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Extending Gocad to improve the modelling – simulation – visualization workflow.

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Sedimentary basins, such as the Thuringian basin in Germany can exhibit complicated geological structures, due to several subsequent extensional and compressional deformation phases. As part of INFLUINS, a project dealing with the present day hydrodynamics of this basin and the influence of its geological history upon them, it is planned to carry out simulations of for example 3D fluid flow, using the simulation software OpenGeoSys (OGS). For this reason it is necessary to convert structural subsurface models constructed by structural geologists, using the commercial software Gocad (Paradigm Ltd.), into 3D grids on which the simulation is run. These grids must meet certain geometric constraints to guarantee a numerically stable simulation. For construction of these grids several options exist. For reservoir simulations hexahedral meshes, so called SGrids in Gocad, are often used to represent the subsurface. The workflows and methods to construct these are well established but the geometrical complexity of the structures that can be represented by them is limited. Tetrahedral finite element meshes, in contrast, can reflect the complicated geological structures in the Thuringian basin better, but are harder to construct.

In order to examine the simulation results in the context of the structural model and also to validate the geometrical model against the original data from which it has been constructed, immersive visualization methods using stereoscopic rendering are of help. They allow multiple scientists to simultaneously view and discuss the whole model together. For this reason we will use UFZ's projection based Virtual Reality display for the visualization of our results.

In order to support the overall workflow, from the models of the structural geologists via the simulation in OpenGeoSys to the visualization in UFZ's Virtual Reality center the software Gocad has been extended with several plugins. These extensions comprise three different groups. Firstly additional tools have been implemented that support the geometric modelling and interface Gocad with open source meshing tools. The aim is to construct a boundary representation of the subsurface model which already fulfils some geometrical constraints that are prerequisites for subsequently generating a 3D mesh. Based on this, finite element conforming tetrahedral meshes of good quality can be generated that reflect the geological structures and the boundaries between the different stratigraphic units. Secondly an interface to the open source simulation software OpenGeoSys (OGS) has been implemented. The 3D mesh can be exported directly and the different geometries can be transferred from Gocad to OGS and be used there for setting boundary and initial conditions. Thirdly an interface from Gocad to UFZ's Virtual Reality Display has been established, using the open source scenegraph OpenSG and the Visualization Toolkit (VTK). We present several examples of the methods described here for constructing models of parts of the Thuringian basin, as part of the INFLUINS project.