11d

Spezialforschungsbereich F013
A Cooperation of the Subprojects F1306 and F1309 and F1311

Geometrical input formats

CSG

CSG (constructive solig geometry) represents geometry using **primitives combined by boolean operations**. The surfaces of the primitives are described implizitely by nonlinear equations.

Supported primitives: Halfspace, cylinder, sphere, cone

```
solid cube =
            plane (0, 0, 0; 0, 0, -1)
        and plane (0, 0, 0; 0, -1, 0)
        and plane (0, 0, 0; -1, 0, 0)
        and plane (100, 100, 100; 0, 0, 1)
        and plane (100, 100, 100; 0, 1, 0)
        and plane (100, 100, 100; 1, 0, 0);

solid all =
            cube
        and sphere (50, 50, 50; 75)
        and not sphere (50, 50, 50; 60);
```

STL

STL (stereolithography) files are the de-facto standard CAD representation for rapid prototyping. They use **faceted surface representation**, i.e. a **list of triangular surface patches** with no adjacency information.

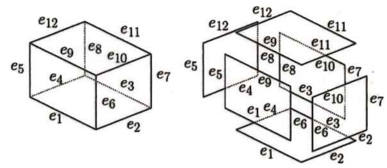
```
solid Solidname
  facet normal 9.838605e-01 3.226734e-02 1.760037e-01
    outer loop
      vertex   -1.070000e+02 0.000000e+00 1.816000e+02
      vertex   -1.060000e+02 0.000000e+00 1.760100e+02
      vertex   -1.070000e+02 1.200000e+00 1.813800e+02
    endloop
  endfacet
  facet normal 9.824255e-01 9.205564e-02 1.623759e-01
    outer loop
      vertex   -1.070000e+02 1.200000e+00 1.813800e+02
      vertex   -1.060000e+02 0.000000e+00 1.760100e+02
      [...]
    endloop
 endfacet
 [...]
endsolid
```

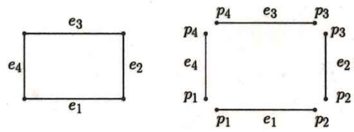
STEP AP 203

STEP (Standard for the Exchange of Product model data) is an ISO standard. Is was designed as a successor of IGES and VDAFS. AP 203 (Application protocol) uses a **boundary representation**, i.e. a **list of surface patches** defining the boundary of the solid. These are bounded by edges with well-defined starting and ending points. **Additional topological information** (how the faces are joined together) is included.

Supported surface types: Plane, cylinder, sphere, cone, torus, sweep and rotatinal surfaces, b-spline and rational b-spline surfaces

Supported curve types: Line, circle, ellipse, parabola, hyperbola, b-spline and rational b-spline curve





Mesh generation features

- **Different elements** supported: Triangles, quadrilaterals; tetrahedra, prisms, pyramids
- **Rule based advancing front mesh generator**: The rules can be specified in form of data structures
- **Surface mesh generation using advancing front methods**: In a trust region around the current segment whose radius is controlled by the geometry, the front is transformed into local 2D-coordinates and the 2D rules are applied.
- **Volume mesh generation** using a combination of **Delaunay's algorithm and advancing front methods**; We use Delauney's algorithm for large parts of the volume and advancing front methods for generating a conforming closure to the boundary mesh.
- **Local mesh size control**: The mesh size is controlled by the local curvature of the geometry.
- **Anisotropic mesh generation** for thin layers
- **Mesh optimization** of surface and volume mesh using
  1. free point relaxation,
  2. point relaxation on edges and surfaces,
  3. edge swapping,
  4. point collapsing,
  5. edge splitting.

Examples