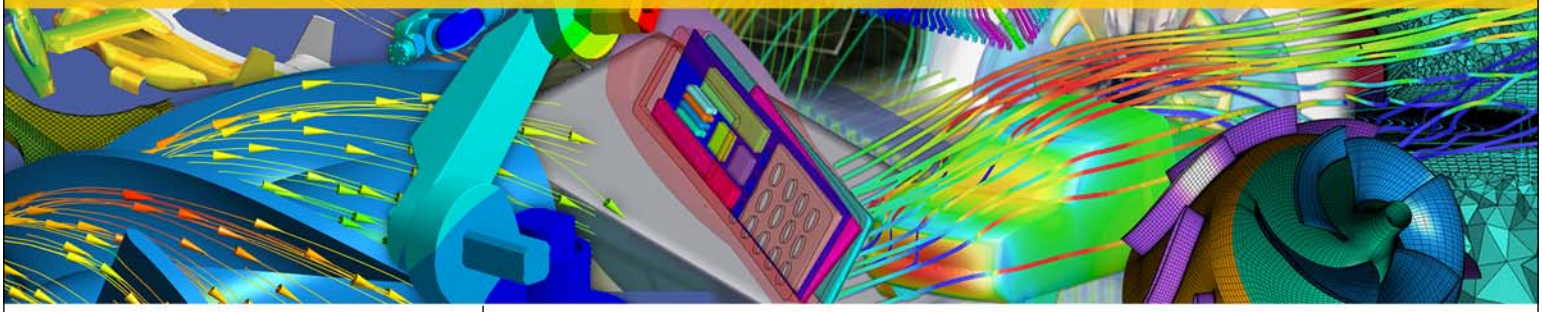
TGrid 5.0



Product Features

Mesh Import Formats
- ANSYS® Mechanical™
- NASTRAN®
- PATRAN®
- I-DEA0053®
- HyperMesh®
- CGNS
- FLUENT®
- GAMBIT®
- FIDAP®
- STL
- Vrml
- Multiple file import
- Append file import
- Support of compressed files

Boundary Mesh Improvement
- Report free and unused nodes
- Remove duplicate/isolated nodes
- Automatic quality improvement
- Automatic removal of small cells
- Quality-based face swapping
- Quality-based node smoothing
- Manual mesh quality improvement

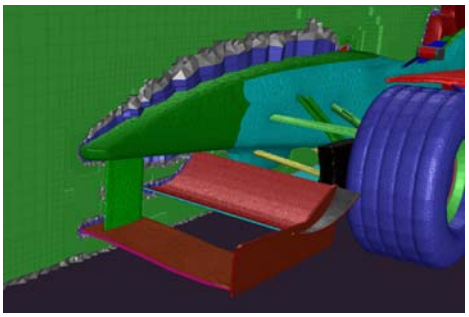
Boundary Mesh (Re-)Creation
- Create face patch
- Create planar rectangular face
- Create closed boundary box
- Create closed boundary cylinder
- Create cylindrical surface
- Re-meshing of existing boundary meshes
- Create edge zones

Boundary Mesh Manipulation
- Boundary refinement tools
- Connecting zones
- Boundary stitch operation
- Quad split operation
- Moving cluster of nodes

TGrid™ software is a specialized pre-processor for fluid flow analysis. It is used to create large unstructured tetrahedral and hexcore meshes for complex geometry. 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 the manufacturers' need to quickly make changes in automotive CFD meshing without time-consuming manual interactions. Enhancements have been made in the latest version of TGrid software to help ensure productivity gain 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.



In this generic Formula One car, TGrid prism layers and HexCore volume meshing are applied on a high quality surface mesh.

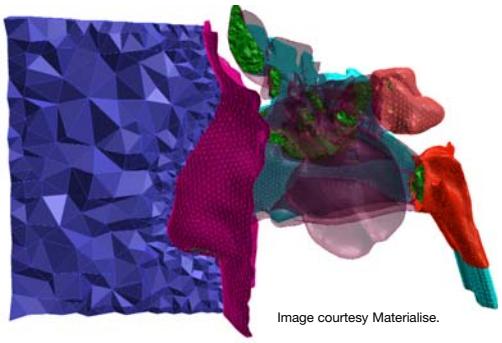


Image courtesy Materialise.

In this human nasal cavity, wrapper has been used to produce a valid high-quality mesh from CAT scan data.

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.

ANSYS®

TGrid5

Product Features

Boundary Zone Manipulation

- Manage boundary zones
  - Summarize
  - Merge
  - Copy
  - Delete
  - 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

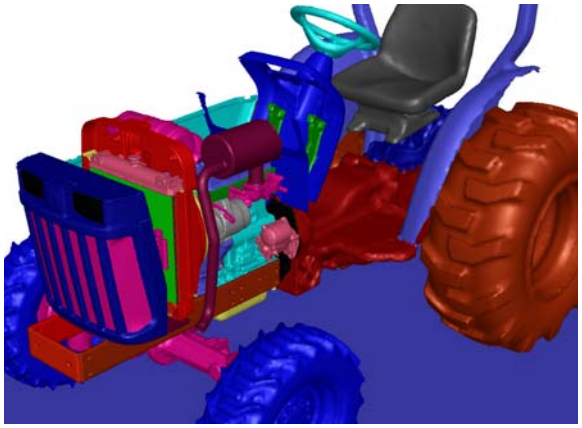
- Prescribe mesh size functions
  - Global curvature and/or proximity
  - Zone-based curvature and/or proximity
  - Fixed zone
  - Region (box)-based
- Visualize and list distributions
- Initialize Cartesian grid
- Region examination
- Refine Cartesian grid
- Manage holes
  - Draw
  - List
  - Fix
  - Open
- Wrapping regions
- Create edge zones
- Imprint wrapper surface
- Deviation between wrapper and geometry
- Coarsening

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
- 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 FLUENT software, results in efficient and accurate thermal solutions

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



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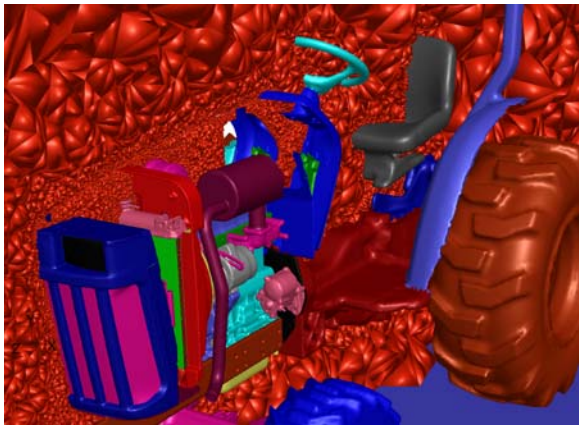


In this example of a tractor, improved wrapper technology is combined with specific meshing tools to properly model heat exchangers and fans.

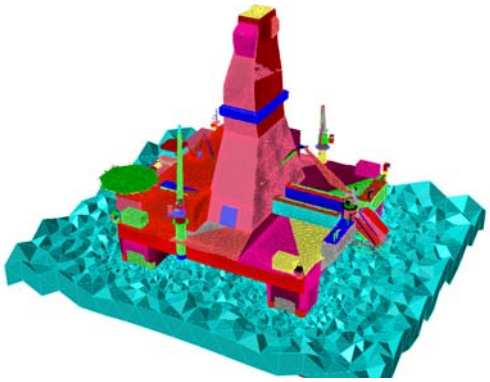
Images courtesy John Deere.

Boundary Mesh Tools

In a large organization, surface meshes often are combined to create the 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. TGrid software's smooth and swap operations result in global quality improvements, and the traditional mesh editing commands have been extended with fully automatic sliver removal tools to produce the best-in-class CFD surface meshes.

There are also a large number of complementary tools such as:

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



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.

Volumetric Mesh Generation

TGrid software's prism and volume generation capabilities are utilized by a large sector of leading auto manufacturers as well as a majority of Formula One racing teams. The auto-mesh procedure in TGrid 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 or nonconformal quad-split or re-meshing techniques

Key Tetrahedral Mesh Capabilities

- State-of-the-art Delaunay tet initialization scheme that ensures success on any valid boundary mesh
- Advancing front- or skewness-based tetrahedral refinement algorithm with controlled growth and optional post-quality improvement tools
- Quality based node-smoothing algorithm with optional boundary movement

Product Features

- 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
- 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
- Locally remove all prism layers

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

Product Features

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

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

- FLUENT
- FIDAP
- 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

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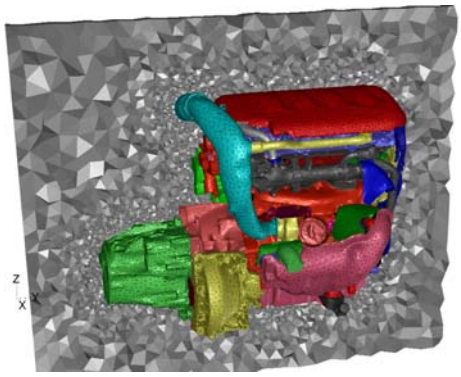


This application shows a wrapped automotive engine model surrounded by a tet mesh from the new high-quality advancing front algorithm.

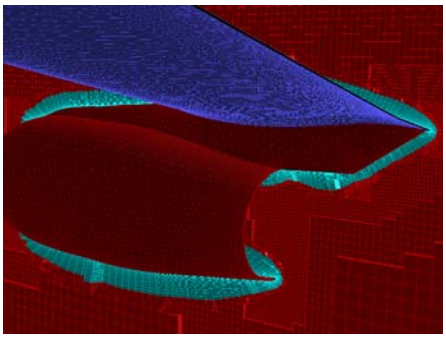
Image courtesy PSA Peugeot Citroën.

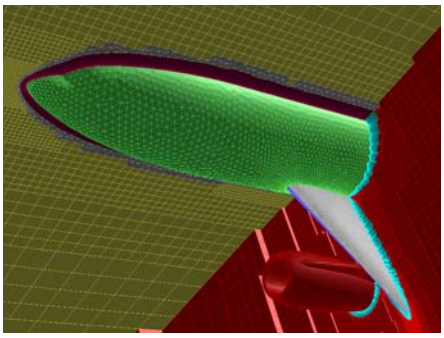
Additional Volume Meshing Tools

Many automotive and aerospace customers rely on Cartesian dominant volume meshes in combination with high-quality prism layers to maximize solution quality. TGrid software's HexCore tool 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 increased hex-to-tet ratio.

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

Drastic and unplanned design changes in large-scale models usually become very expensive, and, in many cases, the user is forced to re-mesh the full domain. The latest TGrid software introduces an alternative with the cavity re-meshing module. This feature allows clients to add, remove, or replace parts and components within their tet and hexcore meshes without the need for re-meshing the full model. The cavity boundary domain can be exported, volume meshed on another process, and then re-inserted into the base model with the new design ready to solve.





TGrid software's enhanced HexCore technology extends the Cartesian grid to planar boundaries. In addition, enhanced prism layer operations now include fully automatic proximity handling to support highly complex geometry, a combination illustrated in this aerospace example.

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