

SHAPER : a new CAD software dedicated to physical simulations

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EDF R&D carries out many studies using numerical simulation for its equipment: dams, power plants, cooling towers, pumps, valves, alternators, pipes, etc. Numerical simulations are performed in order to understand physical phenomena they develop (heating, vibrations, etc.). In order to precisely meet the transverse needs of the simulation, independently of the simulation codes that are used, EDF R&D and CEA¹ have developed the open source SALOME platform (<http://www.salome-platform.org/>) in the 2000s. SALOME provides the users with a generic support for pre- and post-processing for numerical simulations.

Since 2014, EDF R&D has been developing a new CAD software, SHAPER, with CEA and OpenCascade. SHAPER is a new LGPL module of the SALOME platform. It is based on the OpenCascade library². SHAPER will replace the existing module in SALOME: GEOM. SHAPER helps simulation engineers drawing much more efficiently 3D CAD models dedicated to simulations than with GEOM. SHAPER is closer to commercial CAD modellers in terms of ergonomics and functionalities because it includes parametric and variational modelling as well as the capabilities to assemble parts in 3D. It produces CAD models that meet the specific requirements of finite element-based computation codes. In particular, SHAPER can generate non-manifold geometries, which is a major feature, provides a feature to create "groups" of shapes (vertices, edges, faces or solids) useful for the subsequent steps of the simulation process (meshing etc.) and is able to connect multi-dimensional domains between them.

The task of creating a CAD model dedicated to simulation can be divided into two main stages:

- The effective creation of the geometry of a simulation domain;
- The preparation of the geometry for meshing and solving. This phase includes:
 - o The creation of groups;
 - o The division (partitioning) of the domain if a hexahedral mesh is targeted.

The second step represents more than half the total time needed to create a CAD model ready for meshing and solving. In this context, we have decided to facilitate the creation of groups which is often a long, tedious, repetitive work. Two advanced and complementary features are under development: a group creation feature that is movable in the « construction history » and a feature extracting occurrences and families of domains, developed by INRIA/LJK³.

Regarding the partitioning of a domain in order to generate a hexahedral mesh⁴, SHAPER makes it easy enough especially thanks to the « partition » feature and to the non-manifold sketches that can be extruded or revolved to make straightforwardly a "composite solid".

To date, SHAPER is still under development. It already makes it possible to model quite efficiently a dozen of target models of EDF. It offers advanced features to generate groups or partition domains and should be of interest to the open source community of numerical simulations.

¹ French institute «Commissariat à l'énergie atomique et aux énergies alternatives».

² <https://www.opencascade.com/content/core-technology>

³ Partner French laboratory with which we work (<https://www-ljk.imag.fr/>).

⁴ Operation also known as «blocking».