TGrid™ software is a specialized pre-processor for fluid flow analysis. It is used to create large, unstructured tetrahedral and hexcore meshes for complex geometries. TGrid software is utilized heavily for large-scale automotive and aerospace applications in which advanced meshing techniques are required for the computational analysis of fluid flow.

Customers and Applications
Automotive industries around the world are pushing productivity on new car models, resulting in the demand for rapid and high-quality solutions for large-scale computational fluid dynamics (CFD) problems. This trend is accompanied by manufacturers’ needs to quickly make changes in automotive CFD meshing without time-consuming manual interactions. TGrid software helps ensure productivity gains at each step, from geometry to volume mesh. Flexibility and customization allow TGrid meshing tools to be used in a wide range of applications, from external aerodynamics on Formula One (F1) racing cars to droplet distribution inside human nasal cavities.

Wrapper Technology
In today’s automotive industry, front-end underhood thermal management (UTM) represents one of the most challenging meshing applications. TGrid software addresses this challenge by capturing best practices and automating the time-consuming manual meshing once required for this class of problems.

The entire underhood wrapper-based meshing process has been encapsulated for overnight batch execution. Moreover, customized user interfaces can be developed to expose key parameters and automate specific processes.

Key Wrapper Capabilities
• A full suite of global and local size definition tools using a mixture of curvature, proximity and fixed- and region-based sizing
• Both manual and fully automatic leak/hole detection and fixing algorithms
Product Features

- Rename
- Translate
- Triangulate
- Rotate
- Flip normals
- Change type
- Change position

> Boundary group manipulations
  - Create groups
  - Activate groups
  - Draw groups
  - Delete groups

> Separate boundary face zones by:
  - Angle
  - Neighbor
  - Region
  - Mark
  - Shape

> Seed using angle
> Seed using edge loop

> Mesh projection using:
  - Normal direction
  - Closest point
  - Specified normal criteria

> Periodic or cyclic boundary zone
  - Rotational periodicity
  - Translational periodicity

Surface Wrapping Tools

> Prescribe mesh size functions
  - Global curvature and/or proximity
  - Zone-based curvature and/or proximity
  - Fixed zone
  - Region (box)-based

> Visualize and list distributions
> Initialize Cartesian grid
> Region examination
> Refine Cartesian grid
> Manage holes
  - Draw
  - List
  - Fix
  - Open

> Wrapping regions
> Create edge zones
> Imprint wrapper surface
> Deviation between wrapper and geometry
> Coarsening

> Wrapper improvement tools
  - Remove close nodes
  - Resolve self intersecting
  - Resolve overlapping surfaces
  - Remove cell island
  - Smoothing with re-projection
  - Improve quality
  - Removal of small cells
  - Removal of high-aspect ratio cells

- Wrapping of single and multiple regions, including global and selective feature capturing
- A full suite of post-operations, including coarsening, removal of self-intersecting and overlapping surfaces and a comprehensive set of quality enhancement tools
- A single-surface recovery technique for thermal shields, which, together with shell conduction models available in ANSYS® FLUENT® software, results in efficient and accurate thermal solutions

In addition to its use in automotive underhood, wrapper technology is being applied to passenger thermal comfort simulations. It also is utilized in the biomedical, oil and gas, built environment and aerospace industries.

Boundary Mesh Tools

In a large organization, surface meshes often are combined to create a CFD simulation model. TGrid software supports the majority of mesh formats and is equipped with tools to merge, stitch and intersect these together to form conformal domains. Smooth and swap operations in TGrid software result in global quality improvements, and the traditional mesh editing commands have been extended with fully automatic sliver removal tools to produce best-in-class CFD surface meshes. A large number of complementary tools also are available, such as:

- Direct primitive plane, box and cylinder creation
- Zone remeshing, projection and separation tools
- Move, translate, scale and copy zone operations

TGrid software is utilized heavily in large-scale automotive and aerospace applications, in which advanced meshing techniques are required for the computational analysis of fluid flow.

In this example of a tractor, improved wrapper technology is combined with specific meshing tools to properly model heat exchangers and fans.
Volumetric Mesh Generation

Prism and volume generation capabilities in TGrid software are utilized by a large sector of leading automotive manufacturers as well as a majority of F1 racing teams. The auto-mesh procedure in TGrid software ensures that the user selects a desirable prism layer algorithm, quad-tri transitioning type and volume mesh.

Key Prism and Transitioning Capabilities

- Prism layer creation using first height, first aspect ratio, and last aspect ratio algorithms using linear and geometric growth
- Proximity detection with a combination of local layer compression and prism removal with automatic prism side handling
- Large number of post-prism quality enhancement tools
- Prism side transitioning using conformal pyramid, nonconformal quad-split or remeshing techniques

Product Features

- Extract zone boundaries
- Recover single wrapper surface

General Volume Meshing Generation

- Auto meshing options
  - Optionally include prism
  - Choose quad-tri transition option
  - Choose volume mesh type
  - Optionally merge cell zones
- Cavity re-meshing
  - Delete, add and replace options
  - Define cavity-box based on original/new zones
- Ability to export cavity region
- Refill cavity with prism/tet
- Constant size refinement regions
  - Define box using center and delta distances
  - Optionally tilt refinement regions
  - Optionally define transitional growth outside region
  - Optionally activate/deactivate regions

Prism/Pyramid Generation

- Create multiple prismatic layers using:
  - First height and growth
  - First aspect ratio and growth
  - First height and last aspect ratio
- Growth method
  - Slope, rate or exponent
- Operations to enhance quality
  - Proximity/collision detection using:
    - Automatic height shrinkage
    - Local full layer removal

Tetrahedral Mesh Generation

- Tetrahedral initialization
- Tetrahedral refinement algorithms
  - Growth and max size control
  - Advancing front
  - Skewness-based
  - Linear algorithms
- Automatic skewness improvement
- Post-skewness improvement
- Automatic worst-skew node move

Cartesian Hexcore Mesh Generation

- Hexcore characteristics
  - Interior hanging-node Cartesian mesh
  - Quad split transition to tet region
- Hexcore options
  - Manual or automatic max size
  - Buffer layers to control volume growth
  - Peal layers to control distance to boundary
  - Extend Cartesian core to planar boundaries

Additional Volume Meshing Tools

Many automotive and aerospace customers rely on Cartesian-dominant volume meshes in combination with high-quality prism layers to maximize solution quality. The HexCore tool in TGrid software meets this need with a hanging-node Cartesian core generation surrounded by a user-controlled, thin tetrahedral layer. Optionally, the Cartesian core can be extended to planar boundaries for an increased hex-to-tet ratio.

To capture wakes and recirculation zones, both tetrahedral and hexcore meshing support the definition of regional refinement boxes. These can be tilted to capture jets and reticulation wakes. To ensure smooth transitions, multiple mesh growth layers can be applied at the boundaries of these regions.

A combination of the hole-tracing capability and boundary tools was used to efficiently find and close large openings prior to wrapping this highly complex oil rig model.

Images courtesy Lilleaker Consulting AS and Inocean-Marotec AS.
Drastic and unplanned design changes in large-scale models usually become very expensive and, in many cases, the user is forced to remesh the full domain. TGrid software offers an alternative with the cavity remeshing module. This feature allows clients to add, remove or replace parts and components within tet and hexcore meshes without the need to remesh the full model.

The cavity boundary domain can be exported, volume meshed on another process and then reinserted into the base model with the new design ready to solve.

**Product Features**

**Interface, Graphics and Reporting**
- Graphical user interface
  - Fully interactive
  - Extensive hardcopy options
  - Large number of “hot keys”
- View/scene display
- Grid display
  - Selected boundary zones
  - Unmeshed faces
  - Free or multi-connected faces
  - Unused nodes
  - Faces below quality/size criteria
  - Color by ID or boundary type
  - Histogram plots
  - Text user interface
  - Query functions for execution in batch
  - Reporting cell/face quality limit

**Mesh Export**
- ANSYS FLUENT
- ANSYS FIDAP
- ANSYS® POLYFLOW®
- NASTRAN
- PATRAN
- Hypermesh
- STL

**Platforms**
- All major UNIX® workstations
  - Sun®
  - SGI®
  - HP®
  - IBM®
- Intel®-compatible PCs
  - Microsoft® Windows® XP
  - Linux® ES Red Hat®
  - Linux® ES Suse™ on Intel-compatible PCs
- Full functionality on all platform

**The ANSYS Advantage**

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