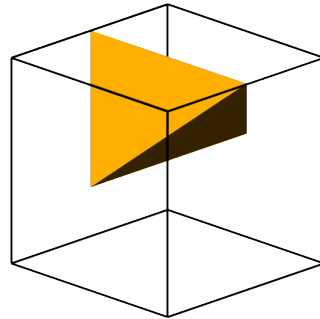
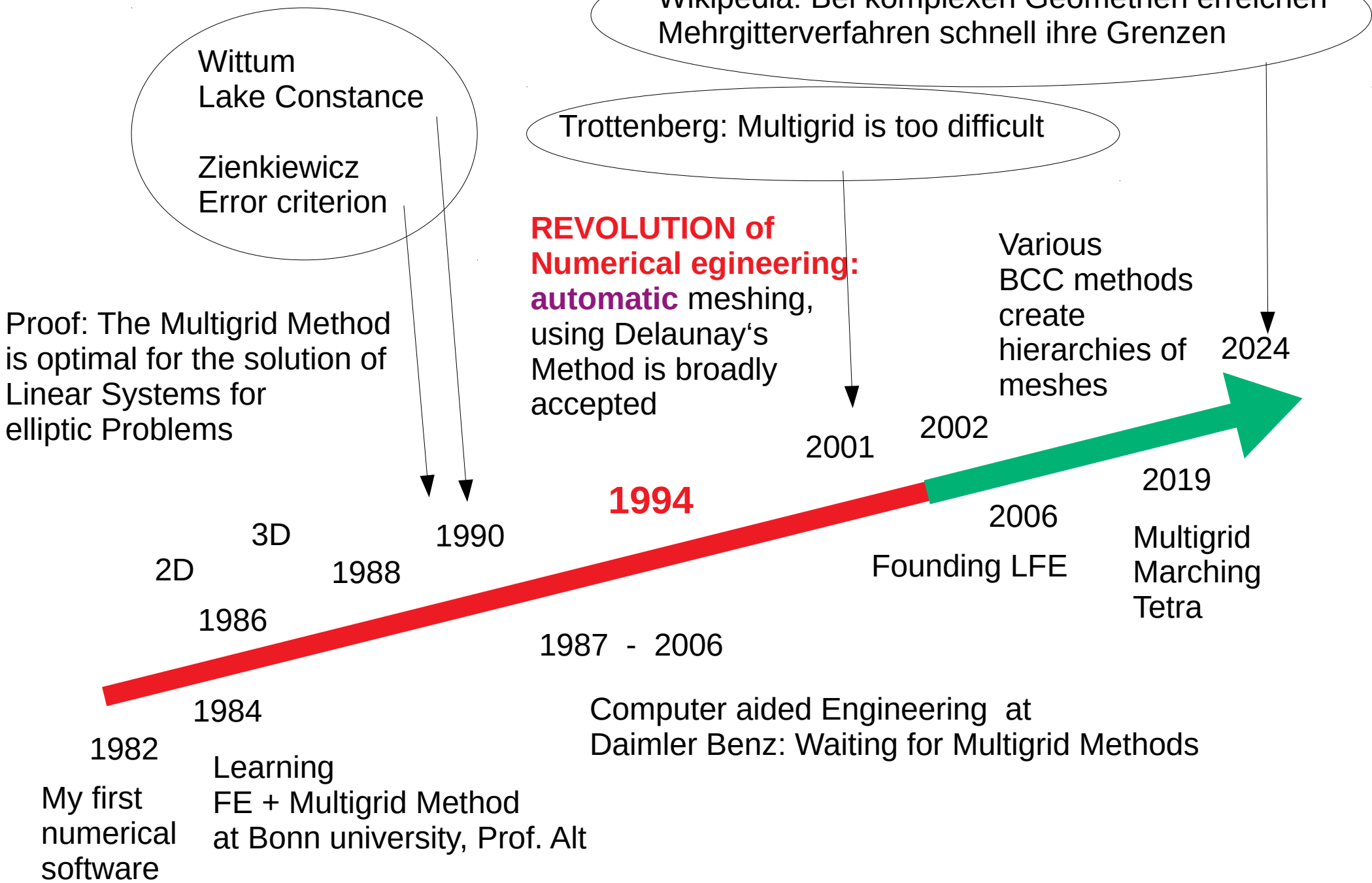


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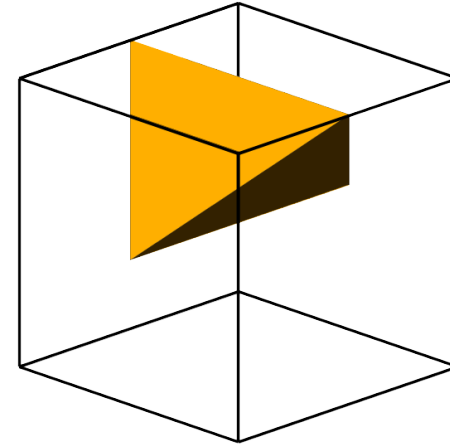
MULTIGRID

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BCC = body centered cubic mesh

is a conformal tetra-mesh built up of this tetra.



2002 BCC Molino

2007 BCC Labelle, Shewchuk

2019 BCC MMT LFE

2024 BCC Matt Staten ... and others

Common: the mesh is refined locally, geometry is introduced in the last refinement step

BCC is MULTIGRID: each new node is a midnode of an elder edge.

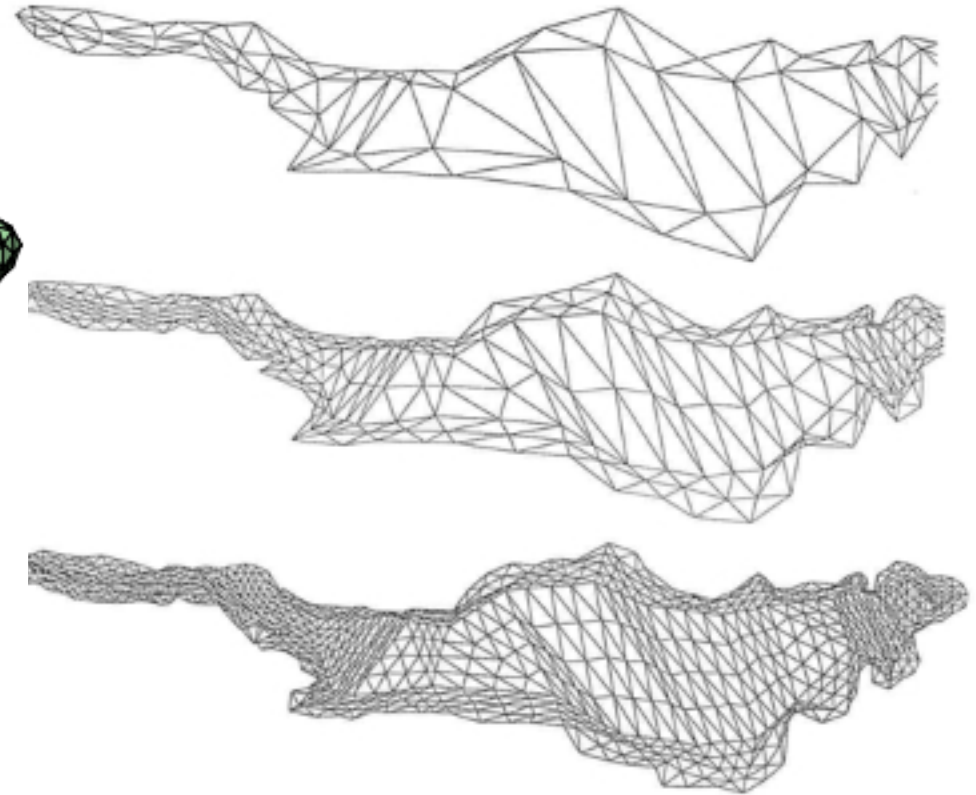
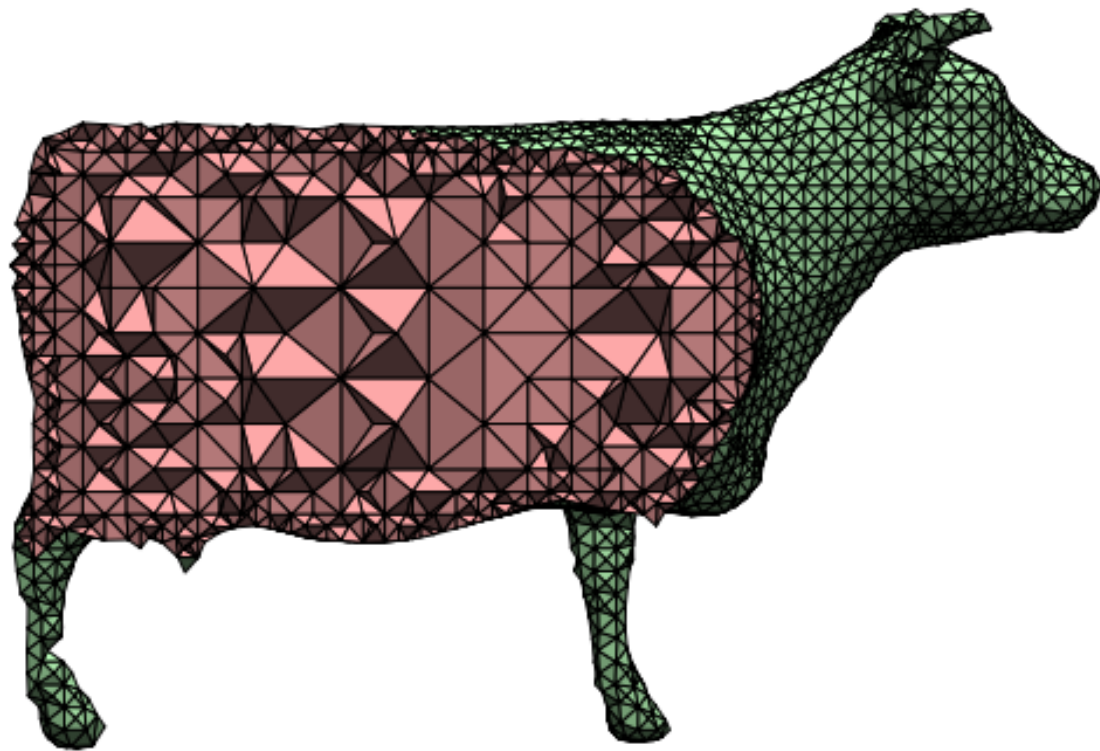
BCC-tetra allow octree refinement.

Let tetra quality be defined by $\text{factor} * \text{volume} / \text{max edge}^{**3}$

such that the quality of the regular tetra is 1.0

the quality of the BCC-tetra is $0.707.. = 0.5 \text{ sqrt } 2.0$

Any local refinement can be performed with tetras better than 0.155 .



Automated 3D multigrid sequence of meshes - 2D multigrid sequence of meshes, created manually

2007 Labelle, Shewchuk

1990 Sautter, Wittum

Multigrid Methods offer the opportunity to solve the linear systems efficiently.

Multigrid Methods offer the opportunity to mesh adaptively.

The workflow of traditional digital engineering has to be changed:

The description of the computation job, loads and boundary conditions have to be performed on the CAD-level. Not on the FE-mesh.

THE MULTIGRID MARCHING TETRA METHOD

A single BCC Tetra covers all parts

3 times octree refinement

Loop: local refinement:

- octree, midnode, edge bisection for tetras which are selected by the refinement criterion

Keep element quality > 0.155 by adding edge bisections

Final local refinement step:

Each **node** is assigned to exactly one part

Each **tetra** is assigned to exactly one part

Keep element quality $> 1.e-7$ by barycentric limits or other means

MT refinement of tetras with different part properties at its nodes.