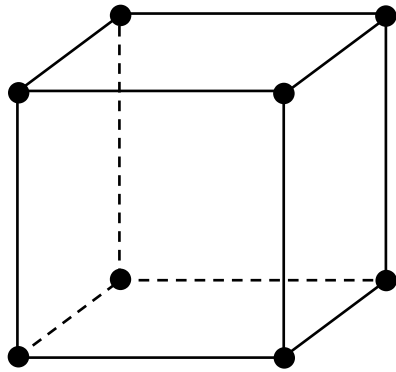
Compromise between area and shape

Meccano Method

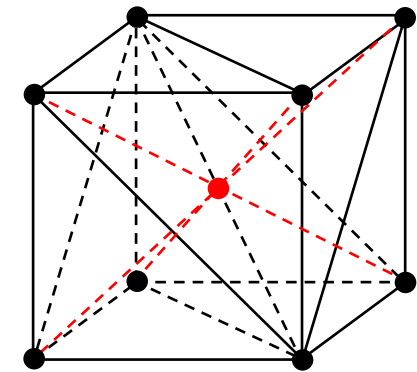
Local Refinement: Kossaczky's Algorithm (JCAM 1994)



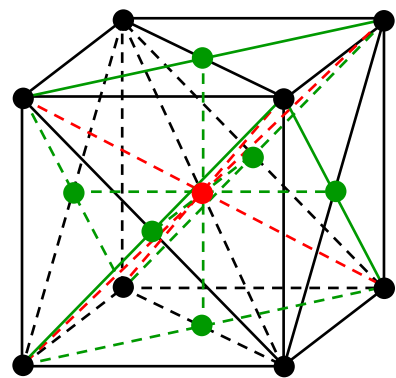
- Initial cube and its subdivision after three consecutive tetrahedron bisection



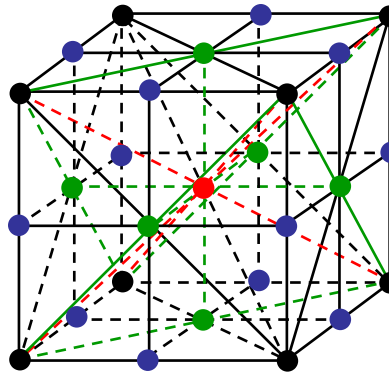
6 tetrahedra



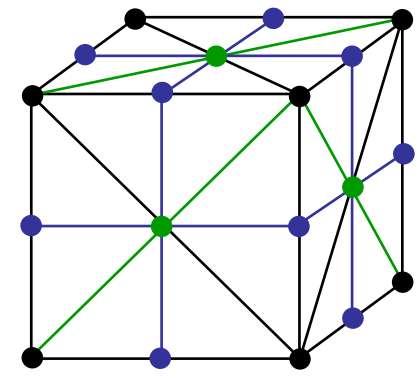
12 tetrahedra



24 tetrahedra

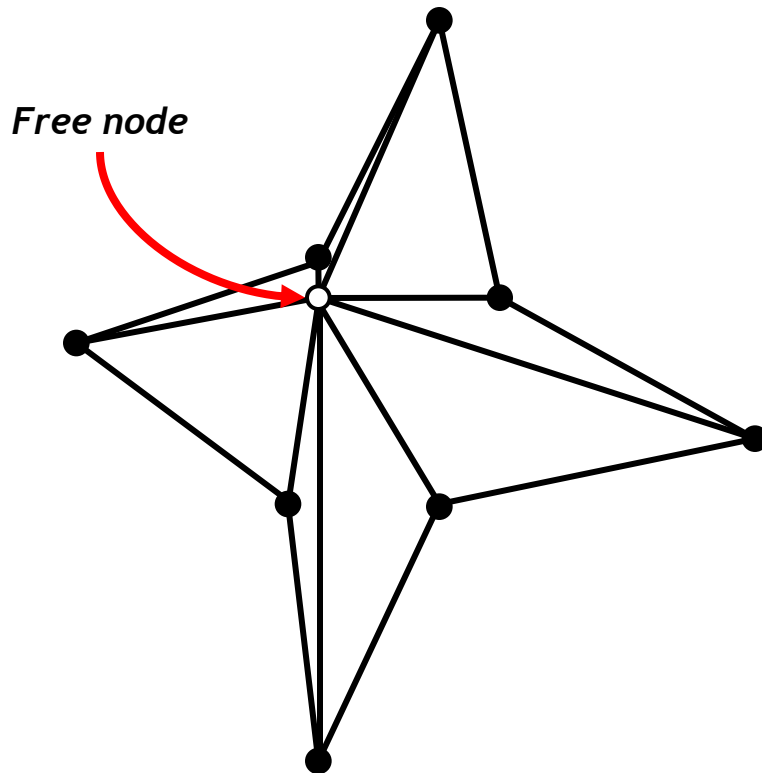


48 tetrahedra



Local optimization

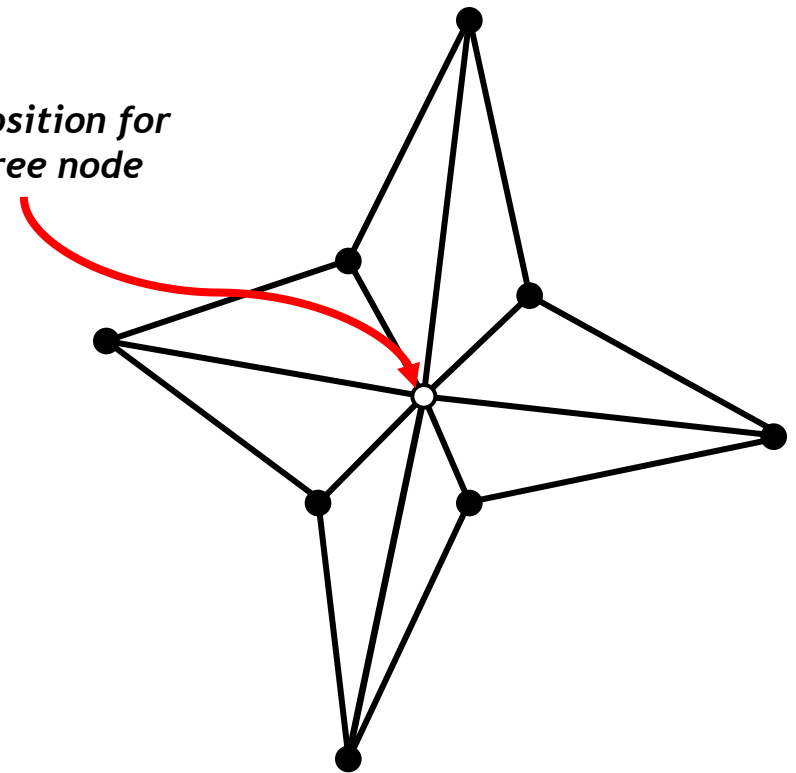
Objective: Improve the quality of the local mesh by minimizing an objective function



Local mesh



New position for the free node



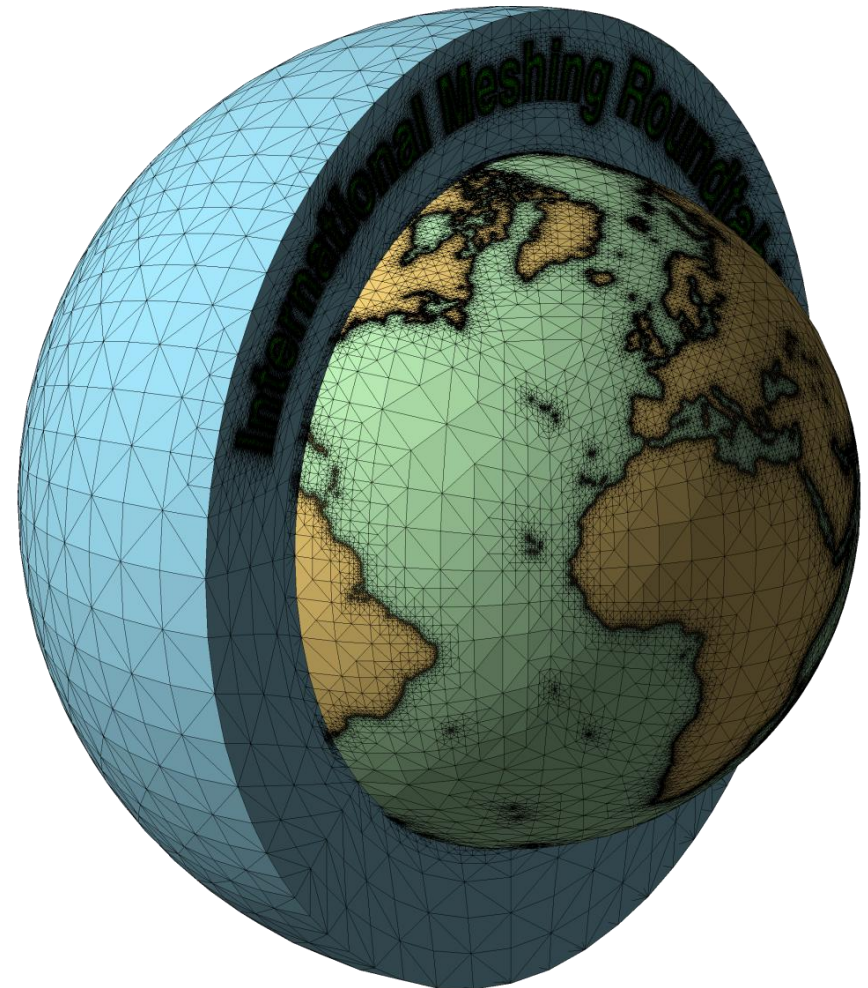
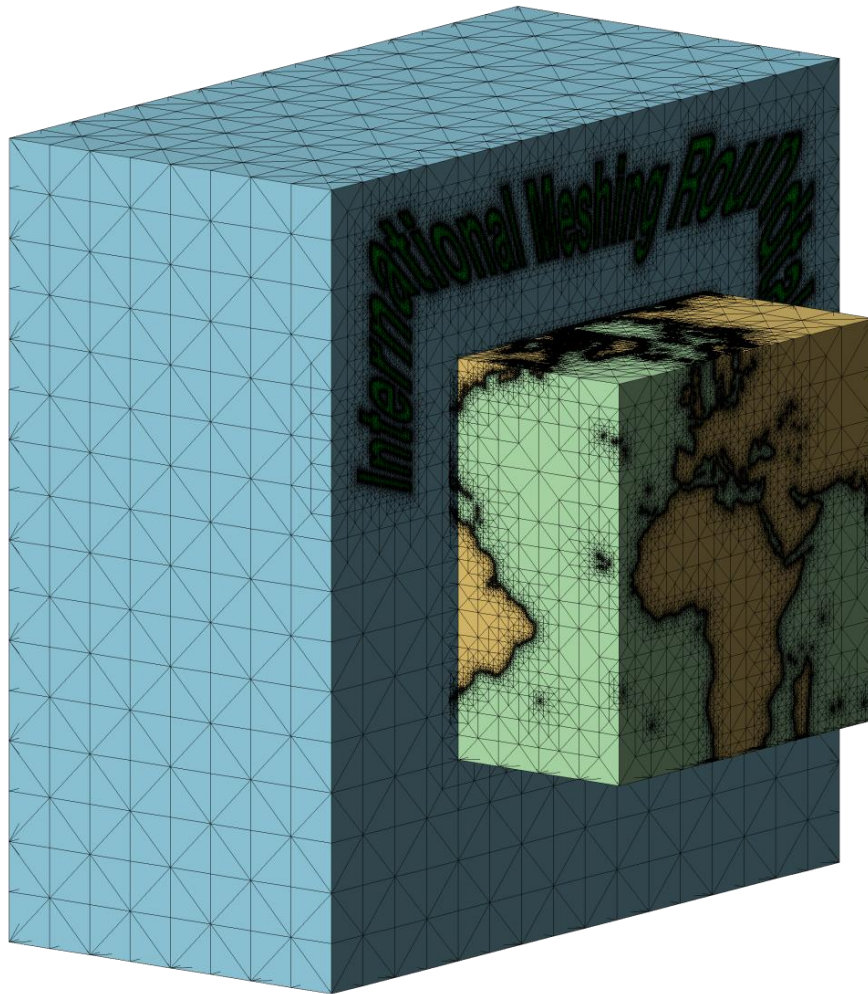
Optimized local mesh

Meccano Method

Example

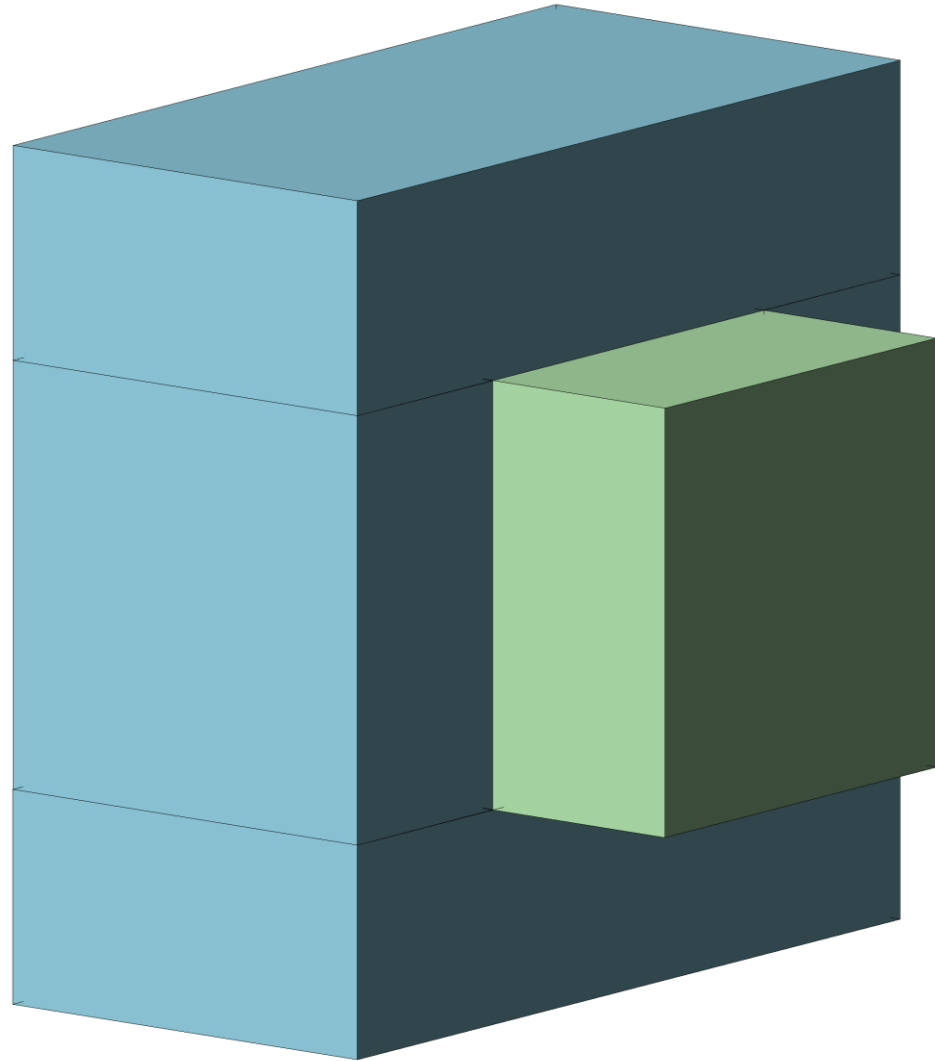


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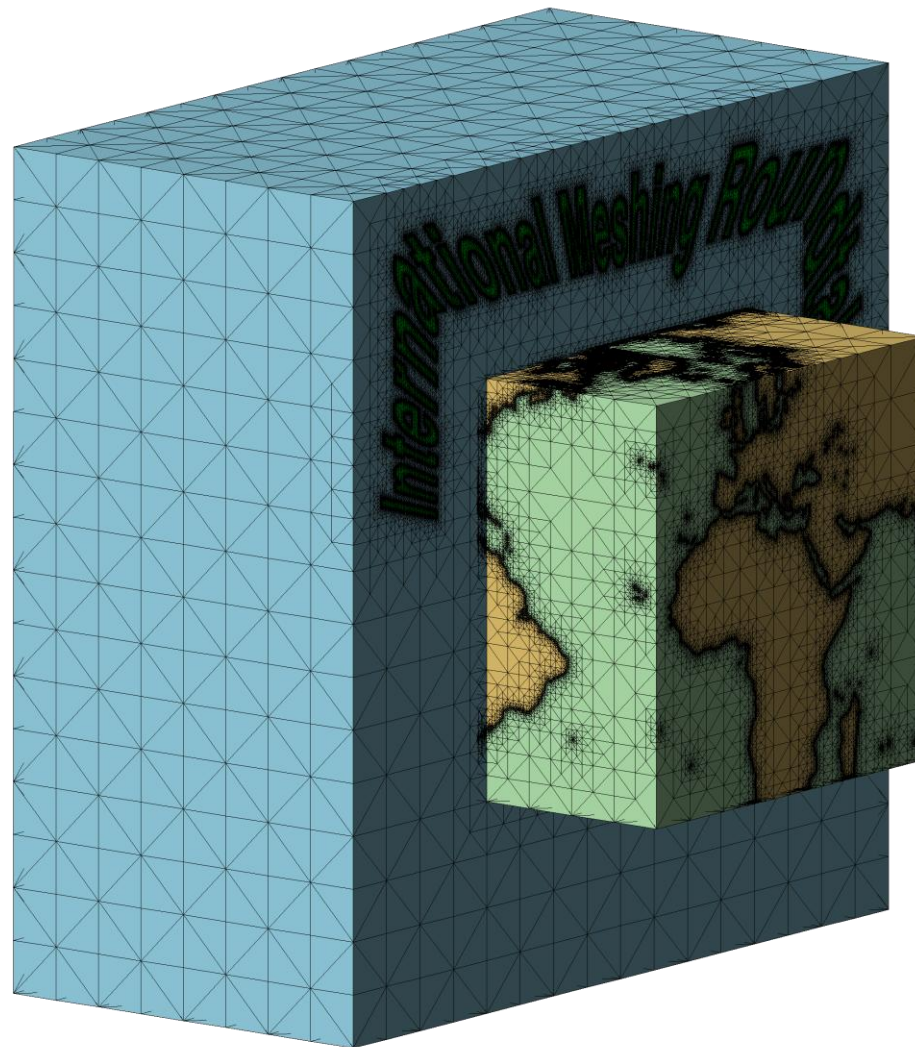
Meccano Method

Example



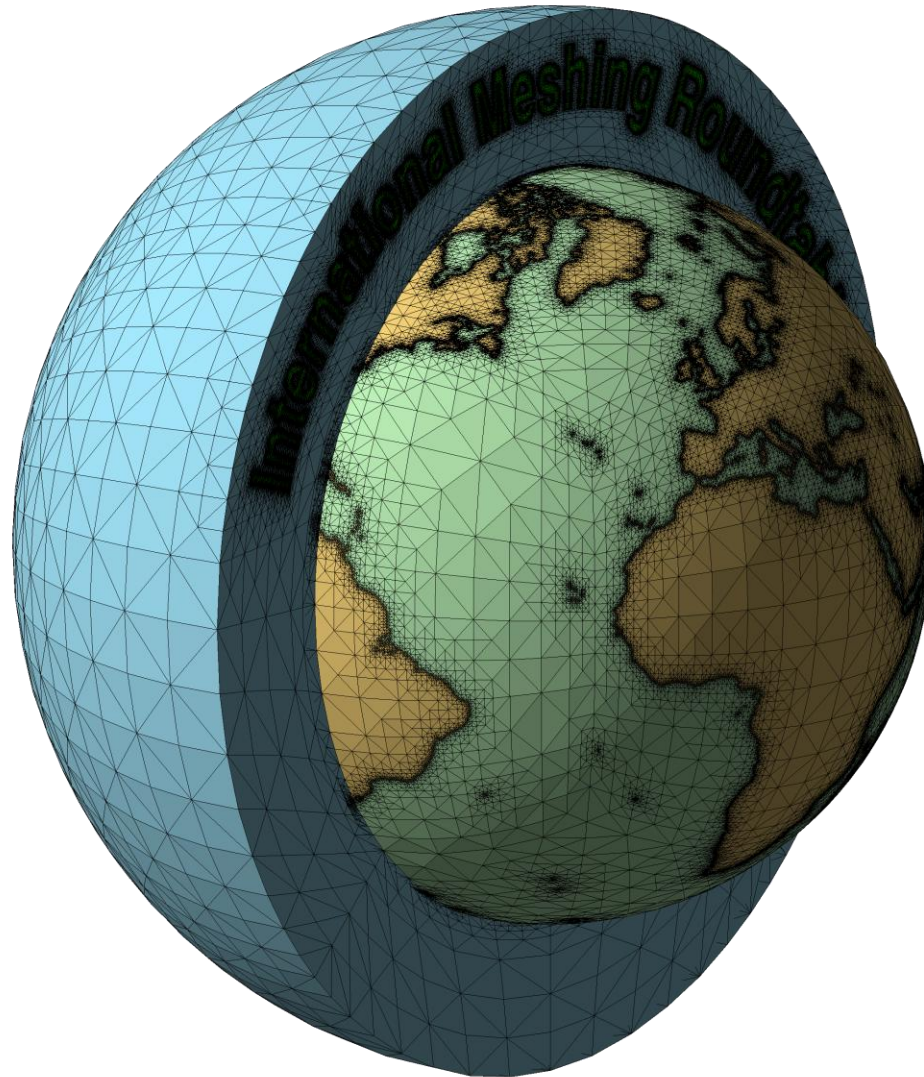
Meccano Method

Example



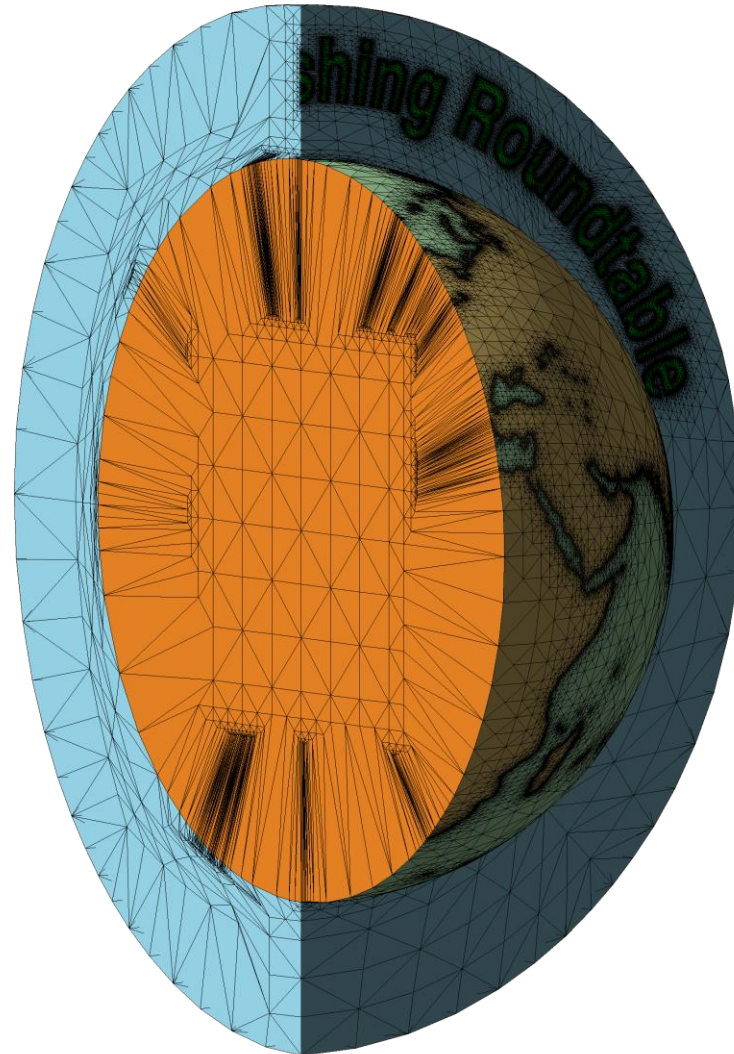
Meccano Method

Example



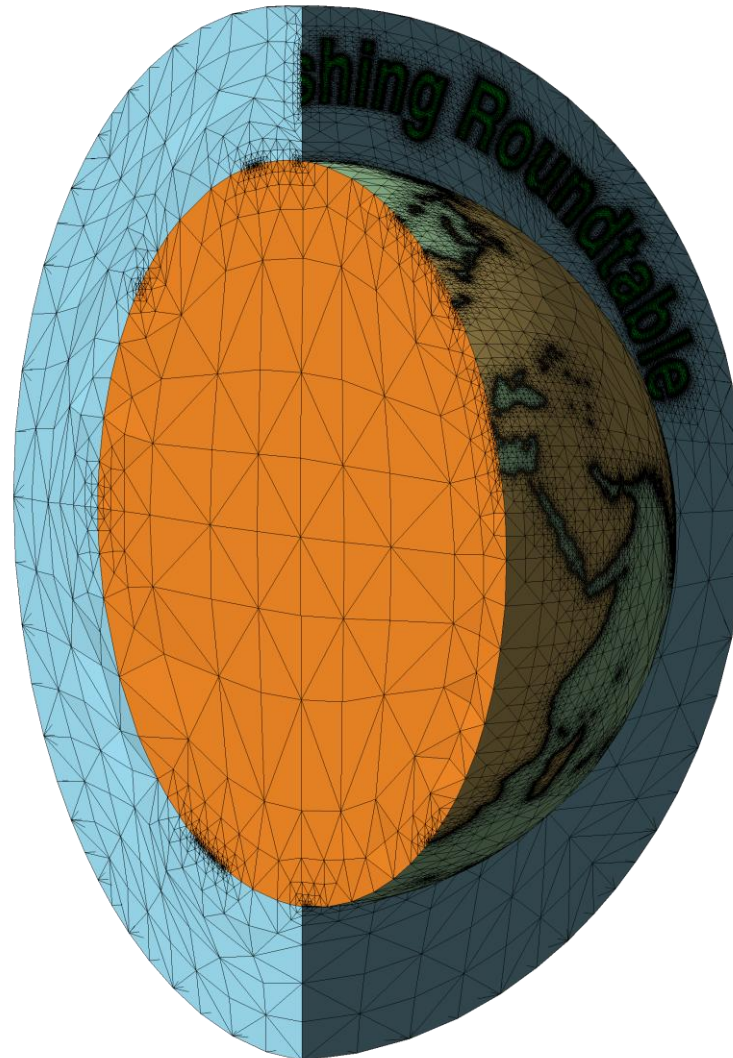
Meccano Method

Example



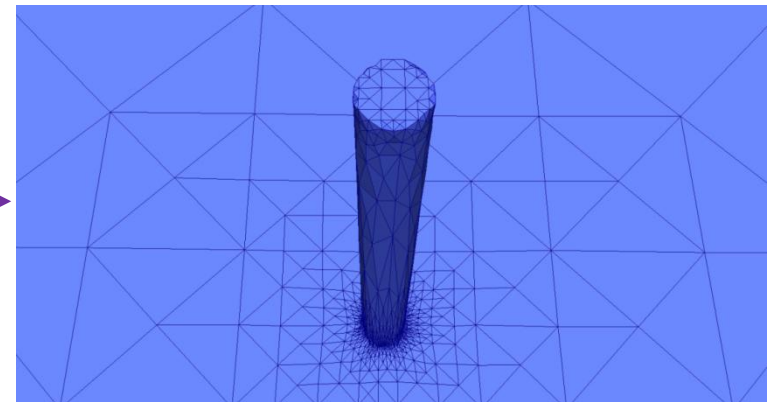
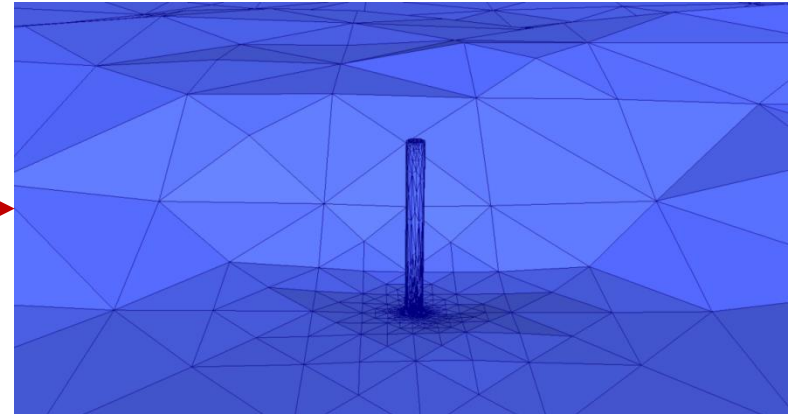
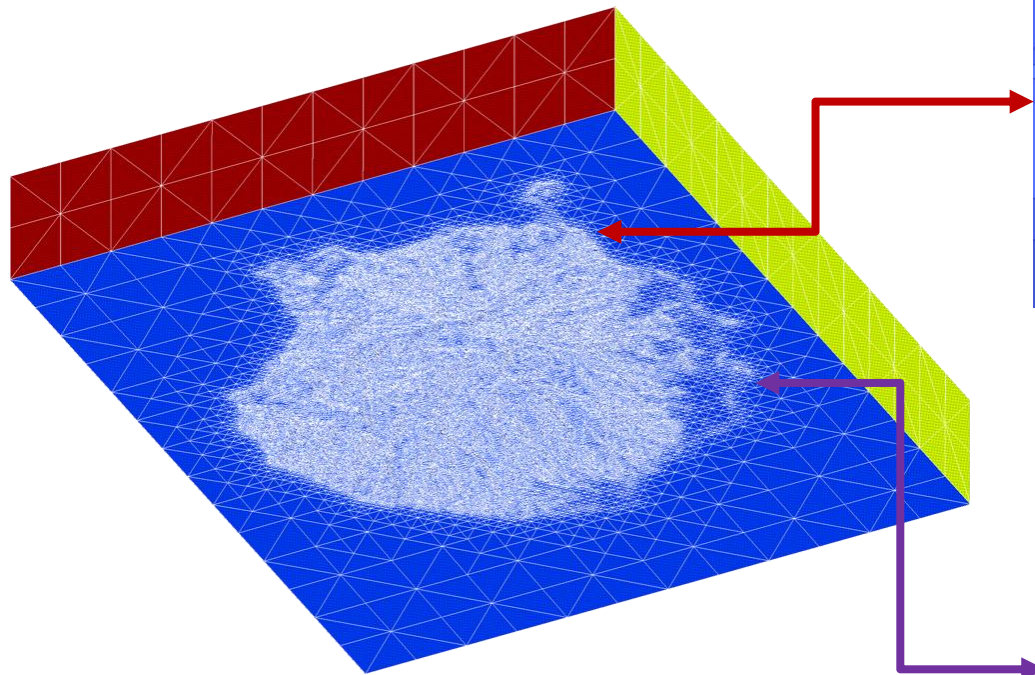
Meccano Method

Example



Meccano Method

Gran Canaria Island







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