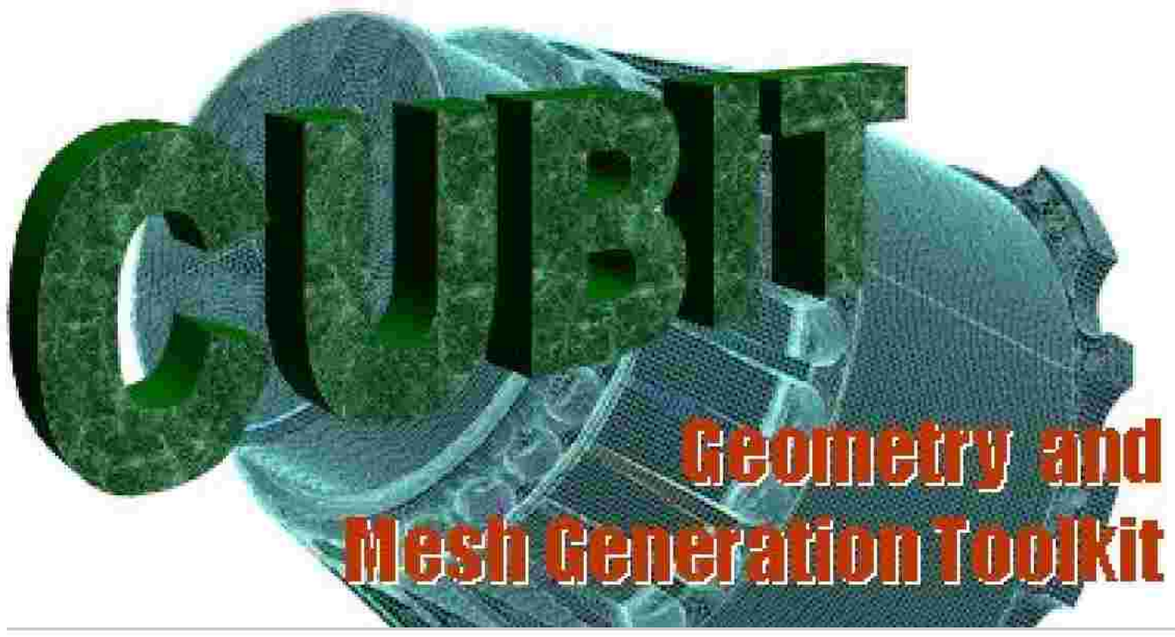
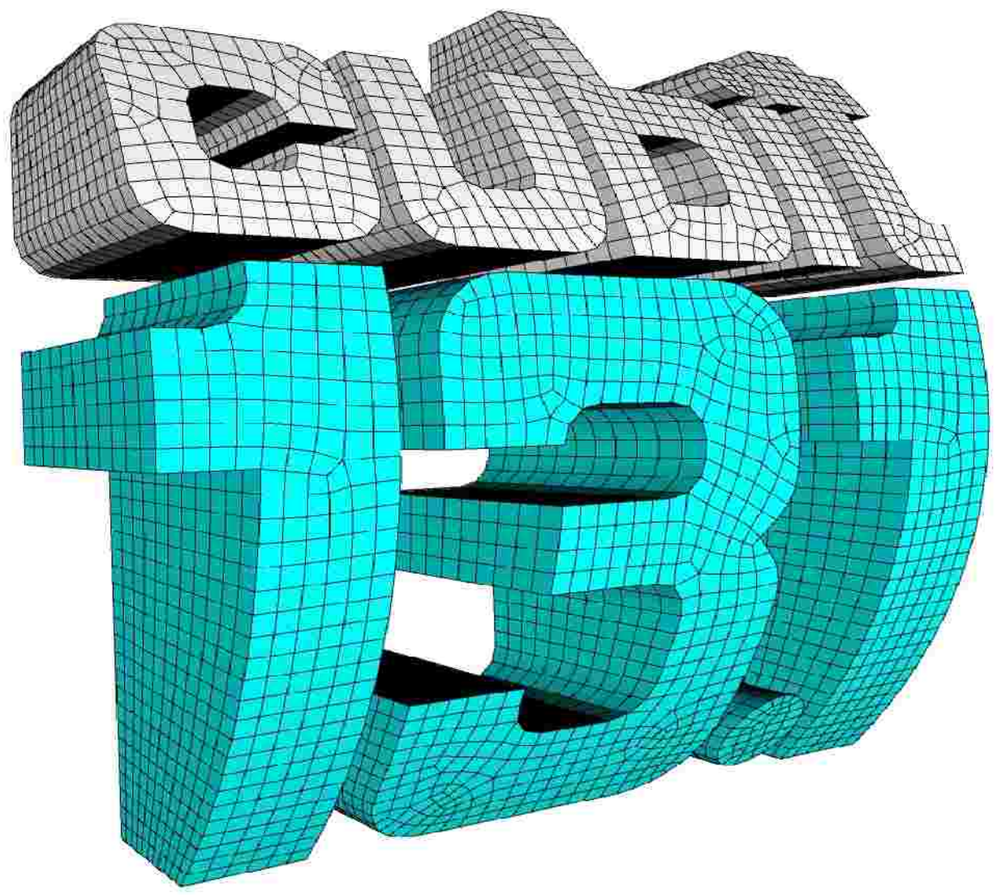




CUBIT 13.1 Release Notes

Released October 2011

Product Description

CUBIT is a full-featured software toolkit for robust generation of two- and three-dimensional finite element meshes (grids) and geometry preparation. Its main goal is to reduce the time to generate meshes, particularly large hex meshes of complicated, interlocking assemblies.

Product Highlights

Meshing: CUBIT is a solid-modeler based preprocessor that meshes volumes and surfaces for finite element analysis. Mesh generation algorithms include quadrilateral and triangular paving, 2D and 3D mapping, hex sweeping and multi-sweeping, tet meshing, and various special purpose primitives. CUBIT contains many algorithms for controlling and automating much of the meshing process, such as automatic scheme selection, interval matching, sweep grouping and sweep verification, and also includes state-of-the-art smoothing algorithms.

Geometry Preparation: One of CUBIT's strengths is its ability to import and mesh geometry from a variety of CAD packages. CUBIT currently integrates the ACIS, Granite, and Catia geometry kernels directly within its code base, allowing direct manipulation of the native CAD geometry format within CUBIT. This reduces the errors and anomalies so often associated with geometry translation. CGM also boasts a facet-based geometry kernel developed at Sandia that can be used for remeshing or editing old mesh files or models defined by triangle facets. In addition, CUBIT has developed a comprehensive virtual geometry capability that permits local composites and partitions to geometry without modifying the underlying native geometry representation. The user can choose to ignore, clean-up or add features to the model allowing greater flexibility to meshing algorithms to generate better quality elements.

CUBIT Environment: CUBIT has developed both a convenient command line interface with an extensive command

language as well as a polished graphical user interface environment. The GUI is based upon the cross-platform standard QT, which allows the same look and feel on all supported platforms. Also included is a graphical environment based upon the VTK graphics standard which has been optimized for display and manipulation of finite element data and geometry. Fast, interactive manipulation of the model is a tremendous advantage for models with thousands of parts or millions of elements.

For more information on CUBIT, including licensing arrangements and terms see the CUBIT website http://cubit.sandia.gov

New Features in CUBIT 13.1

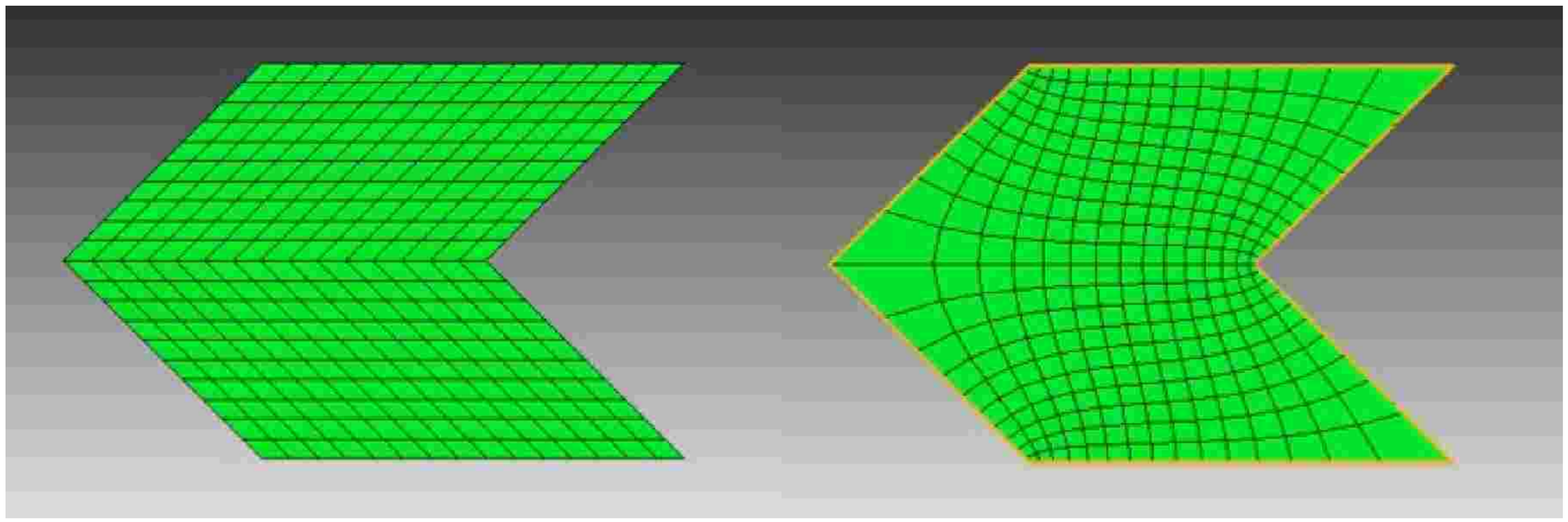
Index of New Features

- Remesh Tets
- Parallel Refinement
- Defeaturing Tool

Meshing

Adjust Boundaries Orthogonal Command

Adjust Boundaries Orthogonal is a new mesh operation that applies smoothing to the nodes of both the curves and surface simultaneously to achieve approximate perpendicular mesh edges at the boundaries.



These images illustrate the effect of the **adjust boundaries orthogonal** command. Left is the initial mesh and right is the mesh after applying the command.

New Sweep Meshing Options

Sweeping continues to be the workhorse algorithm for Cubit, where a large portion of volume meshing tasks utilize this important capability. A number of new options have been added for this release, allowing the user greater control over the resulting hex mesh. The following outlines the main new features:

1. **Propagate Bias:** The new **propagate_bias** option attempts to preserve the source bias by propagating bias mesh schemes from the curves of the source surface to the curves of the target surface.
2. **Sweep Smoothing:** To ensure adequate mesh quality, optional smoothing schemes are available to reposition the interior nodes. The sweep tool permits five types of smoothing: **linear, smart_affine, residual, winslow** and **auto**. These smoothing schemes are described in more detail in the documentation.
3. **Sweep Transform:** Swept meshes are created by projecting points between the source and target surfaces using affine transformations and then connecting them to form hexahedra. The method used to calculate the affine transformations is set using the **sweep_transform** option. In previous versions of Cubit, a generalized **least_squares** approximation was used for computing node locations, which could sometimes perform poorly for simple translation sweeps. In Cubit 13.1 we introduce an explicit **translate** option that will perform a simple interpolation between source and target surfaces. Although **least_squares** remains the default sweep transform method and is the most general, consider using **translate** if you get poor result on simple linear translation swept volumes.
4. **Autosmooth target:** With this option turned on the target surface mesh is smoothed before the volume is swept rather than relying on the sweep transformation to place the nodes.

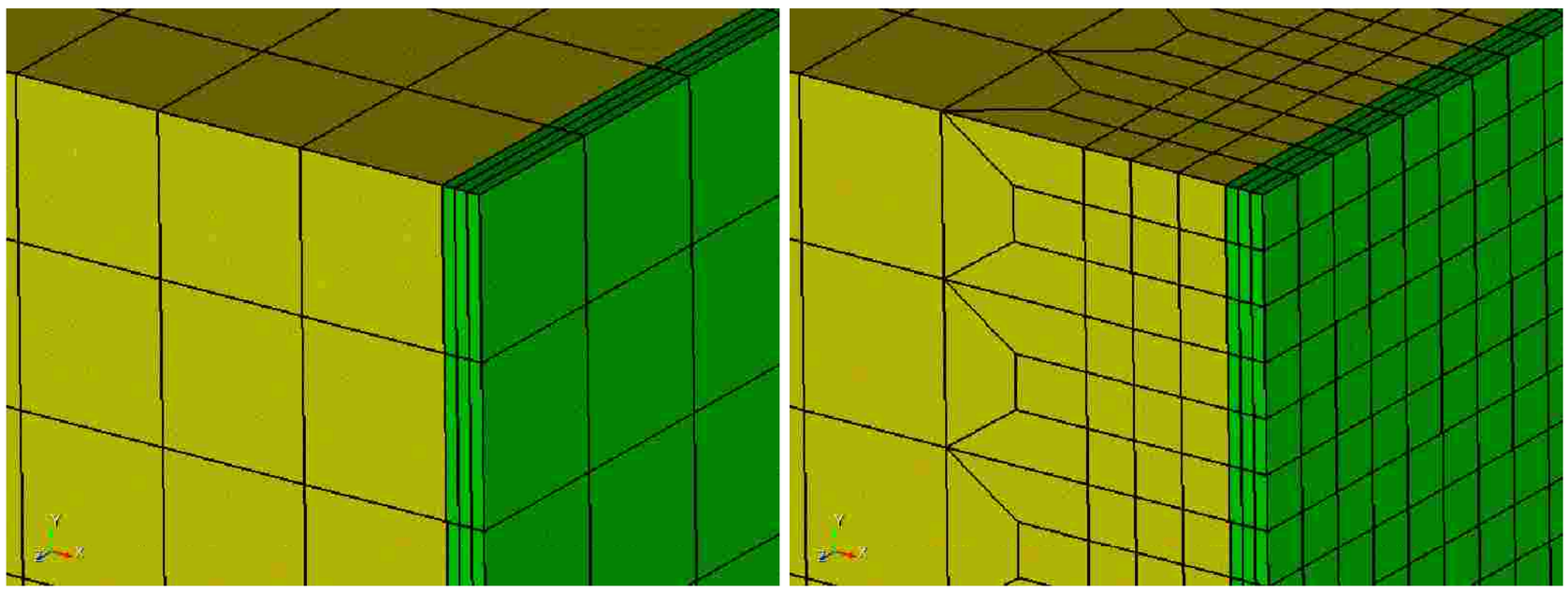
Coincident quad check improvement

The **topology check coincident quad** command now checks for nodes at the same location whether they are part of the same quad, or a different mesh block. In other words, instead of comparing only the actual nodes used to define the two quads, coincident nodes on neighboring meshes are also checked. The previous behavior would detect no coincident quads in two adjoining unmerged blocks.

Directional Refinement

Often there are cases where the model dictates a very thin region such as a gasket or membrane, adjacent to a large blocky region. To achieve a good element aspect ratio in the thin part, the element size in the thick region would may need to be too small. Directional refinement addresses this problem, by allowing the user to limit the directions in which refinement will take place using a reference surface or plane. These figures show how the green membrane was refined only in the plane of the membrane without adding additional elements

through its thickness. Using Cubit's standard refinement operation, the elements through the thickness would also be refined.



Improved preview for curve meshing

The command panel for curve meshing (**Meshing > Curve > Mesh**) currently provides options for previewing the mesh prior to mesh generation. This feature has been improved and made more consistent with this release of Cubit.

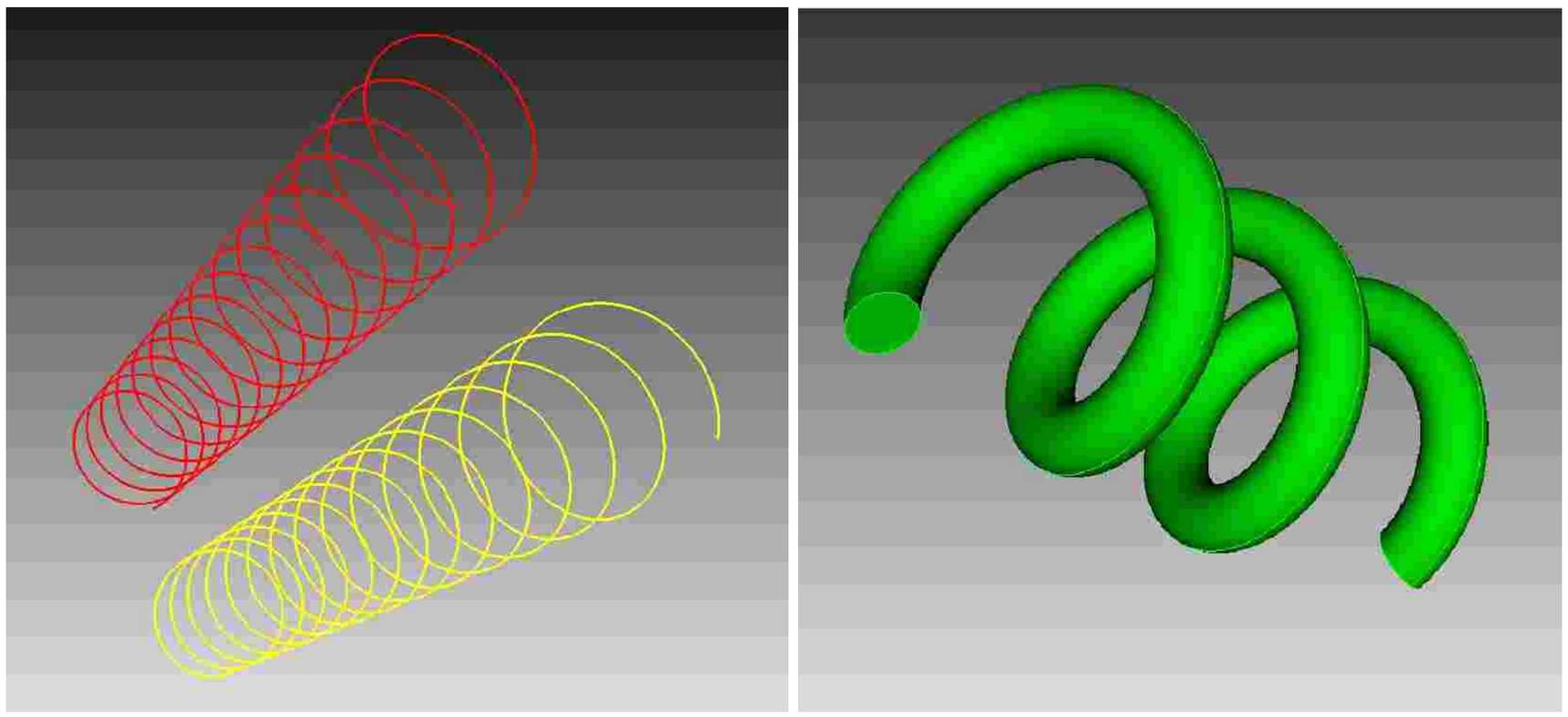
New Options in Curve Bias for Multiple Start Positions

To mesh a set of curves with a bias, often a start vertex is required. Previously the command syntax would only permit a single start vertex, which would not allow specification of bias on multiple curves. This enhancement changes the syntax for the curve bias command to accept multiple start vertices to allowing meshing of multiple curves simultaneously.

Geometry

New Helix Curve and Volume Creation

New commands to generate free curves and volumes defined as helix have been added.



This image on the left shows two helix curves generated with the commands

create curve helix zaxis location 1 0 0 thread_distance 1 angle 5000 left_handed
create curve helix zaxis location 1 0 0 thread_distance 1 angle 5000 right_handed

The image on the right was created by sweeping a circle along a helix path using the following commands

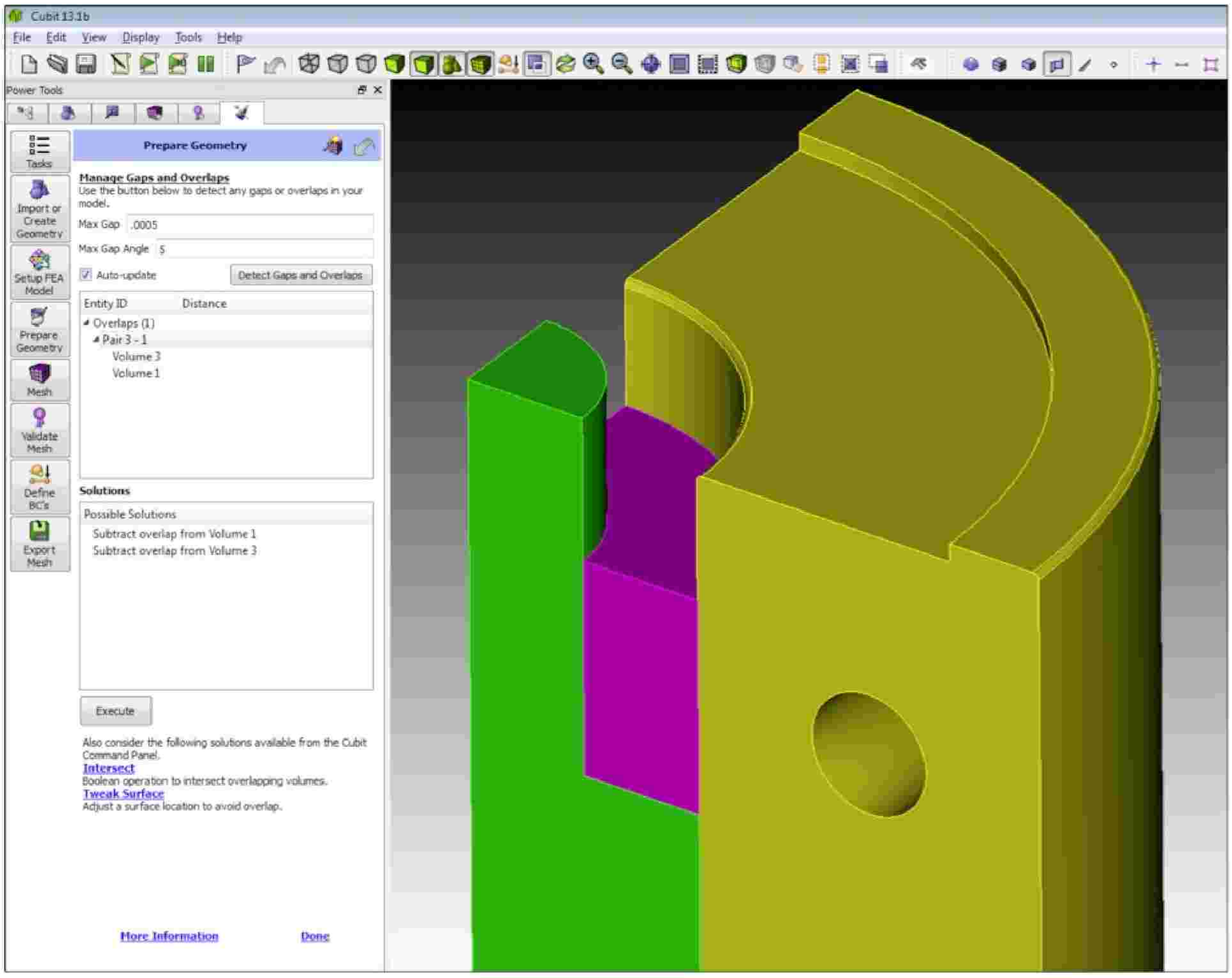
create surface circle radius 0.5 yplane
body 1 mov x 2
sweep surface 1 helix zaxis thread_distance 3 angle 1000 right_handed

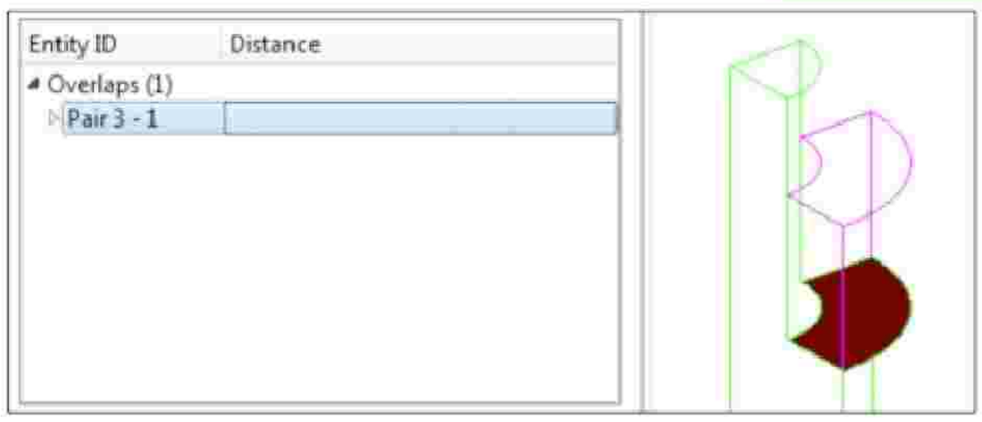
GUI for Auto Midsurface Command

The ability to automatically create midsurfaces from volumes is a relatively new feature in Cubit. In version 13.1, we introduce a command panel in the GUI to control its options. It can be accessed from the command panel **Geometry > Surface > Create > Auto Midsurface**

Manage Gaps and Overlaps Tool

Cubit 13.1 has a new tool for quickly identifying and fixing gaps and overlaps in assembly models. The Gaps and Overlaps Tool is part of Cubit's Wizard Power Tool (or ITEM). This tool provides diagnostic information on gaps and overlaps. Cubit 13.1 introduces a smart solution interface that provides options for resolving the issues that were identified. When the user selects an issue identified by Cubit, the tool displays possible solutions for fixing it. The user simply clicks *execute* to perform the selected solution. Solutions usually consist of typical intersection/subtraction or tweak operations that are currently manually done in cubit. The packaged solutions allows the user to quickly step through each problem and fix it.





Right clicking on an overlap pair in the list and choosing "Draw Pair" will draw the two volumes with the overlap and shade the region of overlap.

Selecting a solution will show the volume that the overlap region will be subtracted from and clicking "Execute" will do the subtraction.

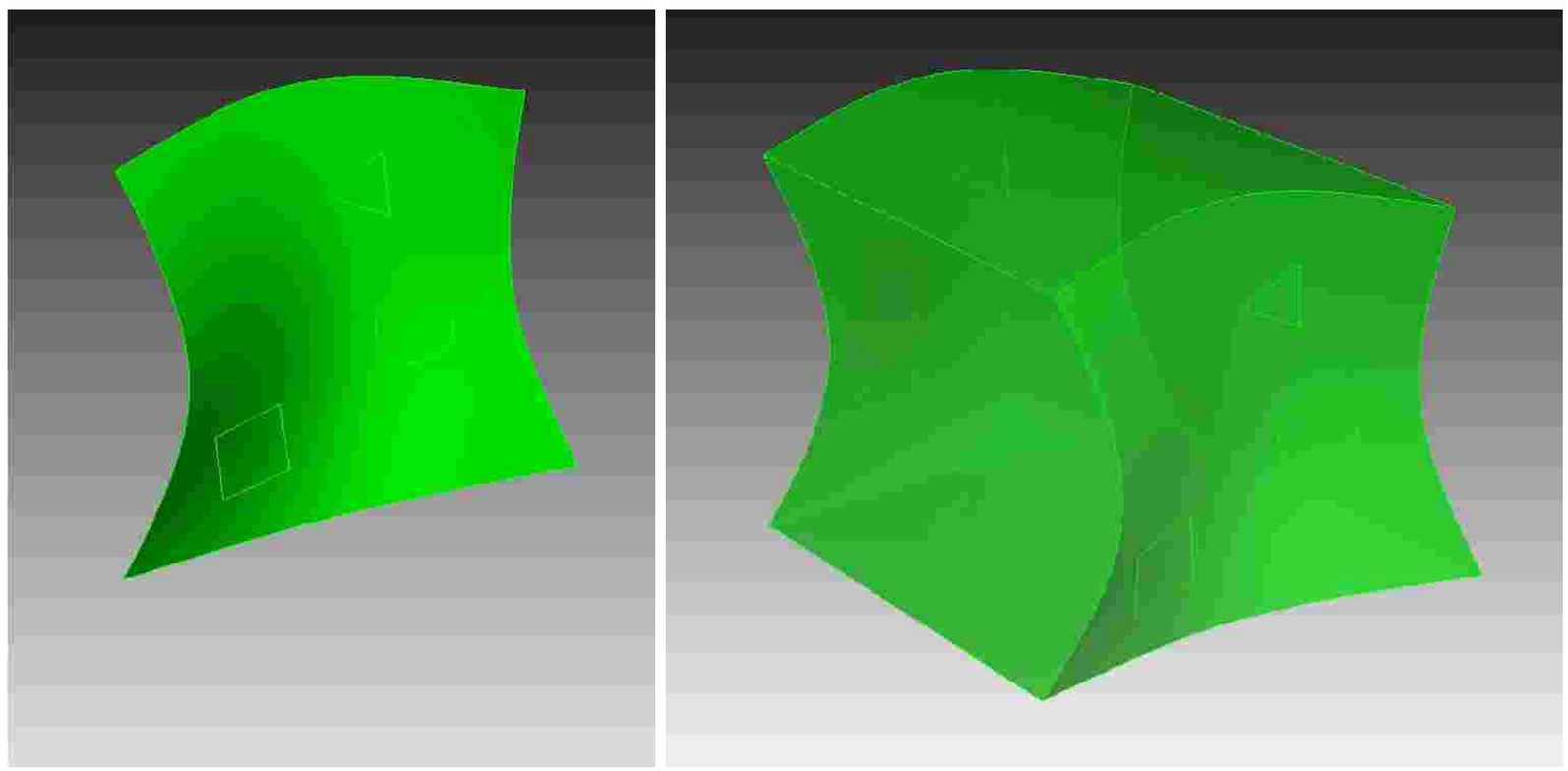
Curve Orient Sense Command

The tangent direction or orientation sense of one or more curves can now be modified using the new command **curve orient sense**. Orientation can be defined using location and direction options. This is especially useful when defining the bias characteristics for multiple curves simultaneously.

Sweep Sheet with Multiple Surfaces

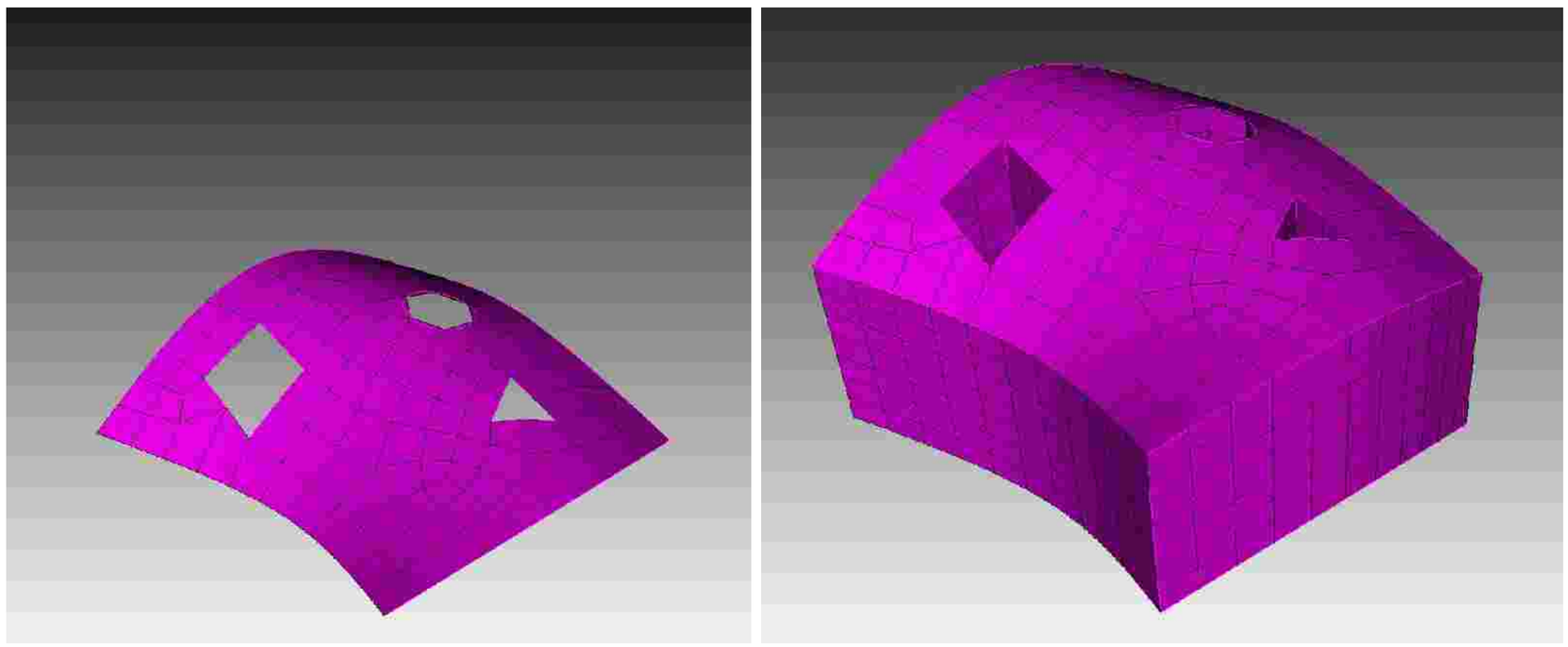
The ability to sweep or extrude a surface to generate a volume has been an important capability in Cubit, however it has been limited to sweeping single surfaces. Cubit 13.1 adds the capbility to sweep multiple surfaces that belong to the same sheet body in the same command. The following figure at left shows a single sheet body containing 4 separate surfaces. The result is shown at right where all 4 surfaces have been

extruded siultaneously.



Sweep Meshed Surfaces

Cubit currently provides the capability to create a volume by sweeping a surface through a specified path. With this release, we provide the feature to sweep a meshed surface. This means that a swept solid mesh will also be generated in the new volume based on the 2D mesh defined on the source surface. To use this capability, use the new **include_mesh** option on most of the **sweep surface** commands.



The image at left shows a surface (sheet body) that has been meshed with quads. Applying the **sweep surface** command with the **include_mesh** option resulted in the mesh at right. The result is a volume meshed with hexahedra where the mesh intervals in the sweep direction are automatically computed.

Sweep Meshed Curves

Similar to sweeping a meshed surface to create a meshed volume, Cubit 13.1 also introduces the feature to sweep a meshed curve into a meshed surface. The resulting mesh generated on the new surface will be a mapped mesh using the intervals defined on the source curve with automatic intervals in the sweeping direction. To use this capability, use the new **include_mesh** option on the **sweep curve** command.

New Merge Option in Split Curve Command

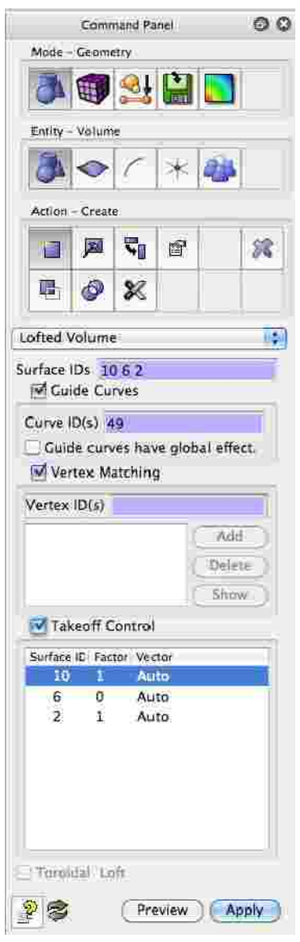
Previously the **split curve** command would split a curve at a specified location but leave the two (or more) resulting curves unconnected. The new merge option allows the user to automatically connect the two curves where the new vertex is created.

New Create Curve Arc Command Options

Two new options for creating Arcs in Cubit have been added. These include:

1. Create an arc by selecting two end vertices and specifying a radius and normal direction.
2. Create an arc using the center position of the arc, the radius, the normal direction and the sweep angle.

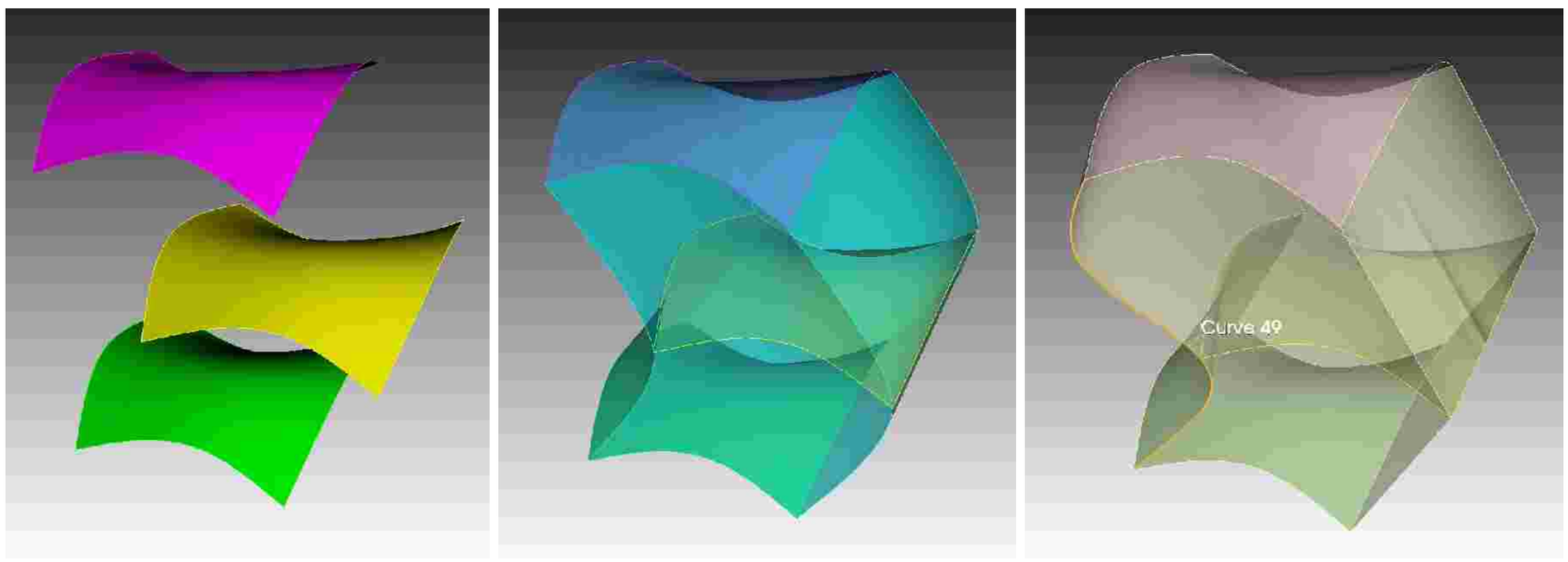
New Options in Loft Volume Command



The **Create Volume Loft** command in Cubit provides the ability to create a volume between two or more reference surfaces. The resulting volume can be controlled in a variety of ways. Cubit 13.1 introduces several new keywordsto the **create volume loft** command to extend the control of how the resulting volume is defined. These include: **Guide curve**, **Takeoff_factors**, **Takeoff_vector**, **Match vertex**, **Closed**, **Preview** and **Show_matching_curves**. See the documentation for a complete description of each option.

These new options can be controlled through an extensive new GUI command panel shown at left. It can be accessed through the command panels at **Geometry > Volume > Create > Lofted Volume**

The images below illustrate some of the new capability. The first image shows three independent surfaces that will be used as reference surfaces for the loft. The second image shows a resulting lofted volume where the **takeoff_factors** have been adjusted. The third image shows the use of a **guide curve**, where curve 49 was used to guide the loft through the three surfaces.



New Options in Sweep Surface Command

The ability to extrude a surface to create a volume has been available in Cubit for some time now. In Cubit 13.1 we introduce several new options for defining the direction of sweep. These include Cartesian axes, curve tangent, surface normal and various methods for defining a vector.

New "include_merged" option in Move and Rotate Commands

To apply a transformation such as a translation or rotation to a set of merged bodies, Cubit previously required that each of the volumes to be moved be transformed separately. Cubit 13.1 introduces the new **include_merged** option for both the rotate and move commands which will automatically apply the same transformation to any entities that are merged with the specified entity.

Move Group Command

The syntax for the command **Move {Vertex|Curve|Surface|Volume|Body|Group} <id_range>** has now been updated to include **Groups**. This makes the command **Move <entity>** syntax consistent with the **<entity> Move** form of the command.

Scale About Reference Point Command

The scale transformation in Cubit has now been enhanced to permit scaling about an arbitrary reference point rather than the previous capability of scaling about the origin.

Materials and Boundary Conditions

New Initial Condition Options

Users may now create and modify initial conditions of temperature, displacement, velocity, acceleration, and field variable. Initial conditions are applied to nodesets. Presently, an initial condition may apply to a single nodeset. Commands to list and delete initial conditions are also available.

New Material Creation Options

Users may specify user constants as part of a material definition. User constants are stored as field properties. The user may also specify a value for **DepVar**, which is an Abaqus-specific variable.

New Copy Boundary Conditions Options

When creating new geometric entities using Cubit's Copy command, Nodesets, Sidesets and Blocks defined on the original entity can now also be copied. The following commands can be used to turn this feature on and off for nodesets, sidesets and blocks respectively:

set copy_nodeset_on_geometry_copy [on | OFF| use_original]
set copy_sideset_on_geometry_copy [on | OFF| use_original]
set copy_block_on_geometry_copy [on | OFF| use_original]

Boundary Conditions propagated through Webcut Operations

New geometric entities will also be created when using Cubit's webcut operations. Nodeset, Sideset and Block information contained on the original entities can now also be transferred to the resulting webcut entities.

Import/Export

Partial ABAQUS Export

Cubit can now export an Abaqus deck that contains only the mesh described by the *NODE, *ELEMENT, *NSET, *ELSET, and *SURFACE keywords. Use the partial option to get only the mesh portion of the Abaqus file. A complete file also includes the Abaqus keywords and data used to define parts, assemblies, instances, materials, initial conditions, and analysis parameters.

Enhanced ABAQUS Export Command

Node-file/element-file output: Use the **nodefile** and **elementfile** options to export separate files of nodes and elements. Cubit writes a different element file for each part.

Flat-file: Use the **flatfile** option to export a Abaqus file with all nodes and elements in the global space, i.e., no *PART or *INSTANCE keywords.

New "Solid" Option when exporting IGES

The new **solid** option on the **export iges** command allows solid volumes to be exported as Manifold Solid B-Rep Objects (MSBO). Without this option, the iges file is simply a collection of stand-alone surfaces.

Graphics, Utilities, etc.

New Delete APREPRO variable function

Users may now delete APREPRO variables after one is defined. For example, the following snippet defines a variable, uses it in a Cubit command, and then deletes it.

```
#{var1=2*PI/5}
create brick x {var1} y {var1/2} z {var1*1.5}
#{delete('var1')}
```

The delete functionality has also been incorporated in to the Graphical APREPRO Editor, where the ability to delete a variable after it has been defined in the table, can now be performed.

New Color Global Command

Normally, Cubit will display surfaces and curves in a rotating set of default colors. The ability to assign a single designated color to all surfaces, curves and vertices has been added for Cubit 13.1

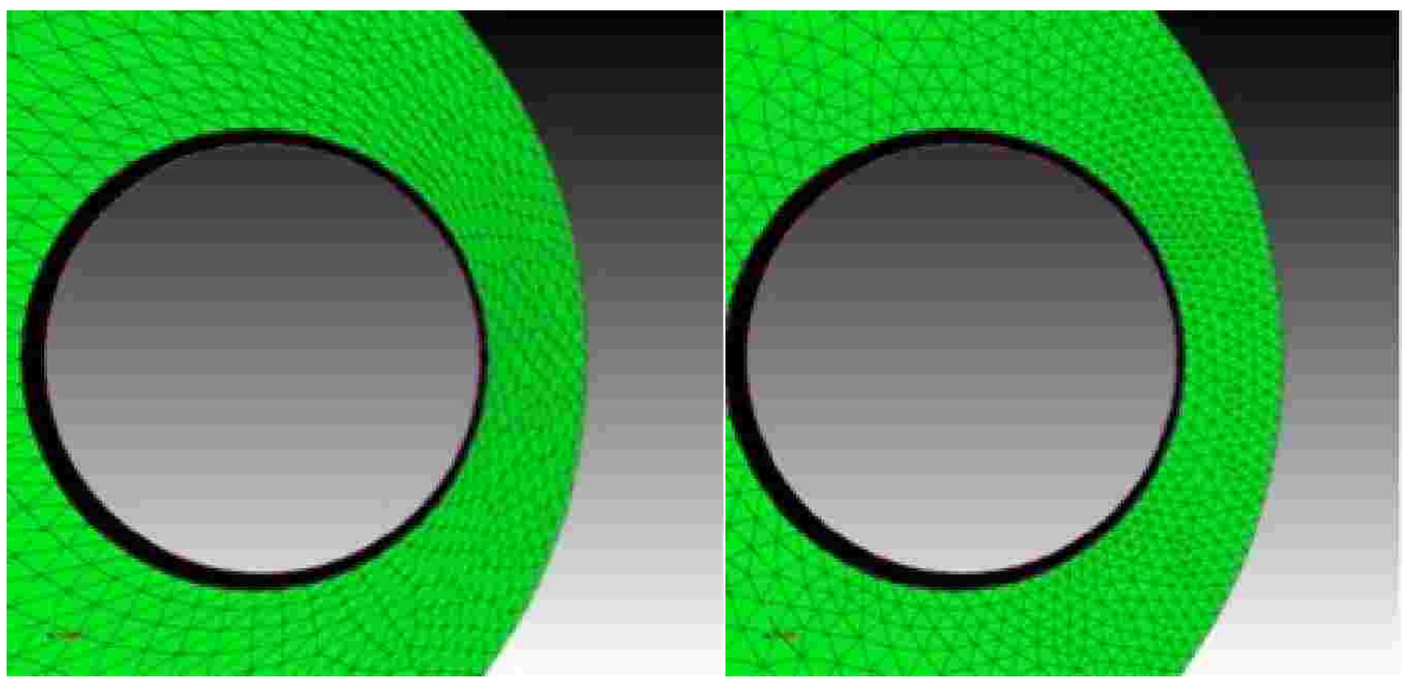
Beta Features

Cubit remains an active development platform for cutting-edge methods in geometry preparation and mesh generation. Some features that are still under development may not be quite ready for release, but may be valuable in some settings. The following is a list of new beta features that have been made available in Cubit version 13.1. Their functionality is not yet complete, has not been fully tested, however in many settings the new capability may be very valuable. Your help in reporting defects and offering suggestions on these features is appreciated. To turn on or off any of the features listed below, issue the following command from the command line:

Set developer [on|off]

Remesh Tets *Free* Option

The **remesh tet <range> free** command is a beta feature and requires the user to enter the command “set developer on” to enable it. The **free** option enables the new capability to re-mesh merged and unmerged surfaces that may bound the specified range of tets. A new triangle mesh replaces the old one, which may improve element quality if the old mesh is distorted. (This option does not yet remesh curves that are within the range defined by the tets).



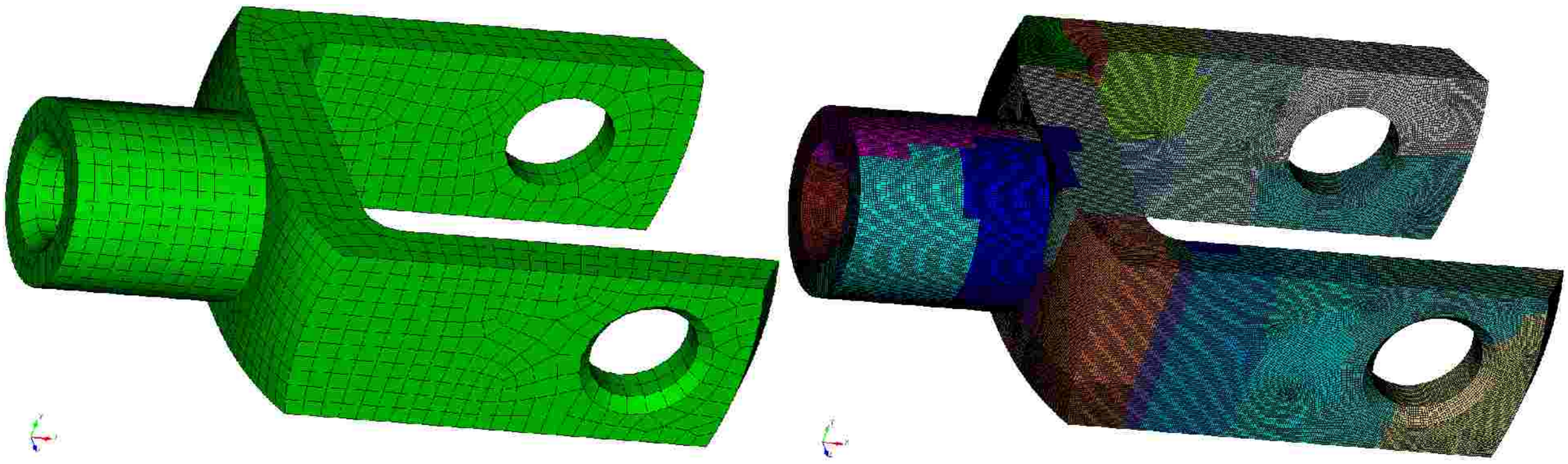
The left image shows the initial deformed tetrahedral mesh. The right image shows the mesh after re-meshing with the free option and an analysis-based sizing function.

Parallel Refinement

For those who have access to the Sierra stk_adapt module, Cubit 13.1 supports parallel refinement. Parallel mesh refinement allows refinement to go beyond the memory limits of a single processor. The resulting mesh size is only limited by the number of processors you have available to perform the refinement. To use this feature, first create a course mesh for your model. Then using the command below, two files will be created that can be used in an external stk_adapt process.

Refine Parallel [Fileroot <'root filename'>] [Overwrite] [No_geom] [No_execute] [Processors <int>] [Numsplit <int>] [Version <'Sierra version'>]

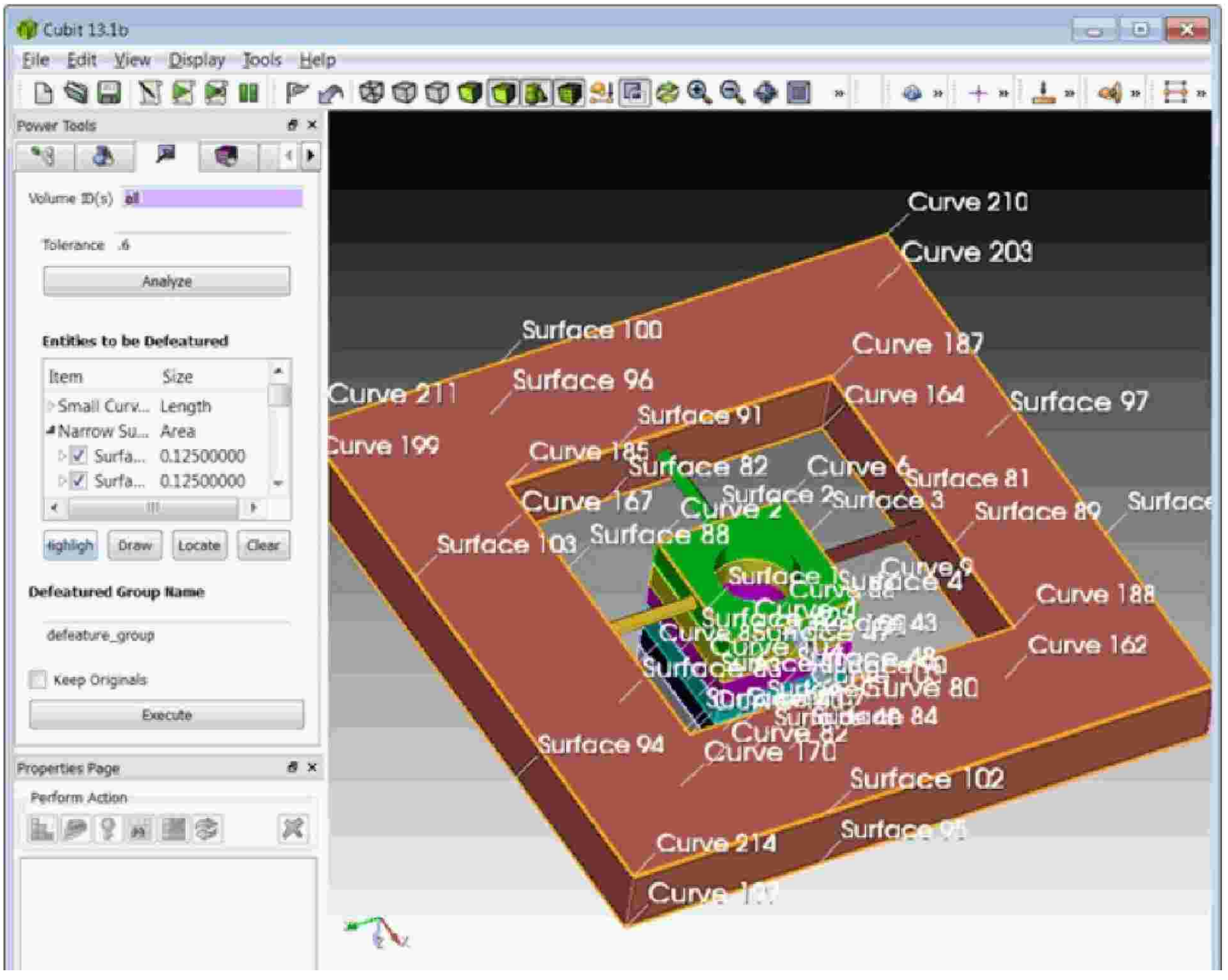
Stk_adapt can also be run directly from Cubit if the executable is in the correct path. When running stk_adapt, a series of mesh files, one for each processor, will be generated on disk that have been refined or subdivided based on the numsplit option. The ability to refine to the precise smooth geometry definition is also available in this beta release.



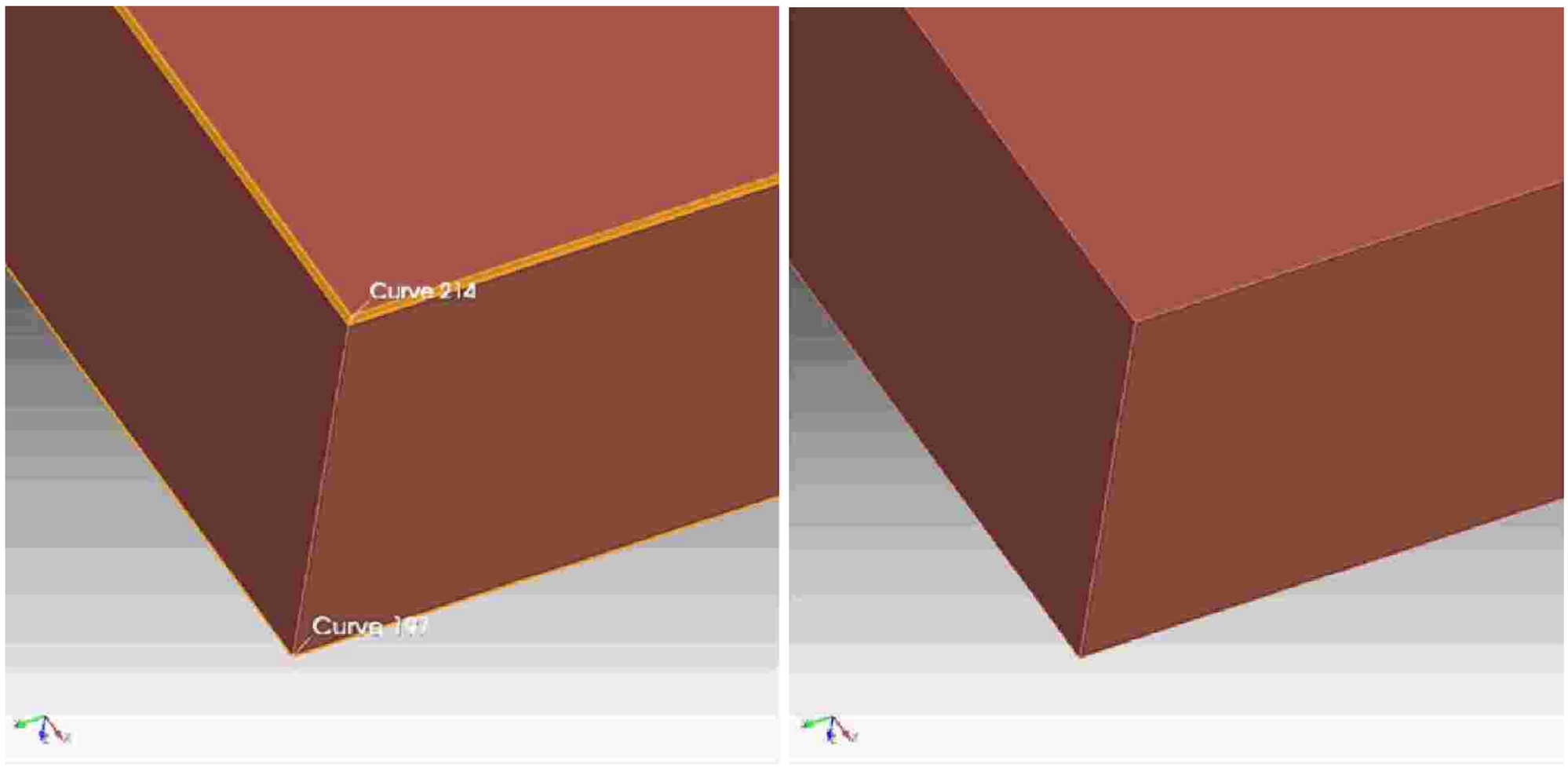
The left image shows an initial hex mesh generated in Cubit with 2365 hexes. The right image displays a uniformly refined mesh using stk_adapt with 20 processors. The result is about 1.35 million hexes where the colors represent the different processors used in the refinement.

Defeaturing Power Tool

A new power tool has been introduced as a beta feature in Cubit 13.1 for defeaturing solid models where the defeaturing process is reduced to a single button click or command. After using the **set dev on** command, this tool is available from the tabs in the tree view window. Selecting the **analyze** button will automaticaly detect and display small features in the model that can be automatically removed. The list can be edited to add or remove features to be defeatured. Individual entities can be graphically interrogated as in other power tools. Selecting the **execute** button will create a new defeatured mesh-based geometry model. With the current release, a new model is generated using Cubit's grouping mechanism where new defeatured volumes are generated and assigned to a user specified group. Meshing can then be performed on the resulting defeatured model.



The defeaturing power tool, shown at the left detects and displays features that will be eliminated when the **execute** button is selected and a new MBG model is generated



The image on the left shows a close up of the model above where a small fillet has been detected. The image on the right shows the same region of the MBG model that has been defeatured.

In addition to the power tool, a new command has been added to support this new capability:

Defeature volume <id_range> [auto_identify] curve_length <value> [Curve <ids>] curve_curvature <value> [Curve <ids>] surface_curvature <value> [Surface <ids>] surface_prox2d <value> [Surface <ids>] [group <id>] [keep]

Also available after issuing **set dev on**, this command provides the full functionality of the automatic defeaturing capability from the command line for use in scripts and journal files.

Back to New Features

Limitations in CUBIT 13.1

- As of Cubit 13.0, the Granite Geometry Kernel is no longer supported.
- The Mac OS X port does not support the changing mouse cursors on pre-selection. It is recommended that a 3-button mouse be used for the Mac OS X version since interactive transformation utilizes all three buttons.

Fixed Defects in CUBIT 13.1

The following items are the user-reported bugs fixed since last release of CUBIT (March 2011). For more information contact Brett Clark (bwclark@sandia.gov)

Ref #	Resolved Defect*
9136	propagate curve bias does not work with DualBias
9084	Cub file from 12.1 crashes 12.2 and later when opened
9140	Left side of geometry window is not working properly
9139	Nodesets not importing correctly in 13.0
9143	Cubit crashing with ITEM showing

*The defects listed above are only those user-reported issues deemed "critical" or "blocker". For information on other resolved defects contact Brett Clark.

Known Defects in CUBIT 13.1

The following items are bugs or limitations that may be encountered in the current release of CUBIT. For more information on these defects or to report additional defects contact Brett Clark(bwclark@sandia.gov).

Ref #	Known Defects in CUBIT 13.1*	Description	Suggested Work-around

*The defects listed above are only those user-reported issues deemed "critical" or "blocker". For information on other known defects contact Brett Clark.

Documentation Updates

The CUBIT 13.1 online documentation may be found at the following URL: http://cubit.sandia.gov/help-version13.1/cubithelp.htm. A PDF version is also available for download. The cubit GUI installation also includes the full user documentation included with the program. The user's manual may be accessed from the Help menu.

CUBIT 13.1 Contents of Release

Cubit Program: The installation package includes executables and libraries, packaged in tar.gz files for Linux machines. For Windows, the package is in a self-installing executable, and for Mac OS X a .dmg file is provided. Both a command line and GUI version of CUBIT are included with the installation package for all platforms.

Documentation: Linux, Windows and Mac versions include full online documentation. Windows also includes .chm (Windows Help File), of the complete documentation that can be run separately from CUBIT.

Platforms Supported

CUBIT 13.1 supports the following Platforms

- Linux RedHat Enterprise 5, 32- and 64-bit
- Windows 7, XP, Vista, 32- and 64-bit
- Mac OS X Intel based (10.4-7)

Non-Sandia Users

CUBIT is available for government and academic use. For information on licensing CUBIT go to the follow URL: http://cubit.sandia.gov/licensing.html. For current CUBIT users, CUBIT 13.1 may be downloaded from the website at the following URL: http://cubit.sandia.gov/downloads.html. If you obtained a password since the release of CUBIT 10.0, your password should work for 13.1 also.

Sandia Personnel Only

Windows

Download a Windows installation file from the dropzone. Go to the following directory **\\dropzone\public\cubit\Windows.** Copy the file **Cubit.WindowsGUI.13.1.exe** to your windows hard drive. Double click on the file and follow the installation instructions.

MAC OS X

Download a Mac OS X disk image file from the dropzone. Go to the following directory **\\dropzone\public\cubit\MAC_OS_X.** Copy the file **Cubit_GUI_13.1.dmg.gz** to your Mac harddrive. Use gunzip to unpack the disk image file.

LINUX LANS

Check with your local LAN administrator for instructions on how to access CUBIT on your local LAN. In most cases typing one of the following commands at the UNIX prompt should allow you to execute CUBIT. In some cases, the full path will need to be specified:

```
/projects/cubit/<cubit_command>
```

CUBIT Help

For general technical questions including download, installation and CUBIT technical assistance

cubit

cubit32

CUBIT Licensing and Passwords

cubit -nogui

cubit -nogui -nographics

cubit-13.0

cubit32-13.0

cubit-beta

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cubit-help@sandia.gov

64-bit Version 13.1 with GUI. The latest released version of CUBIT deployed to the LAN

32-bit Version 13.1 with GUI. The latest released version of CUBIT deployed to the LAN

64-bit Version 13.1 Command Line only with graphics window

64-bit Version 13.1 Command Line only without graphics window

64-bit Version 13.0 with GUI

32-bit Version 13.0 with GUI

Version 13.1 beta. The latest beta version still in development

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