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1. INTRODUCTION TO GAMBIT

GAMBIT is an integrated preprocessor for CFD analysis. You can use GAMBIT to build your geometry and generate a mesh for it, or import a geometry created by a third-party CAD/CAE package, make modifications, and generate a mesh.

GAMBIT's meshing options give you flexibility and choices. You can decompose geometries for structured meshing, or perform automatic unstructured hexahedral meshing. You can also generate high-quality triangular and tetrahedral meshes, as well as meshes containing pyramids and prisms.

GAMBIT also provides tools for checking the quality of the mesh. This helps you ensure that your mesh is appropriate for use in the solver of your choice.
2. STARTING GABMIB

2.1 Startup Command

To start GABMIB, you must enter the following command:

```
  gambit [option1 option2 ...]
```

where the `option` arguments represent any of the startup options described in Section 2.2, below.
### 2.2 Startup Command Options

The startup command options that are available in GAMBIT are as follows.

<table>
<thead>
<tr>
<th>Option (Parameters)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-new filename</code></td>
<td>Specifies the name (filename) of an initialization file that contains the GAMBIT program default values.</td>
</tr>
<tr>
<td><code>-dev driver</code></td>
<td>Specifies a graphics driver name.</td>
</tr>
<tr>
<td><code>-doc</code></td>
<td>Launches the local web browser and opens the table of contents for GAMBIT online documentation.</td>
</tr>
<tr>
<td><code>-geom width x height +x +y</code></td>
<td>Specifies the window size (in pixels).</td>
</tr>
<tr>
<td><code>-help</code></td>
<td>Displays the available startup options.</td>
</tr>
<tr>
<td><code>-id id</code></td>
<td>Specifies an alphanumeric identifier for the GAMBIT session. (NOTE: If you omit the <code>-id</code> option, GAMBIT assigns the session the default identifier, default_id.) For a description of the session identifier and its use, see Section 2.2 of this guide and Chapter 4 of the User's Guide.</td>
</tr>
<tr>
<td><code>-inc filename</code></td>
<td>Specifies the name (filename) of a journal file that is to be run in the batch mode. For a description of the purpose and use of GAMBIT journal files, see Chapter 4 of the User's Guide.</td>
</tr>
<tr>
<td><code>-init filename</code></td>
<td>Specifies the name (filename) of a journal file that is to be run at startup in the GUI mode. For a description of the purpose and use of GAMBIT journal files, see Chapter 4 of the User's Guide.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option (Parameters)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-old</code></td>
<td>Mutually exclusive options that specify whether or not GAMBIT opens a new or existing session.</td>
</tr>
<tr>
<td><code>-new</code></td>
<td>- new specifies that GAMBIT is to open a new session.</td>
</tr>
<tr>
<td><code>-old</code></td>
<td>- old specifies that GAMBIT is to open an existing session</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option (Parameters)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-pro</code></td>
<td>Starts the Pro/ENGINEER CAD program for direct import of Pro/ENGINEER geometry into GAMBIT (see &quot;Importing CAD Geometry&quot; in Section 4.1.9 of the GAMBIT User's Guide). (NOTE: This option does not start the GAMBIT program.)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Option (Parameters)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><code>-res filename</code></td>
<td>Starts GAMBIT in the batch mode. (NOTE: This option is used to restore the journal file from the database file named filename.dbs.)</td>
</tr>
</tbody>
</table>

Some of the startup command options listed above require the specification of numeric or string parameters, such as window dimensions or file names, respectively. The rules that govern GAMBIT startup command syntax require that you do not enclose string parameters in quotation or double-quotuation marks. For example, the correct syntax for starting an existing GAMBIT session named "modell" is as follows:

```
gambit -id modell -old
```

You can also include a path name in string parameters that refer to file names or identifiers. For example, if the files associated with the session "modell" in the previous example are located in a directory named "project1," the correct syntax for the command is as follows:

```
gambit -id project/modell -old
```
3. GAMBIT FILE ORGANIZATION

3.1 Session Files

When you start GAMBIT, either in the batch mode or in the real-time mode employing the GUI, GAMBIT creates a modeling “session.” A GAMBIT modeling session consists of all operations performed in relation to a GAMBIT model. Such operations include but are not limited to the following:

- Import of geometry and mesh information
- Creation of geometry
- Creation and refinement of a mesh
- Assignment of zone types
- Creation and modification of coordinate systems and grids
- Changing the appearance and orientation of the model as displayed in the graphics window

GAMBIT keeps track of session operations, as well as the ongoing status of the model, by means of three data files. The names, titles, formats, and contents of the session data files are as follows.

<table>
<thead>
<tr>
<th>Name</th>
<th>Title</th>
<th>Format</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>.jou</td>
<td>Journal</td>
<td>Text</td>
<td>A sequential list of geometry, mesh, zone, and tool commands executed during the session</td>
</tr>
<tr>
<td>.ern</td>
<td>Transcript</td>
<td>Text</td>
<td>A log of messages displayed in the GAMBIT Transcript window during the session</td>
</tr>
<tr>
<td>.dbs</td>
<td>Database</td>
<td>Binary</td>
<td>A binary database containing geometry, mesh, graphics display, defaults, and journal information associated with the model</td>
</tr>
</tbody>
</table>
In addition to the three data files listed above, GAMBIT creates a "lock" file, named "id.lock", where id represents the session identifier. The purpose of the lock file is to lock out the process number for the current GAMBIT session so that the data files cannot be accessed and/or modified by any concurrent GAMBIT session.

3.2 Directory Structure

GAMBIT employs four types of directories to organize session data files and other files related to GAMBIT operation. The following table describes the type, location, and contents of each of the four directories:

<table>
<thead>
<tr>
<th>Directory Type</th>
<th>Location</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Home</td>
<td>User specified</td>
<td>Files that are global to all GAMBIT sessions, such as initialization files</td>
</tr>
<tr>
<td>Source</td>
<td>User specified</td>
<td>Permanent files containing information related to a specific category, such as a project. Contents may include project-specific initialization files, journal files, database files, transcript files, macros, and environment variables.</td>
</tr>
<tr>
<td>Scratch</td>
<td>User specified</td>
<td>Copies of files from the source directory, temporary files, the working subdirectory, and the id.lock file.</td>
</tr>
<tr>
<td>Working</td>
<td>Subdirectory of the scratch directory (see below)</td>
<td>Temporary session data files—.out, .err, and .dia.</td>
</tr>
</tbody>
</table>
3.2.1 Home, Source, and Scratch Directories

By default, the location of the source and scratch directories is identical to that from which GAMBIT is launched. You can change the default locations of the home, source, and scratch directories by means of the GAMBIT Edit Defaults form. For a description of the Edit Defaults form and its use, see Chapter 4 of the User's Guide.

3.2.2 Working Directory

The working directory is a subdirectory of the scratch directory. Its name consists of the identifier "GAMBIT" appended with a process number. For example, if you start GAMBIT such that the scratch directory is named "users1" and the process number is "12345", GAMBIT locates the session files—that is, jou, dba, trn, and loc—in a directory named

users1/GAMBIT.12345

3.3 File Management

The following sections describe the manner in which GAMBIT manages files when you perform the following operations:

- Open an existing GAMBIT session
- Save a current GAMBIT session

3.3.1 Opening an Existing GAMBIT Session

When you open an existing GAMBIT session, GAMBIT copies the existing session data files in the source directory to their corresponding files in the working directory. For example, if the session information is as follows,

- Session identifier—burner71
- Source directory—mymodel
- Process number—1234

GAMBIT copies files in the following manner.

<table>
<thead>
<tr>
<th>Existing Data File Name</th>
<th>Copied File Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>/mymodel/burner71.jou</td>
<td>/users1/GAMBIT.1234/jou</td>
</tr>
<tr>
<td>/mymodel/burner71.dbu</td>
<td>/users1/GAMBIT.1234/dbu</td>
</tr>
<tr>
<td>/mymodel/burner71.trn</td>
<td>/users1/GAMBIT.1234/trn</td>
</tr>
</tbody>
</table>

Thereafter, if you modify the model during the current GAMBIT session, GAMBIT modifies the jou, dba, and trn files but does not alter the original data files from which they were copied until you perform a save operation.

3.3.2 Saving a Current Session

When you save a GAMBIT session, GAMBIT copies the three active data files from the working directory either to the source directory or to another user-specified directory. The three copied files share a common root name—that is, the session identifier. The extension of each copied file corresponds to the name of the data file from which it is copied.

For example, if the save operation information is as follows,
**File Management**

<table>
<thead>
<tr>
<th>Session File Location/Name</th>
<th>Copy File Location/Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>scratchname/GAMBIT.6789/jou</td>
<td>mymodel/mode11.jou</td>
</tr>
<tr>
<td>scratchname/GAMBIT.6789/dbs</td>
<td>mymodel/mode11.dbs</td>
</tr>
<tr>
<td>scratchname/GAMBIT.6789/tnm</td>
<td>mymodel/mode11.trn</td>
</tr>
</tbody>
</table>

**GAMBIT FILE ORGANIZATION**

- Session identifier—mode11
- Target directory—mymodel
- Process number—6789

GAMBIT copies the active session data in the following manner.

**ACCESSING THE GAMBIT MANUALS**

As described in Section 5.5, GAMBIT's online help provides access to the GAMBIT manual set through HTML files, which can be viewed with your standard web browser (for example, Netscape Communicator). For printing, PostScript and Adobe Acrobat PDF versions of the manuals are also provided. This chapter describes how to access the GAMBIT manuals outside of GAMBIT (that is, not through the GAMBIT on-line help utility). See Section 5.5 for information about accessing the manuals through the on-line help.

You can access the manuals directly from the CD or, if the files have been installed in your Fluent Inc. installation area, you can also access them there. See the separate installation instructions for your platform type for information about installing the files from the documentation CD.

The comments in this chapter about accessing files from the installation area assume that all files on the documentation CD have been installed. If the files you are looking for are not in the installation area, you will need to install them or access them directly from the CD.

Section 4.1 of this chapter describes how to access the HTML versions of the manuals (without running GAMBIT), and Section 4.2 describes how to access the PostScript and PDF files for printing. See Section 5.5 for information about accessing the manuals through the GAMBIT online help.
4.1 Viewing the HTML Files

To view the HTML versions of the manuals, you will need a web browser. If you do not have one, contact your Fluent support engineer and ask for the Netscape Communicator CD-ROM.

4.1.1 How to Access the HTML Files in the Installation Area

If the files on the documentation CD have been installed, you can view the HTML versions of the manuals by pointing your browser to

```
path/Fluent.Inc/gambit2.x/help/index.htm
```

where Fluent.Inc is the directory in which GAMBIT has been installed. You must replace path by the path to the directory where the Fluent.Inc directory is located, and x by the appropriate number for your GAMBIT release (for example, "0" for gambit.t2.0).

If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to browse through your directories to find the file.

This will bring up the GAMBIT documentation "home" page (Figure 4-1), from which you can select the HTML version of the particular GAMBIT manual you want to view.

---

Figure 4-1: The GAMBIT documentation home page

See Section 5.5 for information about accessing the GAMBIT HTML files through the GAMBIT Help menu.
4.1.2 How to Access the HTML Files on the CD

The procedure for accessing the HTML files directly on the CD differs slightly for UNIX and Windows NT systems:

- For UNIX systems, you can access the files by inserting the documentation CD into your CD-ROM drive and pointing your browser to the following file:

```
/edrom/gambit2.x\help/index.htm
```

where edrom is the name of your CD-ROM drive, and `x` is the number appropriate to the GAMBIT 2 release—for example, "0" for GAMBIT 2.0.

If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to browse through your directories to find the file.

- For Windows NT systems, you can access the files by inserting the documentation CD into your CD-ROM drive and pointing your browser to the following file:

```
edrom:\Gambit2.x\Help\index.htm
```

where edrom is the name of your CD-ROM drive (for example, `e:`), and `x` is the number appropriate to the GAMBIT 2 release—for example, "0" for GAMBIT 2.0.

If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to select the CD-ROM drive (which will be named `\Gambit2.x\Help\`), followed by the letter for the CD-ROM drive) and choose the appropriate file.

This will bring up the GAMBIT documentation "home" page (Figure 4-1), from which you can select the HTML version of the particular GAMBIT manual you want to view.

4.1.3 Navigating the Manuals

When you are viewing a manual in your browser, a set of navigation buttons will appear at the upper right and lower right corners of the HTML page, as shown in Figure 4-2.

Figure 4-2: Navigation buttons

The navigation buttons are as follows:

- Next will take you to the next page in the manual. Note that this is not the same function as the "Forward" button of your browser.
- Previous will take you to the page just before the current one in the manual. Note that this is not the same function as the "Back" button of your browser.
- Index will take you to the index for the manual set.
- Contents will take you to the table of contents for the manual.
- Return to Home will take you to the GAMBIT documentation home page (Figure 4-1).

Note that these buttons will not necessarily appear on all pages, and in some cases, they will appear, but be inactive; in such cases, they will be "grayed out" as the Previous button is in Figure 4-2.

4.1.4 Finding Information in the Manuals

Three tools are available to help you find the information you are looking for in a manual.

Index

The index gives an alphabetical list of keywords, each linked to relevant sections of the manual. You can access the index by clicking the Index button that appears at the top and bottom of the page.

Table of Contents

The table of contents gives a list of the titles of the chapters, sections, and subsections of the manual in the order in which they appear. Each title is linked to the corresponding chapter or section. You can access the table of contents by clicking the Contents button that appears at the top and bottom of each page.
4.2 Viewing and Printing PostScript and PDF Files

PostScript and Adobe Acrobat PDF files are provided on the GAMBIT documentation CD for printing all or part of the manuals.

4.2.1 About the PostScript Files

PostScript files can be printed with a PostScript-compatible printer, and are distinguished by a .ps suffix in their file names. They can also be viewed with a PostScript viewing program (such as Ghostview). If you are unable to print PostScript files, you should use the PDF files instead.

The PostScript files are formatted for US letter-sized paper. If you are printing to a different paper size, you may want to use the PDF files for better page layout.

4.2.2 About the PDF Files

The PDF files are appropriate for viewing and printing with Adobe Acrobat Reader, which is available for most UNIX and Windows NT systems. These files are distinguished by a .pdf suffix in their file names.

Note that you can select the paper size to which you are printing in Adobe Acrobat Reader by selecting the File/Print Setup... menu item and choosing the desired Paper size. If the page is too large to fit on your paper size, you can reduce it by selecting the File/Print... menu item and enabling the Shrink to Fit option.

If you do not have Adobe Acrobat Reader, you can download it (at no cost) from www.adobe.com. If you are not able to download files from the Internet, contact your Fluent support engineer and ask for the Adobe Acrobat Reader CD-ROM.

4.2.3 How to Access the PostScript and PDF Files in the Installation Area

If the PostScript and/or PDF files on the documentation CD have been installed, you can access them by pointing your browser to

```
path/fluent Inc/gambit3.x/help/index.htm
```

where Fluent Inc is the directory in which GAMBIT has been installed. You must replace path by the path to the directory where Fluent Inc is located, and x by the appropriate number for your GAMBIT release (for example, "3" for gambit3.0).
If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to browse through your directories to find the file.

This will bring up the GAMBIT documentation "home" page (Figure 4-1), from which you can select the PostScript or PDF file(s) for the particular GAMBIT manual you want. For large manuals, PostScript and PDF files are provided for the individual chapters, rather than for the entire manual.

4.2.4 How to Access the PostScript and PDF Files on the CD

The procedure for accessing the PostScript and PDF files directly on the CD differs slightly for UNIX and Windows NT systems:

- For UNIX systems, you can access the files by inserting the documentation CD into your CD-ROM drive and pointing your browser to the following file:

  /cdrom/gambit2/x-help/index.htm

  where cdrom is the name of your CD-ROM drive, and x is the number appropriate to the GAMBIT 2 release—for example, "0" for GAMBIT 2.0.

- If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to browse through your directories to find the file.

- For Windows NT systems, you can access the files by inserting the documentation CD into your CD-ROM drive and pointing your browser to the following file:

  cdrom: \Gambit2 \xHelp\Index.htm

  where cdrom is the name of your CD-ROM drive (for example, E), and x is the number appropriate to the GAMBIT 2 release—for example, "0" for GAMBIT 2.0.

- If, for example, you are using Netscape Communicator as your browser, select the File/Open Page... menu item and click the Choose File... button to select the CD-ROM drive (which will be named E: in Windows NT) followed by the letter for the CD-ROM drive and choose the appropriate file.

This will bring up GAMBIT documentation "home" page (Figure 4-1), from which you can select the PostScript or PDF file(s) for the particular GAMBIT manual you want. For large manuals, PostScript and PDF files are provided for the individual chapters, rather than for the entire manual.

5. THE GAMBIT GRAPHICAL USER INTERFACE (GUI)

GAMBIT allows you to construct and mesh models by means of its graphical user interface (GUI). The GAMBIT GUI (Figure 5-1) is mouse-driven and user-friendly.

Figure 5-1: GAMBIT graphical user interface (GUI)

The following sections of this chapter describe the appearance and use of the basic GUI components and control elements as well as instructions for using the mouse and the Global Control toolpad.
5.1 GUI Components

The GAMBIT GUI consists of eight components, each of which serves a separate purpose with respect to the creating and meshing of a model. The GUI components are as follows:

- Graphics window
- Main menu bar
- Operation toolpad
- Form field
- Global Control toolpad
- Description window
- Transcript window
- Command text box

The following sections describe the features of the components listed above as well as other features of the GUI.

5.1.1 Graphics Window

The graphics window (Figure 5-2) is the region of the GUI in which the model is displayed. It is located in the upper left portion of the GUI and occupies most of the screen in the default layout configuration.

![Figure 5-2: Graphics window](image)

The graphics window includes the following subcomponents:

- Quadrants
- Sashes
- Sash anchor

The following sections describe each of the subcomponents listed above.
Graphics-Window Quadrants

The graphics window consists of four separate quadrants, any one, two, or four of which can be displayed simultaneously. You can customize each quadrant to create a distinct representation of the current model—both with respect to the viewing angle and with respect to the model attributes within the quadrant. It is possible, for example, to display a wireframe view of a portion of the model in the -z direction in one quadrant while displaying a shaded isometric view of another portion of the model in a separate quadrant. The default graphics-window configuration displays only the upper left quadrant with a wireframe view of the model oriented in the -z direction.

Each quadrant possesses a set of orientation axes in its lower left corner. The axes indicate the current global orientation of the model as viewed in that quadrant.

Graphics-Window Sashes

The quadrants of the graphics window are separated from each other by means of two graphics-window sashes—one horizontal, the other vertical. The horizontal sash separates the upper and lower quadrants of the graphics window. The vertical sash separates the left and right quadrants.

The graphics-window sashes appear on the GUI as thin, grey lines. In the default configuration, the horizontal and vertical sashes are located at the bottom and right sides, respectively, of the graphics window.

To resize the vertical dimensions of the quadrants, left-click the horizontal graphics-window sash and drag it to a new location within the graphics window. When you release the mouse button, GAMBIT automatically resizes the quadrants according to the final position of the sash. To resize the horizontal dimensions of the quadrants, left-click and drag the vertical graphics-window sash to a new location.

Graphics-Window Sash Anchor

The graphics-window sashes are linked to each other by means of the sash anchor, which appears as a small, gray box located at their point of intersection. The graphics-window sash anchor allows you to resize all four quadrants by means of a single mouse operation. In the default configuration, it is located at the lower right corner of the graphics window.

To resize the quadrants using the sash anchor, left-click the sash anchor and drag it to a new location within the graphics window. When you release the mouse button, GAMBIT automatically resizes the quadrants according to the final position of the sash anchor.

Resizing Quadrants Using Preset Configurations

The graphics-window sashes and sash anchor also allows you to resize the quadrants according to 11 preset configurations. When you select a preset configuration, GAMBIT resizes the quadrants so that the selected quadrants fill the entire graphics window. The preset configurations represent various combinations of the upper and lower, left and right quadrants and also include two user-defined configurations.

To select a preset configuration, right-click the graphics-window sashes or sash anchor to open a menu of preset-configurations, then left-click the desired configuration.

Redefining the User-Defined Preset Configurations

Two of the preset graphics-window configurations are user-definable. The default configuration for both options displays only the upper left quadrant.
To redefine either user-defined configuration, perform the following steps.

<table>
<thead>
<tr>
<th>Step</th>
<th>Location</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Graphics window</td>
<td>Create the graphics-window layout to be used as the user-defined configuration.</td>
<td>You can use either the graphics-window sash anchor or the preset configurations to create the desired layout.</td>
</tr>
<tr>
<td>2</td>
<td>Graphics-window sash or sash anchor</td>
<td>Right-click the sash or sash anchor.</td>
<td>Opens the preset-configuration menu</td>
</tr>
<tr>
<td>3</td>
<td>Preset-configuration menu</td>
<td>Left-click the arrow at the lower right corner of the menu.</td>
<td>Opens the Set/Clear submenu</td>
</tr>
<tr>
<td>4</td>
<td>Set/Clear submenu</td>
<td>Click Set.</td>
<td>Opens the user-definition submenu</td>
</tr>
<tr>
<td>5</td>
<td>User-definition submenu</td>
<td>Left-click the symbol representing the configuration to be defined (1 or 2).</td>
<td>Defines the specified configuration to represent the layout currently displayed in the graphics window</td>
</tr>
</tbody>
</table>

To reset either user-defined configuration to its default setting, perform the following steps.

<table>
<thead>
<tr>
<th>Step</th>
<th>Location</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Graphics-window sash or sash anchor</td>
<td>Right-click the sash or sash anchor.</td>
<td>Opens the preset-configuration menu</td>
</tr>
<tr>
<td>2</td>
<td>Preset-configuration menu</td>
<td>Left-click the arrow at the lower right corner of the menu.</td>
<td>Opens the Set/Clear submenu</td>
</tr>
<tr>
<td>3</td>
<td>Set/Clear submenu</td>
<td>Click Clear.</td>
<td>Opens the user-definition submenu</td>
</tr>
<tr>
<td>4</td>
<td>User-definition submenu</td>
<td>Left-click the symbol representing the configuration to be reset (1 or 2).</td>
<td>Resets the specified configuration to its default settings.</td>
</tr>
</tbody>
</table>
5.1.3 Operation Toolpad

The Operation toolpad (Figure 5-3) is located in the upper right portion of the GUI. It consists of a field of command buttons, each of which performs a specific function associated with the process of creating and meshing a model.

![Figure 5-3: Operation toolpad](image)

Within the Operation toolpad, command buttons are grouped according to their hierarchy and purpose in the overall scheme of creating and meshing the model. The topmost group constitutes the main pad. All other command button groups constitute subpads.

**Main Pad**

The topmost group of command buttons on the Operation toolpad constitutes the main pad (Figure 5-4).

![Figure 5-4: Operation toolpad—main pad](image)

The main pad includes the following command buttons.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Command Button</th>
<th>Purpose(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>🗺️</td>
<td>Geometry</td>
<td>Create and refine model geometry</td>
</tr>
<tr>
<td>🛡️</td>
<td>Mesh</td>
<td>Create and refine the mesh</td>
</tr>
<tr>
<td>🏛️</td>
<td>Zones</td>
<td>Specify boundary and continuum types</td>
</tr>
<tr>
<td>🍴</td>
<td>Tools</td>
<td>Specify coordinate systems and grids, specify size functions, and perform specialized GAMBIT operations</td>
</tr>
</tbody>
</table>

**Subpads**

When you click a main-pad command button, GAMBIT opens an associated subpad. For example, if you click the Geometry command button on the main pad, GAMBIT opens the Geometry subpad (Figure 5-5).

![Figure 5-5: Geometry subpad](image)

Each subpad contains command buttons that perform operations related to the overall purpose of the subpad. For example, the Geometry subpad contains the following command buttons:

- Vertex
- Edge
- Face
- Volume
- Group
Each of the subpad command buttons listed above allows you to perform operations related to the creation and refinement of model geometry.

Some of the command buttons located on subpads open related subpads of their own. For example, when you click the Volume command button on the Geometry subpad, GAMBIT opens the Geometry/Volume subpad (Figure 5-6).

![Volume Subpad](image)

**Figure 5-6: Geometry/Volume subpad**

The Geometry/Volume subpad allows you to perform operations related to creating and working with volume entities. It contains the following command buttons:
- Form Volume
- Create Volume
- Boolean Operations
- Blend Volume
- Modify Volume Color/Label
- Move/Copy/Align Volumes
- Split/Merge Volumes
- Heal Real Volume
- Summarize/Query/Check Volumes and Total Entities
- Delete Volumes

Each command button on the Geometry/Volume subpad is associated with a specification form that allows you to specify parameters related to the function indicated on the button.

### 5.1.4 Form Field

When you click any subpad command button, GAMBIT opens an associated _specification form_. Specification forms, such as that shown in Figure 5-7, allow you to specify parameters related to modeling and meshing operations, the assignment of boundary attributes, and the creation and manipulation of GAMBIT coordinate systems and grids. Specification forms can be used, for example, to define the radius of a sphere, designate edges of the model to be aligned, or select a particular meshing option from a list of available procedures.

![Specification Form](image)

**Figure 5-7: Example GAMBIT specification form**

When you open a specification form, it appears in the _form field_. The form field is located at the right side of the GUI, immediately below the Operation toolpad. After a specification form has been opened, you can move it to any other location on the GUI. To move the form, left-click its title bar and drag it to its new location.
5.1.5 Global Control Toolpad

The Global Control toolpad (Figure 5-8) is located at the lower right corner of the GUI. Its purpose is to allow you to control the layout and operation of the graphics window, specify the appearance of the model as displayed in any particular quadrant, and undo GAMBIT operations.

![Global Control Toolpad](image)

Figure 5-8: Global Control toolpad

The Global Control toolpad contains 15 active command buttons. The upper set of five command buttons allows you to enable and disable individual graphics window quadrants. The lower set of command buttons allows you to control the appearance of the graphics window and/or the model as viewed in any individual quadrant and to undo GAMBIT operations.

Section 5.4 of this guide describes the function and use of each button on the Global Control toolpad.

5.1.6 Description Window

The Description window (Figure 5-9) is located at the bottom of the GUI, immediately to the left of the Global Control toolpad. The purpose of the Description window is to display messages describing the various GUI components, including sashes, fields, windows, and command buttons.

![Description Window](image)

Figure 5-9: Description window

Messages displayed in the Description window describe the component of the GUI coinciding with the current location of the mouse pointer. As you move the mouse pointer across the screen, GAMBIT updates the Description window message to reflect the change in the location of the pointer.
5.1.7 Transcript Window and Command Text Box

The Transcript window is located in the lower left portion of the GUI. The Command text box is located immediately below the Transcript window (see Figure 5-10).

![Figure 5-10: Transcript window and Command text box]

The purpose of the Transcript window is to display a log of commands executed and messages displayed by GAMBIT during the current modeling session. The Command text box allows you to perform GAMBIT modeling and meshing operations by means of direct keyboard input, rather than by means of mouse operations on the GUI. (NOTE: The Command descriptor also provides access to a hidden menu that allows you to copy Transcript window commands to the Command text box and to insert pause commands in the current journal file (see below.).)

Resizing the Transcript Window

GAMBIT allows you to change the proportions of the Transcript window by means of a resize command button located in the upper right corner of the window. The resize command button contains an upward-pointing arrow on its face.

When you click the resize command button, GAMBIT expands the Transcript window vertically to occupy the entire height of the GUI—including the area ordinarily occupied by the graphics window. To restore the Transcript window to its default size, click the resize button (downward-pointing arrow) again.

> NOTE: You can also resize the Transcript window horizontally by dragging the sash located at the right side of the window.
5.1.8 GUI Sashes

You can reaponn the overall layout of the GAMBIT GUI by means of the GUI sashes. The GUI sashes are similar in function to graphics-window sashes but reaponn the entire GUI rather than just the graphics window.

There are two GAMBIT GUI sashes: each is represented as a thin, gray line—one vertical, the other horizontal. The vertical sash runs from the top edge to the bottom edge of the GUI and separates the Operation toolpad, form field, and Global Control toolpad (on the right) from the graphics window and Description window (on the left). The horizontal sash runs from the vertical GUI sash (on the right) to the left edge of the GUI and separates the graphics window (above the sash) from the Transcript window and Description window (below the sash).

To resize portions of the GUI by means of either the horizontal or vertical GUI sash, left-click the sash and drag it to its new location. When you release the mouse button, GAMBIT reapons the GUI according to the new location of the sash.

5.1.9 GUI Sash Anchor

The GUI sash anchor is located at the intersection of the horizontal and vertical GUI sashes and is represented as a small, gray box. Its purpose is to allow you to reapon the entire GUI layout by means of a single mouse operation.

Resizing the GUI Using the GUI Sash or Sash Anchor

To resize the GUI using the GUI sash anchor, left- or middle-click the sash anchor and drag it to a new location. When you release the mouse button, GAMBIT automatically resizes each part of the GUI according to the final position of the sash anchor.

Resizing the GUI Using Preset Configurations

You can also resize the parts of the GUI according to four preset GUI configurations. When you select a preset configuration, GAMBIT resizes the GUI components so that the selected configuration fills the entire GUI window. The preset configurations are as follows.

<table>
<thead>
<tr>
<th>Configuration</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Default) Graphics window, Operation toolpad, form field, Global Control toolpad, Description window, and Transcript window</td>
</tr>
<tr>
<td>2</td>
<td>Graphics window, Description window, and Transcript window</td>
</tr>
<tr>
<td>3</td>
<td>Graphics window, Operation toolpad, form field, and Global Control toolpad</td>
</tr>
<tr>
<td>4</td>
<td>Graphics window only</td>
</tr>
</tbody>
</table>

To select a preset GUI configuration, right-click the GUI sashes or sash anchor to open the preset-configuration menu, then left-click the desired configuration.
5.2 GUI Control Elements

GAMBIT allows you to control program operation by means of GUI control elements. The following table depicts the GAMBIT GUI control elements.

<table>
<thead>
<tr>
<th>Control Element</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Command button</td>
<td><img src="image1" alt="Command button" /></td>
</tr>
<tr>
<td>Option button</td>
<td><img src="image2" alt="Option button" /></td>
</tr>
<tr>
<td>Radio button</td>
<td><img src="image3" alt="Radio button" /></td>
</tr>
<tr>
<td>Check box</td>
<td><img src="image4" alt="Check box" /></td>
</tr>
<tr>
<td>Text box</td>
<td><img src="image5" alt="Text box" /></td>
</tr>
<tr>
<td>List box</td>
<td><img src="image6" alt="List box" /></td>
</tr>
<tr>
<td>Text window</td>
<td><img src="image7" alt="Text window" /></td>
</tr>
</tbody>
</table>

The following sections describe the purpose and operation of each of the control elements shown above.
5.2.1 Command Buttons

Command buttons allow you to execute program actions. There are two types of command buttons: toolpad and form. The following table shows examples of each type of command button.

<table>
<thead>
<tr>
<th>Type</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Toolpad</td>
<td>![Toolpad Button]</td>
</tr>
<tr>
<td>Form</td>
<td>![Form Button]</td>
</tr>
</tbody>
</table>

Toolpad command buttons are located on the Operation toolpad and Global Control toolpad; form command buttons are located on GAMBIT forms (for example, specification forms). To execute the action associated with any command button, left-click the button.

Toolpad Command Buttons

Toolpad command buttons allow you to execute program commands that are related to building, meshing, assigning zone types, or viewing the model and working with the GUI. Some toolpad command buttons cause a direct action to occur; others open specification forms.

Each toolpad command button contains a symbol representing the function of the button. Any button that performs more than one function (a multifunction command button) contains a small, downward-pointing arrowhead in the lower left corner of the button. For example, the Stitch Faces command button shown at left also performs the following functions:

- **Sweep Real Face**
- **Revolve Real Faces**
- **Form Real Volume From Wireframe**

To execute the command represented by the symbol currently displayed on a multifunction command button, left-click the button. To change the function of a command button, right-click it to open a list of available functions, and left-click the desired function to select it from the list.

5.2.2 Option Buttons

Option buttons allow you to select from a hidden menu of related, mutually exclusive options. They appear only on specification forms and are distinguished by a small, raised rectangle on the button face. The title displayed on the face of an option button represents the option currently selected from its hidden menu.

To open the hidden menu of options associated with any option button, left-click or right-click the button. To select an option from the menu, left-click its title in the menu list.

5.2.3 Radio Buttons

Radio buttons allow you to select from among a displayed group of related, mutually exclusive options. They appear as small, round or diamond-shaped buttons located on forms, and they always exist in groups of two or more. The title of each option in a group is shown immediately to the right of its associated radio button.

To select a particular option from a displayed group of mutually exclusive options, left-click its radio button. The selected option is identified by a small, colored dot or diamond in the center of the button.

5.2.4 Check Boxes

Check boxes allow you to specify non-mutually exclusive options for program operations. They are located on forms and can appear alone or in groups of two or more. The title of each option is shown immediately to the right of its check box.

To select a particular check-box option, left-click its check box. When you select a check-box option, the check box turns color and, on some systems, a check mark appears in the box to indicate that the option has been selected.
5.2.5 Text Boxes

Text boxes allow you to input alphanumeric data. They are located on forms and appear as indented rectangles. The title of any text box appears immediately to its left.

The following bullet points summarize the use of GAMBIT text boxes.

- To enter data by means of a text box, left-click in the box to enable it for user input, then input the data from the keyboard.
- To scroll text that overflows the text box, left-click the text and left-drag the mouse past the right or left edge of the box.
- To delete one or more characters in the box, left-click and drag the mouse pointer to highlight the character(s), then press Delete or Backspace, or enter data to replace the character(s) being deleted.
- To highlight all of the text in a text box, double-click the text box.

5.2.6 List Boxes

List boxes allow you to select from lists of items—for example, a list of face entities—that currently exist in the model. Each list box consists of a text box with a pick-list button located immediately to the right of the box. (NOTE: The pick-list button is a small, rectangular button with an upward-pointing arrow on its face.)

When you click the pick-list button, GAMBIT opens the pick-list form associated with the list box item type. For example, if you click the pick-list button associated with a list box titled Vertices, GAMBIT opens a Vertex List pick-list form. While the pick-list form is open, the upward-pointing arrow on the pick-list button is replaced by a downward-pointing arrow, indicating that the button closes, rather than opens, the pick-list form. For a general description of pick-list forms and their use, see Section 5.2.8, below.

5.2.7 Text Windows

Text windows appear on forms that contain lines of text—such as parameter lists or text files. When the size of the displayed text exceeds the size of the text window, GAMBIT displays scroll bars on the right side and/or bottom of the text window. To display text that exists beyond the current limits of the text window, either resize the form to resize the window, left-drag the horizontal or vertical scroll bar, or left-click the appropriate scroll arrow located at the end of a scroll bar.

Figure 5-11: Example Edge List pick-list form

> NOTE: You can also specify the vertices by using the mouse to pick them from the graphics window (see “Picking Entities,” in Section 5.3.2) or by inputting their labels in the Edges text box on the Create Face From Wireframe form.

The following sections describe the basic components of pick-list forms.

Form Components

Each pick-list form includes the following components:

- Title bar
- Available scroll list
- Picked scroll list
- Transfer command buttons
- Filter option button
The following subsections describe these components.

**Title Bar**
The title bar displays a title that describes the function of the form. The title includes the following subcomponents:
- **Item type**
- **Number of items**

The **item type** describes the type of item listed on the form—for example, Vertex List or Face List. The **number-of-items** subcomponent describes the number of items that are to be picked by means of the form. It always appears on the right side of the title bar and is bracketed by parentheses. There are three number-of-items designations, each of which indicates how many items can be picked from those listed in the Available scroll list on the form.

- **Single**—indicates that you must pick only one item.
- **Double**—indicates that you must pick two of the items.
- **Multiple**—indicates that you can pick one or more items.

**Available Scroll List**
The Available scroll list displays all currently existing items of the type associated with the form. (NOTE: If you right-click the Available scroll list, GAMBIT opens a hidden menu of options that allow you to sort, toggle the select state of, or deselect all items in the Available list (see below).)

**Picked Scroll List**
The Picked scroll list displays all currently picked items of the type associated with the form. (NOTE: If you right-click the Picked scroll list, GAMBIT opens a hidden menu containing a single option that allows you to deselect all items in the Picked list (see below).)

**Transfer Command Buttons**
The transfer command buttons allow you to transfer individual items or sets of items between the Available and Picked scroll lists (see below).

**Filter Option Button**
The filter option button allows you to specify filtering characteristics for items that are to be transferred by means of the All transfer command buttons. The filter options are as follows:
- **No filter**
- **Real**
- **Nonreal**
- **Meshed**
- **Unmeshed**

For example, if you open an Edge List (Multiple) pick-list form, specify the Meshed option, and click the All→ transfer button, GAMBIT transfers all meshed edges from the Available scroll list to the Picked scroll list on the Edge List (Multiple) form and does not transfer any unmeshed edges.

**Using a Pick-List Form**
Pick-list forms, such as that shown in Figure 5-11, above, include the following options and specifications.

<table>
<thead>
<tr>
<th>Available</th>
<th>displays all currently existing object types that are associated with the title of the form.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Picked</td>
<td>displays all currently picked object types that are associated with the title of the form.</td>
</tr>
</tbody>
</table>

**NOTE:** The Available scroll list includes a hidden menu of options that allow you to sort, toggle, and deselect items in the list. To open the hidden menu, right-click anywhere in the Available scroll list.

The hidden-menu options are as follows:
- **Sort**—sorts list items in alphabetical order.
- **Toggle all**—highlights those items that are not currently highlighted, and vice versa.
- **Deselect all**—deselects all items in the list.

**NOTE:** The Picked scroll list includes a hidden option that allows you to deselect all currently selected items in the list. To access the hidden option, right-click anywhere in the Picked scroll list.
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adds to the Picked scroll list only those items that are currently highlighted in the Available scroll list. To add one or more items to the Picked scroll list, highlight the item(s) in the Available scroll list and click this command button.

NOTE: If you double-click an item in the Available scroll list, GAMBIT adds the item to the Picked scroll list.

removes from the Picked scroll list only those items that are currently highlighted in the Picked scroll list. To remove one or more items from the Picked scroll list, highlight the item(s) in the Picked scroll list and click this command button.

adds to the Picked scroll list all objects that are currently displayed in the Available scroll list.

removes all items from the Picked scroll list.

specifies the types of entities that are to be transferred by the All transfer buttons.

closes the pick-list form.

► NOTE (1): GAMBIT allows you to add items to pick lists by means of mouse operations in the graphics window. For a description of the mouse operations that are related to picking items, see "Picking Entities," in Section 5.3.2, below.

► NOTE (2): You can close the pick-list form either by clicking the Close button on the form or by clicking the pick-list button (with the downward-pointing arrow) on the associated list box.

5.2.9 Query-List Forms

Query-list forms display a comprehensive list of entities—such as faces or edges—that currently exist in the model. They always appear as individual forms, titled "Query" and displaying the entity type that is associated with the form. Each query-list form includes a scroll list of entity names as well as Reset and Close command buttons.

To select a single entity from a query list, left-click (highlight) the name of the entity in the scroll list. To deselect a highlighted entity, left-click its highlighted name. To deselect all highlighted entities, click Reset.

Figure 5-12: Example Query Vertices query-list form
Using Query-List Forms

To open a query-list form, such as that shown in Figure 5-12, above, click the Query toolpad command button on one of the Geometry subpads. For a description of the use of Query forms, see “Query Vertices” in Section 2.2.6 of the GAMBIT Modeling Guide.

All query-list forms include the following specifications.

- **Label Names** contains the names of all entities associated with the form that currently exist in the model. Entities highlighted in the Label Names scroll list are also highlighted in the graphics window.

- **Filter** specifies a filter text string.

  The Filter specification allows you to identify and highlight subsets of entities. To highlight a subset of entities, input a string value common to all entities in the subset. For example, if you specify the filter string, “vertex.2” in the Filter text box on the Query Vertices form, GAMBIT highlights vertex.2, vertex.20, vertex.21, ..., vertex.29, vertex.200, vertex.201, ..., vertex.299, and so on.

- **Label** specifies that labels corresponding to highlighted entities names are displayed in the graphics window.

- **Reset** deselects all entities in the query list.

- **Close** closes the query-list form.

5.2.10 Slider Bars

Slider bars allow you to adjust settings in a continuous manner across a specified range of values. They are located on display-related specification forms and on boundary-layer specification forms, and they appear as horizontal bars containing a small, gray rectangle with a vertical line in its center (the slider box).

You can adjust a slider bar setting in the following ways:

- Continuous—Click the slider box and drag it to its new location
- Incremental—Click in the region on either side of the slider box
5.3 Using the Mouse

The GAMBIT GUI is designed for use with a three-button mouse. The function associated with each mouse button varies according to whether the mouse is operating on menus and forms or in the graphics window. Some graphics-window mouse operations involve keyboard keys in conjunction with the mouse.

5.3.1 Menus and Forms

Mouse operations for GAMBIT menus and forms require only the left and right mouse buttons and do not involve any keyboard key operations.

Left Mouse Button

Most of the mouse operations performed on GAMBIT GUI menus and forms require only the left mouse button. The left mouse button allows you to perform the following form-related operations:

- Open the menu associated with an item on the main menu bar
- Select a menu command
- Execute the operation indicated on a command button
- Select an option from a list of mutually exclusive radio buttons
- Open the hidden menu for an option button
- Select an option from an option-button menu
- Open or close a pick-list form
- Enable a text box for entering data
- Highlight an item in a list
- Relocate (drag) a form on the GUI

Right Mouse Button

The right mouse button allows you to perform the following form-related functions:

- Open a menu of options available by means of a multifunction toolpad command button
- Open a hidden menu of options, such as that described in “Using a Pick-List Form” in Section 5.2.8, above.

5.3.2 Graphics Window

There are three general types of GAMBIT GUI graphics-window mouse operations:

- Display
- Task
- Vertex creation

Display operations allow you to directly manipulate the appearance of the model in any of the graphics-window quadrants. Task operations allow you to specify topological entities and to execute geometry and meshing operations. The vertex creation operation allows you to create vertices on any displayed coordinate system grid.

Display Operations

GAMBIT GUI graphics-window display operations employ all three mouse buttons as well as the Shift and Ctrl keyboard keys. The types of display operations are as follows:

- Rotate
- Translate
- Revolve
- Zoom and pan-zoom
- Enlarge
- Show previous view
- Journal view
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**NOTE (1):** The following descriptions of display-window operations are based on the default functionality of the GAMBIT mouse buttons. For example, in the GAMBIT default configuration, GAMBIT rotates the model when you left-drag the mouse across the graphics window (see "Rotating the Model (Left-drag)," below.) Similarly, if you Shift-left-click an entity in the graphics window, GAMBIT adds the entity to the appropriate open pack list (see "Picking Entities," below).

GAMBIT allows you to exchange the functionality of the mouse buttons with respect to the Shift key operations. For example, you can exchange the functions of the left mouse button such that you need only to left-click an entity to add it to a pick list but must Shift-left-drag the mouse to rotate the model.

To exchange the functionality of the mouse buttons with respect to Shift key operations, perform the following steps:

1. Hold down the right mouse button
2. Click the left mouse button once

When you do so, GAMBIT changes the appearance of the cursor to indicate that the functionality of the mouse buttons has been exchanged.

To restore the default functionality of the mouse buttons, repeat the procedure described above. When you do so, GAMBIT restores the default cursor shape to indicate that the mouse functionality has been restored to its default state.

**NOTE (2):** GAMBIT graphics window mouse operations apply only to "enabled" graphics-windows quadrants. For a description of the enabling and disabling of graphics-windows quadrants, see Section 5.4.1, below.

---

Rotating the Model (Left-drag)

To rotate the model in any quadrant, left-click anywhere in the quadrant and left-drag the cursor either horizontally or vertically in the quadrant. GAMBIT rotates the model around an axis in the plane of the screen and perpendicular to the direction of mouse movement.

Translate the Model (Middle-drag)

To translate the model across the screen in any quadrant, middle-click anywhere in the quadrant and middle-drag the cursor either horizontally or vertically in the quadrant.

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Using the Mouse

Revolve/Zoom the Model (Right-drag)

The right mouse button performs two different types of display operations in the graphics window, each of which corresponds to a different direction of mouse movement:

- Revolve (horizontal movement)
- Zoom (vertical movement)

When you right-click anywhere in a quadrant and right-drag the mouse horizontally, GAMBIT revolves the model around a central axis normal to the plane of the screen. When you right-drag the mouse vertically, GAMBIT zooms in or out on the model.

Enlarging the Model

GAMBIT allows you to enlarge any portion of the model display by means of the control (Ctrl) keyboard key and either the left or middle mouse buttons. The Ctrl-left and Ctrl-middle mouse button functions differ with respect to whether GAMBIT retains or ignores the proportions of the model when the model display is enlarged.

Retaining Model Proportions (Ctrl-left-drag)

When you enlarge the model display by means of the Ctrl-left mouse button, GAMBIT enlarges a region of the modeling space the size of which is directly proportional to the quadrant in which the model display is enlarged. Consequently, the enlarged display retains the correct proportions with respect to model dimensions.

When you Ctrl-left-drag the mouse in a quadrant of the graphics window, GAMBIT displays two rectangles that bound the region to be enlarged. The rectangles differ from each other as follows.

- The outer (dashed) rectangle represents the total region that is included when the display is enlarged. Its dimensions are directly proportional to those of the quadrant in which it exists.
- The inner (solid) rectangle shows the region over which the mouse has been dragged.

When you release the mouse button, GAMBIT enlarges the display.
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**Ignoring Model Proportions (Ctrl-middle-drag)**

When you enlarge the model display by means of the Ctrl-middle mouse button, GAMBIT ignores the proportions of the graphics-window quadrant in which it enlarges the display. Consequently, the dimensions of the model in the enlarged display do not necessarily reflect the actual dimensions of the model.

When you Ctrl-middle-drag the mouse in a quadrant of the graphics window, GAMBIT displays a single solid rectangle that represents the region to be enlarged. When you release the mouse button, GAMBIT enlarges the model display such that the horizontal and vertical dimensions of the rectangle fill the entire width and height, respectively, of the quadrant in which the model display is enlarged. If the dimensions of the rectangle are not directly proportional to those of the quadrant, the enlarged model appears to be stretched in either the horizontal or vertical directions.

**Show Previous View (Double-middle-click)**

When you double-click the graphics window using the middle mouse button, GAMBIT displays the model as shown immediately previous to the current view. For example, if you display a model in an isometric view, then rotate the model to view one side, you can return to the isometric view by double-middle-clicking the mouse anywhere in the graphics window.

**Journal View (Double-right-click)**

When you double-click the graphics window using the right mouse button, GAMBIT writes the command associated with the currently displayed view of the model to the active journal file.

---

**Task Operations**

GAMBIT graphics window task operations employ all three mouse buttons in conjunction with the Shift key to allow you to specify entities and to execute actions related to GAMBIT forms. There are two types of task operations:

- **Picking entities**
- **Executing actions**

**Picking Entities**

Many GAMBIT modeling and meshing operations require you to specify one or more entities to which the operation applies. There are two ways to specify an entity for a GAMBIT operation:

- Input the entity name in the appropriate list box on the specification form or select by means of the appropriate pick-list form.
- Use the mouse to "pick" the entity from the model as displayed in the graphics window

When you use the mouse to pick an entity from the model as displayed in the graphics window, GAMBIT includes the entity name in the currently active pick list as if you had specified its name on the currently open specification form.

There are two different types of GAMBIT entity picking operations, each of which involves the Shift key. The two entity picking operations are as follows.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shift-left-click</td>
<td>Highlights the entity in the graphics window and includes the entity in the currently active pick list.</td>
</tr>
<tr>
<td>Shift-middle-click</td>
<td>Performs the following functions:</td>
</tr>
<tr>
<td></td>
<td>- Removes currently highlighted items from the pick list</td>
</tr>
<tr>
<td></td>
<td>- Picks any unselected entities in a manner identical to that of the Shift-left-click operation</td>
</tr>
</tbody>
</table>

As an example of the Shift-middle-click operation, consider the procedure required to pick one of the three faces shown in Figure 5-13 for a face-related geometry operation. All three faces share a common edge, labeled edge1.
Using the Mouse

Figure 5-13: Three faces with adjoining edge

If you Shift-middle-click on edge 1, GAMBIT highlights face 1 and adds its label to the current pick list. If you Shift-middle-click a second time on edge 1, GAMBIT removes face 1 from the pick list and replaces it with face 2. If you Shift-middle-click a third time on edge 1, GAMBIT removes face 3 from the face pick list and replaces it with face 3. Finally, if you Shift-middle-click a fourth time on edge 1, GAMBIT removes face 3 from the pick list and replaces it with face 1.

NOTE: To pick any face or volume in a given model, you must pick an edge that is associated with the face or volume. The type of entity picked depends on the currently active list box. For example, if you open the Faces list box and activate the Faces list box, then pick an edge that constitutes a boundary of a face, GAMBIT adds the face to the list of specified faces. Similarly, if you open the Delete Volumes form and activate the Volumes list box, then pick an edge that constitutes part of a volume, GAMBIT adds the volume to the list of specified volumes.

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Executing Actions

When you Shift-right-click the mouse in the graphics window, GAMBIT executes the operation associated with the currently open form or skips to next available list box or text box on the form. If all of the form specifications are complete, the Shift-right-click operation is equivalent to the act of clicking Apply on the bottom of the form. For example, if you open the Create Real Sphere form, input a positive value in the Radius text box and Shift-right-click in the graphics window, GAMBIT creates a sphere with the specified radius.

Creating Vertices

GAMBIT allows you to create vertices by mean of the Ctrl-right mouse button. The Ctrl-right-click method of creating vertices applies in any graphics window quadrant that contains an active "grid." For a description of the procedures and specifications required to display a grid, see Section 5.1.2 of the GAMBIT Modeling Guide.

To create a vertex by means of the mouse, Ctrl-right-click the point at which the vertex is to be created. The geometrical location of the vertex depends on whether you do or do not select the Snap option when you activate the grid display.

- If you select the Snap option, GAMBIT locates the vertex at the grid point that is nearest to the point of intersection between the plane and the screen normal vector described above.
- If you do not select the Snap option, GAMBIT locates the vertex at the point of intersection between the grid plane and a vector that is perpendicular to the screen and passes through the point at which you click the quadrant.
5.4 Using the Global Control Toolpad

The Global Control toolpad (Figure 5-8 and below) allows you to control the layout and operation of the graphics window as well as the appearance of the model as displayed in any individual quadrant. In addition, the Global Control toolpad includes an Undo/Redo button that undoes the most recently executed GAMBIT operation or re-executes the most recently undone operation.

The Global Control toolpad contains two types of command buttons:

- Quadrant
- Control

![Global Control toolpad]

The quadrant command buttons allow you to specify whether or not any or all of the quadrants are enabled or disabled with respect to changes in their appearance. The control command buttons allow you to perform the following operations:

- Change the overall layout of the graphics window
- Alter the appearance of the model in any individual quadrant
- Undo or redo GAMBIT operations

The following sections describe the operation and use of both types of command buttons.

5.4.1 Quadrant Command Buttons

Quadrant command buttons allow you to enable and disable any or all of the graphics-window quadrants with respect to changes in the model appearance. From left to right on the Global Control toolpad, the quadrant command buttons correspond to the following quadrants:

- Upper left
- Upper right
- Lower left
- Lower right
- All four quadrants (enable only)

Each quadrant command button toggles its corresponding quadrant between the enabled and disabled states. Enabled quadrants are displayed in red on their corresponding command buttons. Disabled quadrants are displayed in gray.

To enable a disabled quadrant or disable an enabled quadrant, click the corresponding quadrant command button. To enable all quadrants, click All.
5.4.2 Control Command Buttons

Control command buttons allow you to specify the appearance of the graphics window itself and of the model as viewed in any individual quadrant. In addition, the Undo/Redo control command button undoes the most recently executed GAMBIT operation or re-executes the most recently undone operation. The Global Control toolpad contains the following control command buttons.

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Command</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fit to Window</td>
<td>Scales the graphics display to fit within the boundaries of the enabled quadrants</td>
</tr>
<tr>
<td></td>
<td>Select Pivot</td>
<td>Specifies the location of the pivot point for model movement by means of the mouse</td>
</tr>
<tr>
<td></td>
<td>Select Preset</td>
<td>Arranges the graphics window to reflect one of six preset configurations</td>
</tr>
<tr>
<td></td>
<td>Configuration</td>
<td>Modify Lights</td>
</tr>
<tr>
<td></td>
<td>Annotate</td>
<td>Allows you to add arrows, lines, and text to the graphics display</td>
</tr>
<tr>
<td></td>
<td>Specify Label Type</td>
<td>Specifies the types of labels displayed by means of the Specify Display Attributes form</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Undo</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Redo</td>
</tr>
</tbody>
</table>

**Symbol**

Orient Model

Applies a preset model orientation to all active quadrants, orients the model with respect to a specified face or vector, and stores commands related to the current orientation in a journal file.

Specify Display Attributes

Allows you to specify the characteristics of the graphics display.

Render Model

Specifies whether the model is displayed in a wireframe, shaded, or hidden perspective.

Specify Color Mode

Specifies whether model colors are based on entity types or on connectivity.

Examine Mesh

Allows you to interactively view an existing mesh.

The following sections describe the function and use of the command buttons listed above.

**Fit to Window**

The Fit to Window command button scales the graphics display to fit in each of the enabled quadrants.
The **Select Pivot** command button allows you to change the pivot point around which the model turns when you rotate and/or revolve it using the left and right mouse buttons (see “Rotating the Model (Left-drag)” and “Revolve/Zoom the Model (Right-drag),” above).

GAMBIT allows you to specify either of two points about which to pivot the model:

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Pivot Point</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="center_point" /></td>
<td>Center of viewing volume (default)</td>
</tr>
<tr>
<td><img src="image" alt="user_point" /></td>
<td>User-specified point</td>
</tr>
</tbody>
</table>

To define a user-specified pivot point, click the **Select Pivot** command button to display the user-specified point symbol, then left-click at the selection point in the graphics window to identify the new pivot point location. GAMBIT locates the pivot point according to the following hierarchy of rules:

1. If the selection point intersects one or more coordinate systems, GAMBIT locates the pivot point at the system closest to the viewer.
2. If the selection point intersects one or more vertices, GAMBIT locates the pivot at the vertex closest to the viewer.
3. If the selection point intersects one or more edges, GAMBIT locates the pivot in reference to the selection point and the nearest edge. GAMBIT uses either the point of intersection as the anchor point or the tangent to the edge at that point as an axis of rotation.
4. If the selection point intersects one or more faces, GAMBIT locates the pivot at the point of intersection with the closest face.
5. If the selection point does not intersect any model components, GAMBIT sets the center of the viewing volume as the pivot point.

To restore the pivot point to its default (quadrant centroid) location, click the **Select Pivot** command button to display the quadrant centroid symbol.
Modify Lights

When you click the Modify Lights command button, GAMBIT opens the Modify Lights form. The Modify Lights form allows you to customize the appearance of model shading.

Using the Modify Lights Form

The Modify Lights form (see below) allows you to specify the direction and brightness of eight different light sources used to determine model shading. Each light source is represented on the Modify Lights form by one of eight colors: white, cyan, magenta, blue, yellow, green, red, and black.

The Modify Lights form consists of the following components:
- Status buttons
- Orientation globe

Status Buttons

The Modify Lights form contains eight sets of status buttons corresponding to each of the eight light sources. Each set of status buttons includes the following buttons:
- Light command button
- Ambient and Distant radio buttons

Each Light command button toggles the state of its associated light source between the active (On) and inactive (Off) states. The Ambient and Distant radio buttons constitute mutually exclusive selectors that allow you to specify whether a specific light source is located close to (Ambient) or distant from (Distant) the model.

Orientation Globe

The Modify Lights orientation globe consists of a wireframe sphere upon which are located eight colored circles—each of which is displayed as either solid or hollow. Each circle represents one of the eight light sources. Solid circles represent light sources that are currently specified as On; hollow circles represent light sources that are currently specified as Off.

To reposition any of the eight light sources relative to the model (center of globe) left-click its corresponding circle on the orientation globe and left-drag the circle to the new location. To drag the light source to the side of the globe farthest from the viewer, drag it to the edge of the globe, then back toward the middle. The light source is located on the far side of the globe when it is located on the dashed portion of a circumferential line.

> NOTE: If you reposition lights that are Ambient or Off, GAMBIT does not change model shading.
Annotate

When you click the Annotate command button, GAMBIT opens the Annotate form. The Annotate form allows you to add annotation objects—such as arrows, lines, or text—to any individual graphics window quadrant and to modify or delete such objects.

GAMBIT allows you to perform the following operations with respect to annotation objects.

<table>
<thead>
<tr>
<th>Operation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Add</td>
<td>Creates a new object in the graphics window</td>
</tr>
<tr>
<td>Modify</td>
<td>Modifies an existing object</td>
</tr>
<tr>
<td>Delete</td>
<td>Deletes an existing object</td>
</tr>
<tr>
<td>Delete all</td>
<td>Deletes all existing objects</td>
</tr>
</tbody>
</table>

Adding an Annotation Object

GAMBIT allows you to add the following types of annotation objects:
- **Arrow**—a straight line or series of connected line segments with a single arrowhead at one end
- **Line**—a straight line or series of connected line segments without an arrowhead at either end
- **Text**—alphanumeric text that can be placed anywhere in the graphics window

When you Add an annotation object to a graphics window quadrant, GAMBIT creates the object and fixes its position and orientation at an anchor point relative to the quadrant itself. Annotation objects do not move when you translate, rotate, or zoom in or out on the model. To specify the anchor point, left-click the graphics window at the anchor point.

If you resize a quadrant that contains annotation objects, GAMBIT maintains the positions of the object anchor points relative to the original proportions of the quadrant. However, GAMBIT does not alter Text or Title characters when you resize a quadrant, therefore, the characters retain their original size.

Arrow Object

To add an Arrow annotation object, perform the following steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select the Add radio button on the Annotate form.</td>
</tr>
<tr>
<td>2</td>
<td>Select the <strong>Object</strong>:Arrow option.</td>
</tr>
<tr>
<td>3</td>
<td>Specify the object <strong>Color</strong> and <strong>Width</strong>.</td>
</tr>
<tr>
<td>4</td>
<td><strong>Shift-left-click</strong> the graphics window at the point at which the tail of the arrow is to be located, and release the mouse button.</td>
</tr>
<tr>
<td>5</td>
<td><strong>Shift-left-click</strong> again in the graphics window, and <strong>Shift-left-drag</strong> the mouse pointer to the point at which the head of the arrow is to be located.</td>
</tr>
<tr>
<td>6</td>
<td>Click <strong>Apply</strong> on the Annotate form (or <strong>Shift-right-click</strong> in the graphics window).</td>
</tr>
</tbody>
</table>

> **NOTE**: To create an arrow consisting of more than one line segment, repeat Step 5 for each endpoint of each intermediate segment. When you **Shift-right-click** to **Apply** the arrow annotation object, GAMBIT creates an arrow defined by the series of line segments and possessing a single arrowhead located at the last point selection point.

Line Object

To add a Line annotation object, follow the general directions outlined above with respect to adding an Arrow object but select the **Object**:Line in lieu of the **Object**:Arrow option in Step 2. The Line and Arrow annotation objects differ only in that the Line object does not include an arrowhead.
Text Object

To add a Text annotation object, perform the following steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select the Add radio button on the Annotate form.</td>
</tr>
<tr>
<td>2</td>
<td>Select the Object:Text option.</td>
</tr>
<tr>
<td>3</td>
<td>Specify the object Color and Size, and input the alphanumeric Text associated with the object.</td>
</tr>
<tr>
<td>4</td>
<td>Shift-left-click in the graphics window, and drag the text to its final location.</td>
</tr>
<tr>
<td>5</td>
<td>Click Apply on the Annotate form (or Shift-right-click in the graphics window).</td>
</tr>
</tbody>
</table>

**NOTE:** When you select the Object:Text option, GAMBIT displays a push-button labeled "Title" to the right of the Object option button. If you click the Title pushbutton, GAMBIT automatically fills the Text input field with the title of the current GAMBIT session.

Modifying an Annotation Object

To modify an annotation object, perform the following steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select the Modify radio button on the Annotate form.</td>
</tr>
<tr>
<td>2</td>
<td>Pick the object to be modified. <em>(NOTE: To unpick a picked object, Shift-middle-click on the object.)</em></td>
</tr>
<tr>
<td>3</td>
<td>Specify the modifications by means of the Object and Properties fields on the Annotate form. <em>(NOTE: To change the position of an object within its quadrant, Shift-left-drag or Shift-middle-drag the object to its new location.)</em></td>
</tr>
<tr>
<td>4</td>
<td>Click Apply on the Annotate form (or Shift-right-click in the graphics window).</td>
</tr>
</tbody>
</table>

Deleting an Annotation Object

To delete an annotation object, perform the following steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select the Delete radio button on the Annotate form.</td>
</tr>
<tr>
<td>2</td>
<td>Shift-left-click the object to be deleted.</td>
</tr>
<tr>
<td>3</td>
<td>Click Apply on the Annotate form (or Shift-right-click in the graphics window).</td>
</tr>
</tbody>
</table>
Deleting All Existing Annotation Objects

To delete all existing annotation objects, perform the following steps:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Select the Delete all radio button on the Annotate form.</td>
</tr>
<tr>
<td>2</td>
<td>Click Apply on the Annotate form (or Shift-right-click in the graphics window).</td>
</tr>
</tbody>
</table>

Using the Annotate Form

The Annotate form (see below) allows you to add, modify, or delete annotations to the graphics display. To open the Annotate form, click the Annotate command button on the Global Control toolpad.

The Annotate form includes the following options and specifications.

- **Operation**: specifies the addition of an annotation object.
  - **Add**
  - **Modify** specifies the modification of an existing annotation object.
  - **Delete** specifies the deletion of an existing annotation object.
  - **Delete all** deletes all existing annotation objects.

- **Object**: (active for Add and Modify options only)
  - **Arrow**
  - **Line**
  - **Text** specifies the type of annotation to be added or modified.

- **Properties**: specifies the color of the annotation.
  - **Color**
  - **Width**
    - (Arrow and Line options only) specifies the thickness of the Arrow or Line annotation object.
  - **Text**
    - (Text option only) specifies the wording of the annotation. (NOTE: When you select the Object:Text option, GAMBIT displays a pushbutton labeled “Title” to the right of the Object option button. If you click the Title pushbutton, GAMBIT automatically fills the Text input field with the title of the current GAMBIT session.)
Using the Set Color Form

The Set Color form allows you to specify the color of an annotation object. To open the Set Color form (see below), click the Color bar on the Annotate form.

The Set Color form includes the following specifications:

- **Color name** specifies the color by name.
- **Colors:** allows you to select a color from a list of available colors.

To select a color, left-click the color in the scroll list. GAMBIT displays the currently selected color on a color band located immediately above the Colors scroll list.

> **NOTE:** You must click Apply to apply the color specification and close the form.

---

### Specify Label Type

When you click the Specify Label Type command button, GAMBIT opens the Specify Label Type form. The Specify Label Type form allows you to specify the kinds of labels that are displayed when you display labels by means of the Specify Display Attributes form (see "Specify Display Attributes," below).

GAMBIT allows you to specify the display of any or all of the following types of labels:

<table>
<thead>
<tr>
<th>Label Type</th>
<th>Description</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>Entity</td>
<td>face.3</td>
</tr>
<tr>
<td>Scheme</td>
<td>Meshing schemes</td>
<td>scheme = pave</td>
</tr>
<tr>
<td>Interval</td>
<td>Edge mesh intervals</td>
<td>int = 15</td>
</tr>
<tr>
<td>Boundary Layer</td>
<td>Boundary layers</td>
<td>b_layer = b_layer.5</td>
</tr>
<tr>
<td>Size Function</td>
<td>Size functions</td>
<td>st = stuc.1</td>
</tr>
<tr>
<td>Boundary Type</td>
<td>Boundary-type zone specifications</td>
<td>btype = WALL</td>
</tr>
<tr>
<td>Continuum Type</td>
<td>Continuum-type zone specifications</td>
<td>type = FLUID</td>
</tr>
</tbody>
</table>

To display a label, you must specify the label type, by means of the Specify Label Type form, and activate labels for the entry (or entities) of interest, by means of the Specify Display Attributes form. For example, to display the numbers of mesh intervals for all edges in the model, you must select the Interval option on the Specify Label Type form, then activate labels for all edges by means of the Specify Display Attributes form.

> **NOTE (1):** If the Label option on the Specify Display Attributes form is On, changes made on the Specify Label Type form affect the model display as soon as they are specified.

> **NOTE (2):** The Specify Label Type form specifications do not affect coordinate system labels.
Using the Global Control Toolpad

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Using the Specify Label Type Form

The Specify Label Type form (see below) allows you to specify the types of labels that are displayed by means of the Specify Display Attributes form. To open the Specify Label Type form, click the Label Type command button on the Global Control toolpad.

![Specify Label Type Form](image)

The Specify Label Type form consists of a field of check boxes that allow you to specify the display of the following label types (see above):

- Regular
- Scheme
- Interval
- Boundary Layer
- Size Function
- Boundary Type
- Continuum Type

Overview

When you click the Undo command button, GAMBIT reverses the most recently executed operation. For example, if you create a vertex and click Undo, GAMBIT deletes the vertex.

Multiple Undo Operations

As you create and/or mesh a model, GAMBIT maintains and updates an "undo" list—that is, a first-in/last-out sequential list of Geometry, Mesh, Zones, Tools and Global Control commands performed during the modeling session. When you execute the Undo command, GAMBIT reverses the most recently executed operation and removes it from the undo list. If you execute the Undo command a second time, GAMBIT reverses and removes from the undo list the operation that you performed immediately prior to the most recently executed operation—and so on. For example, if you create and mesh a cylindrical volume, then click Undo, GAMBIT removes the mesh from the volume. If you click Undo a second time, GAMBIT deletes the volume.

By default, GAMBIT maintains 10 undo levels—that is, the undo list contains the 10 most recently executed operations. To increase or decrease the number of operations retained in the undo list, modify the GAMBIT UNDO default variable by means of the Edit Defaults form (see Section 4.2.4 of the User’s Guide).

**NOTE:** Increasing the number of undo levels necessarily increases the amount of disk space required by the GAMBIT program.
Redo

The Redo command reverses the most recently executed GAMBIT Undo operation.

Overview

When you click the Redo command button, GAMBIT reverses the most recently executed Undo operation. For example, if you create a vertex and click Undo, GAMBIT deletes the vertex. If you then click Redo, GAMBIT restores the vertex to the model.

Multiple Redo Operations

GAMBIT allows you to Redo multiple-operation sequences that are undone by means of the Undo command. For example, if you create and mesh a cylindrical volume, then click Undo, GAMBIT removes the mesh from the volume. If you click Undo a second time, GAMBIT deletes the volume. If you then click Redo, GAMBIT restores the volume, and if you click Redo a second time, GAMBIT restores the mesh.

By default, GAMBIT allows you to undo the 10 most recently executed operations and to redo the 10 most recently executed Undo operations. To increase or decrease the number of operations that can be undone and/or redone, modify the GAMBITUndo default variable by means of the Edit Defaults form (see Section 4.3.4 of the User’s Guide.)

► NOTE: Increasing the number of undo and/or redo levels necessarily increases the amount of disk space required by the GAMBIT program.

Orient Model

The Orient Model command button allows you to apply a preset model orientation to all currently enabled quadrants, to orient the model with respect to a specified face or vector, and to store commands related to the current orientation in a journal file.

To open the menu of Orient Model options, right-click the Orient Model command button. The Orient Model menu includes the following options.

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="xy.png" alt="Image" /></td>
<td>Displays the model as viewed in the $-x$ direction.</td>
</tr>
<tr>
<td><img src="yx.png" alt="Image" /></td>
<td>Displays the model as viewed in the $+x$ direction.</td>
</tr>
<tr>
<td><img src="zy.png" alt="Image" /></td>
<td>Displays the model as viewed in the $-y$ direction.</td>
</tr>
<tr>
<td><img src="zy.png" alt="Image" /></td>
<td>Displays the model as viewed in the $+y$ direction.</td>
</tr>
<tr>
<td><img src="zx.png" alt="Image" /></td>
<td>Displays the model as viewed in the $-z$ direction.</td>
</tr>
<tr>
<td><img src="zx.png" alt="Image" /></td>
<td>Displays the model as viewed in the $+z$ direction.</td>
</tr>
<tr>
<td><img src="iso.png" alt="Image" /></td>
<td>Displays an isometric view of the model.</td>
</tr>
<tr>
<td><img src="rot.png" alt="Image" /></td>
<td>Reverses the orientation of the model as currently displayed in each quadrant.</td>
</tr>
</tbody>
</table>
Using the Global Control Toolpad

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Orients the model in a direction either normal to an existing face or defined by a vector (see &quot;Using the View Face/Vector Form,&quot; below)</td>
</tr>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Displays the model according to its previous orientation and configuration. (NOTE: This operation is identical to the double-middle-click in the graphics window (see &quot;Show Previous View (Double-middle-click),&quot; above).)</td>
</tr>
<tr>
<td><img src="image" alt="Icon" /></td>
<td>Saves the commands corresponding to the current model orientation and configuration to the session journal text file. (NOTE: This operation is identical to the double-right-click in the graphics window (see &quot;Journal View (Double-right-click),&quot; above).)</td>
</tr>
</tbody>
</table>

Using the View Face/Vector Form

The View Face/Vector option on the Orient Model menu allows you to view the model from a direction normal to any one of the model faces or in relation to a specified vector. When you select the View Face/Vector option, Gambit opens the View Face/Vector form (see below). The View Face/Vector form allows you to specify the face toward which or vector along which the model is to be viewed.

![View Face/Vector Form](image)

The View Face/Vector form includes the following options:

- Quadrant command buttons enable or disable any or all quadrants with respect to changes in model appearance.

The following sections describe each of these options.

Normal to Face Option

The Normal to Face option allows you to orient the model in the direction normal to a specified face. For instructions in specifying the face that defines the view direction, see "List Boxes," above. (NOTE: When you specify the Normal to Face option, Gambit scales the graphics display in each enabled quadrant when it reorients the model.)

Along Vector Option

The Along Vector option allows you to view the model in the direction of a specified vector. Gambit orients the model so that the specified vector is normal to the plane of the screen.

When you select the Along Vector option, Gambit displays a Define command button immediately below the Along Vector button. To specify the vector in the direction of which the model is to be viewed, click the Define command button to open the Vector Definition form. (See "Using the Vector Definition Form," below.)
Using the Vector Definition Form

The Vector Definition form (see below) allows you to define a vector for use in GAMBIT operations such as model orientation or the specification of axes of rotation (for example, see Section 2.1.4 of the GAMBIT Modeling Guide). To define a vector, you must specify information regarding its magnitude and direction, as well as the location of its origin. GAMBIT provides several options for specifying such information.

![Vector Definition Form]

The Vector Definition form includes the following specifications.

- **Active Coordinate System Vector**: displays the coordinates of the origin (Start) and up (End) for the current vector definition. (NOTE: The Start and End locations are always defined in terms of the active coordinate system.)

- **Magnitude**: specifies the magnitude of the vector. (NOTE: If you input a negative value for the Magnitude parameter, GAMBIT reverses the direction of the vector relative to its Method-option definition but does not change the location of the vector origin.)

- **Coord. Sys. Axis**: allows you to specify the method to be used for specifying the vector endpoints. The available options are as follows:
  - **Coord. Sys. Axis**: defines the vector with respect to one of the coordinate axes
  - **Edge**: defines the vector by means of the endpoints of an existing edge
  - **2 Points**: defines the vector by means of two existing vertices
  - **2 Points**: defines the vector by means of two specified locations (points) in space
  - **Screen View**: defines the vector relative to the model orientation currently displayed in the graphics window

The specifications available in the lower section of the Vector Definition form vary according to Method option. The following subsections describe specifications associated with each of the options listed above.
Using the Global Control Toolpad

THE GAMBIT GUI

Specifying a Vector Defined by a Coordinate System Axis

When you select the Coord. Sys. Axis option, GAMBIT defines the vector with respect to a coordinate axis. To define the vector, you must specify the following information:

- The coordinate system to be used in defining the vector
- The axis and direction that defines the vector

For this option, the lower portion of the Vector Definition form appears as shown above and includes the following specifications.

- Coordinate Sys.
- Direction:

 specifies the reference coordinate system for the vector.

contains radio buttons that allow you to specify the axis and direction to be used in the vector definition. The available options are as follows:

- X—Positive or Negative
- Y—Positive or Negative
- Z—Positive or Negative

For example, if you specify c.sys.1 in the Coordinate Sys. list box and select the Z Negative orientation option, GAMBIT defines a vector that points in the negative direction along the z axis of c.sys.1 with an origin at the origin of c.sys.1.

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Using the Global Control Toolpad

Specifying a Vector Defined by a Model Edge

When you select the Edge option, GAMBIT defines the vector by means of the endpoints vertices of an existing edge. For this option, the lower portion of the Vector Definition form appears as shown below and includes the following specification.

Vector Definition form—Edge option specification

- Edge

specifies an edge the endpoints of which define the origin, magnitude, and direction of the vector.

The origin of the vector is located at the edge start endpoint vertex, and its tip is located at its end endpoint vertex. To reverse the direction of the vector, either middle-click the edge to reverse its sense or input a negative value for the Magnitude specification. (For a description of edge start and end vertices and the meaning of edge sense, see Section 2.3.1 of the GAMBIT Modeling Guide.)
**Using the Global Control Toolpad**

### Specifying a Vector Defined by Two Vertices

When you select the **2 Vertices** option, GAMBIT defines the vector by means of the locations of two existing vertices. For this option, the lower portion of the Vector Definition form appears as shown below and includes the following specifications.

<table>
<thead>
<tr>
<th>Method</th>
<th>2 Vertices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertices</td>
<td></td>
</tr>
<tr>
<td>Start</td>
<td></td>
</tr>
<tr>
<td>End</td>
<td></td>
</tr>
</tbody>
</table>

**Vector Definition form—2 Vertices option specifications**

- **Vertices**: contains two list boxes that specify vertices defining the origin (Start) and tip (End) of the vector. (NOTE: To reverse the direction of the vector, either switch the Start and End vertex specifications or input a negative value for the Magnitude specification.)

---

### Specifying a Vector Defined by Two Points

When you select the **2 Points** option, GAMBIT defines the vector by means of two point locations. For this option, the lower portion of the Vector Definition form appears as shown below and includes the following specifications.

<table>
<thead>
<tr>
<th>Method</th>
<th>2 Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coordinate Values:</td>
<td></td>
</tr>
<tr>
<td>(Point 1)</td>
<td>(Point 2)</td>
</tr>
<tr>
<td>Coordinate Sys:</td>
<td>Cartesian</td>
</tr>
</tbody>
</table>

**Vector Definition form—2 Points option specifications**

- **Coordinate Values**: contains two radio buttons that specify the point associated with the values currently displayed in the lower part of the form. The options, Point 1 and Point 2, specify the positions of the vector origin and tip, respectively. (NOTE: To reverse the direction of the vector, either switch the specifications for the two points or input a negative value for the Magnitude specification.)

- **Coordinate Sys**: specifies the coordinate system of reference for the points that define the vector.

- **Type**: specifies the type of coordinate system to be used in the current point specification.

- **Global | Local**: specifies the location of the point with respect to either the Global or Local system.
Specifying a Vector Defined by the Current Screen View

When you select the Screen View option, GAMBIT defines the vector relative to the current orientation of the model in the graphics window. For this option, the lower portion of the Vector Definition form appears as shown below and includes the following specifications:

- **Method:** Screen View
- **Direction:**
  - **Piercing:** Out or In
  - **Horizontal:** Right or Left
  - **Vertical:** Up or Down

Vector Definition form—Screen View option specifications

- **Direction:**
  - Contains a group of paired radio buttons that allow you to specify the vector definition relative to the currently displayed orientation of the model in the graphics window. The six Direction options are as follows:
    - Piercing—Out or In
    - Horizontal—Right or Left
    - Vertical—Up or Down

For example, if you select the Piercing—Out option and left-click on a graphics window quadrant, GAMBIT defines a vector pointing directly into the screen with an origin located in the center of the quadrant.

The Specify Display Attributes form allows you to customize the appearance of the model in any or all of the graphics window quadrants. It includes the following options:

- **Apply** (quadrant command buttons) enable or disable any or all quadrants with respect to changes in model appearance.
Using the Global Control Toolpad

THE GAMBIT GUI

The middle section of the Specify Display Attributes form allows you to select individual model entities or entire entity types for display specification. The available entity-type options include groups (Groups), volumes (Volumes), faces (Faces), edges (Edges), vertices (Vertices), boundary layers (B. Layers) and coordinate systems (G. Sys).

Specifying Display Attributes—Groups Example

The options available for each entity type are identical to those for model groups—which are as follows.

Groups applies the specified display attributes to any or all groups in the model.

All—specifies all groups in the model

Pick—specifies groups selected by means of the Group list box (see below). (NOTE: If you pick a group in the graphics window or click in the Group list box, GAMBIT automatically selects the Pick option.)

Groups allows you to select specific groups to which to apply the display attributes.

Visible specifies the visibility of the selected groups. The visibility options are visible (On) or invisible (Off).

Label specifies the visibility of labels for the selected groups. The visibility options are visible (On) or invisible (Off). To select the types of labels to be displayed, use the Specify Label Type command on the Global Control toolbar.

Silhouette specifies the visibility of silhouettes for the selected groups. The visibility options are visible (On) or invisible (Off). Silhouettes display outlines of surfaces that do not possess edges—for example, the curved surfaces of cylinders and spheres.

Mesh specifies the visibility of the mesh. The visibility options are visible (On) or invisible (Off).
Using the Global Control Toolpad

THE GAMBIT GUI

Render Model

The Render Model command allows you to render the model as either shaded, wireframe, or hidden. The symbol displayed on the Render Model command button indicates its current function. To change the function of the button, right-click it to open the menu of available functions, then select the desired function from the menu. When you select a function from the menu, GAMBIT automatically renders the model according to the selected function.

THE GAMBIT GUI

Specify Color Mode

The Specify Color Mode command button allows you to toggle between two modes of defining color for the lines, curves, and points as displayed in the active graphics-window quadrants. The two color modes are as follows:

- Topology—specifies that the colors displayed for vertices, edges, faces, and volumes correspond to the hierarchy of model entities.
- Connectivity—specifies that model colors are based on connectivity between entities.

Topology Mode

In the topology color mode, GAMBIT displays entity colors according to the GAMBIT geometry color conventions. The default topology color conventions are as follows.

<table>
<thead>
<tr>
<th>Entity</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex</td>
<td>white</td>
</tr>
<tr>
<td>Edge</td>
<td>yellow</td>
</tr>
<tr>
<td>Face</td>
<td>cyan</td>
</tr>
<tr>
<td>Volume</td>
<td>green</td>
</tr>
</tbody>
</table>

You can change the default topology color conventions by means of the Edit Defaults form (see "Using the Edit Defaults Form" in Chapter 4 of the User's Guide).

The colors listed in the table above correspond to only those entities that do not constitute parts of higher-topology entities. For example, if an edge exists on its own, it is displayed as yellow, but if it constitutes part of a face, it is displayed as cyan.
Connectivity Mode

In the connectivity color mode, GAMBIT displays colors based on the connectivity between entities. The default connectivity color conventions are as follows:

<table>
<thead>
<tr>
<th>Number of Connections</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>white</td>
</tr>
<tr>
<td>1</td>
<td>orange</td>
</tr>
<tr>
<td>2</td>
<td>deepskyblue</td>
</tr>
<tr>
<td>3 or more</td>
<td>cyan</td>
</tr>
</tbody>
</table>

For example, in the connectivity color mode, lone vertices are white but any vertex that constitutes an endpoint for two separate edges is colored orange. Similarly, lone edges are white, but an edge that is shared by three separate faces is colored deepskyblue.

If two coincident entities differ in the degree of their connectivity to other entities in the model, GAMBIT displays the color corresponding to the least-connected entity. For example, if a lone vertex is coincident with the corner vertex of a four-sided face, GAMBIT displays a white vertex at the location of coincidence.

**NOTE (1):** GAMBIT determines connectivity coloration for any entity on the basis of the number of sides of the entity that are connected to higher entities. If you create a face that includes a dangling edge, GAMBIT assigns the dangling edge a connectivity color of deepskyblue, because the face itself exists on two separate sides of the edge.

**NOTE (2):** You can change the default connectivity color conventions by means of the Edit Defaults form (see "Using the Edit Defaults Form" in Chapter 4 of the User's Guide).

---

Examine Mesh

When you click the Examine Mesh command button, GAMBIT opens the Examine Mesh form (see below). The Examine Mesh form allows you to display an existing mesh and to customize the characteristics of the mesh display.
Figure 5.14: Skewed elliptical cylinder

The following sections describe each of the speculations listed above.

- Qualityinez
- Element area
- Domain
- 

Specifying the Domain

Using the Define Central Topped...

THE GAMBIT GUI
Plane Option

When you select the Plane option, GAMBIT displays a plane cut through the mesh. To customize the plane cut, you must specify two parameters:

- Cut Type
- Cut Orientation

The Cut Type specification determines whether GAMBIT displays a zero-thickness plane cut through the mesh or an array of mesh elements defined by their position with respect to the cutting plane. The Cut Orientation specification allows you to align the cutting plane with one of the three planes of the active coordinate system and to specify the position of the cutting plane.

Specifying the Cut Type

To specify the Cut Type, you must select one of the following options:

- Display cut
- Display elements

Display cut Option

When you select the Display cut option, GAMBIT displays a zero-thickness plane cut through the mesh—such as that shown in Figure 5-15. The plane cut shown in Figure 5-15 is located in the center of the ellipsoidal cylinder and is aligned with the y-z coordinate plane.

![Figure 5-15: Plane cut—Cut Type: Display cut option, y-z plane](image)

You can align the cutting plane with any of the three Cartesian coordinate planes by means of the Cut Orientation slider bars (see "Specifying the Cut Orientation," below).

Display elements Option

When you select the Display elements option, GAMBIT displays a region of the mesh defined with respect to the cutting plane. You can specify which region of the mesh is displayed by means of Display elements suboptions. The Display elements suboptions are as follows:

<table>
<thead>
<tr>
<th>Suboption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Displays elements that exist below the cutting plane</td>
</tr>
<tr>
<td>0</td>
<td>Displays elements that are intersected by the cutting plane</td>
</tr>
<tr>
<td>+</td>
<td>Displays elements that exist above the cutting plane</td>
</tr>
</tbody>
</table>

A set of radio buttons corresponding to the Display elements suboptions is located above the Cut Orientation slider bars in the lower section of the Examine Mesh form. To select a Display elements suboption, click its corresponding radio button.
Figure 5-16 and Figure 5-17 show the effect of the 9 and - suboptions, respectively, on the mesh display for the elliptical cylinder shown in Figure 5-14. In both figures, the cutting plane is centered in the cylinder and aligned with the y-z plane.

Figure 5-16: Plane cut—Cut Type: Display elements, y-z plane, Suboption (9)

Figure 5-17: Plane cut—Cut Type: Display elements, y-z plane, Suboption (-)

**Specifying the Cut Orientation**

To specify the Cut Orientation, you must specify the alignment and position of the cutting plane. The alignment and position specifications determine the following characteristics of the cutting plane:

- Alignment relative to the planes of the active coordinate system
- Location in the model domain

The alignment and position of the cutting plane are specified by means of the Cut Orientation slider bars located in the lower section of the Examine Mesh form (see above). There are three Cut Orientation slider bars, labeled X, Y, and Z.

GAMBIT allows you to align the cutting plane such that it is parallel to any one of the three coordinate planes of the active coordinate system. To orient the cutting plane, click the slider box corresponding to the axis that is normal to the desired coordinate plane. For example, to orient the reference plane such that it is parallel to the x-y coordinate plane (Figure 5-18), click the slider box labeled Z.
Figure 5-18: Plane cut—Cut Type: Display elements, x-y plane

To reposition the cutting plane in the model domain, left-drag the slider box to the left or right. When you left-drag the slider box, GAMBIT automatically updates the graphics window mesh display to reflect the current position of the box. To change the position of the cutting plane in increments, left-click the slider bar on either side of the slider box.

NOTE: If you activate a coordinate system other than the currently active system, GAMBIT automatically updates the orientation of the cutting plane with reference to the newly active system.

Sphere Option

When you select the Sphere option, GAMBIT displays a spherical cut through the mesh. To customize the spherical cut, you must specify two parameters:

- Cut Type
- Cut Orientation

The Cut Type specification determines whether GAMBIT displays a zero-thickness spherical shell or an array of mesh elements defined by their position with respect to the shell. The Cut Orientation specification allows you to position the center of the sphere and to specify the radius of the sphere.

Specifying the Cut Type

To specify the Cut Type, you must select one of the following options:

- Display cut
- Display elements

The spherical-cut Display cut and Display elements options produce effects similar to those of the corresponding plane-cut options but differ as outlined below.
Display cut Option

When you select the spherical-cut Display cut option, GAMBIT displays a zero-thickness spherical shell, such as that shown in Figure 5-19.

![Figure 5-19: Sphere cut — Cut Type: Display cut option](image)

The lines shown on the surface of the spherical cut represent lines of intersection between the sphere and either the mesh-element faces or the geometrical boundaries of the model components. You can position the sphere within the model domain and specify its radius by means of the Cut Orientation slider bars (see "Specifying the Cut Orientation," below).

Display elements Option

When you select the Display elements option, GAMBIT displays a region of the mesh defined relative to the cutting sphere. You can specify which region of the mesh is displayed by means of Display elements suboptions. The Display elements suboptions are as follows:

<table>
<thead>
<tr>
<th>Suboption</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>Displays elements that exist entirely outside the cutting sphere</td>
</tr>
<tr>
<td>0</td>
<td>Displays elements that are intersected by the cutting sphere</td>
</tr>
<tr>
<td>+</td>
<td>Displays elements that exist entirely inside the cutting sphere</td>
</tr>
</tbody>
</table>

A set of radio buttons corresponding to the Display elements suboptions is located above the Cut Orientation slider bars in the lower section of the Examine Mesh form. To select a Display elements suboption, click its corresponding radio button.

Figure 5-20, Figure 5-21, and Figure 5-22 show the effect of the -, 0, and + suboptions, respectively, on the mesh display for the elliptical cylinder shown in Figure 5-14. In each figure, the cutting sphere is located in the center of the cylinder, and its radius is that shown in Figure 5-19, above.

![Figure 5-20: Sphere cut — Cut Type: Display elements, Suboption (-)](image)
NOTE: When you select the Display elements option, GAMBIT displays only those elements that meet both the domain and element type specifications currently specified in the Display Type field on the Examine Mesh form. For example, if you select the Sphere option and specify the display of pyramidal elements only, GAMBIT displays only those mesh elements that are pyramidal in shape and are intersected by the specified cutting sphere. (See "Specifying the Element Type," below.)

**Specifying the Cut Orientation**

To specify the Cut Orientation, you must specify the position and radius of the cutting sphere. The position and radius of the cutting sphere are specified by means of the Cut Orientation slider bars located in the lower section of the Examine Mesh form (see above).

When you specify a Sphere cut, GAMBIT displays four Cut Orientation slider bars, labeled X, Y, Z, and R. The X, Y, and Z slider bars allow you to specify the position of the center of the sphere relative to the axes of the active coordinate system. The R slider bar allows you to specify the radius of the sphere.
Range Option

When you select the Range option, GAMBIT displays only those mesh elements the quality of which falls within a specified range with respect to a specified Quality Type criterion (see Figure 5-23).

Figure 5-23: Elliptical cylinder mesh—Range option

To display mesh elements by means of the Range option, you must specify the following parameters:

- Quality criterion
- Range

To specify the quality criterion, you must use the Quality Type option button located at the bottom of the Display Type field (see "Specifying the Quality Type," below). To define the range, you must specify its lower and upper limits by means of the range components located in the lower section of the Examine Mesh form (see below).

When you select the Range option, GAMBIT displays two types of range components on the Examine Mesh form:

- Histogram
- Lower and Upper limit slider bars

Histogram

The range histogram consists of a bar chart representing the statistical distribution of mesh elements with respect to the specified quality criterion. Each vertical bar on the histogram corresponds to a unique set of lower and upper quality limits. To display those elements the quality of which falls within the limits represented by any vertical bar on the histogram, left-click the corresponding bar.

Lower and Upper Limit Slider Bars

The Lower and Upper limit slider bars allow you to specify the lower and upper limits of the quality range that determines which elements are displayed in the graphics window. To specify the Lower or Upper limit of the range, left-drag the appropriate slider box to the desired location. To change the Lower or Upper limit of the range incrementally, left-click the appropriate slider bar on either side of the corresponding slider box.

► NOTE: If the Lower value is greater than the Upper value, GAMBIT simultaneously displays all elements with quality values less than the Upper value and all elements with quality values greater than the Lower value.
Figure 5-24: Plane cut, y-z plane—2D Element, Quad

Specifying the Quality Type

The quality-type specification defines the criterion that determines the following mesh display characteristics:

- Which elements are displayed by means of the domain Range option (see "Range Option," above)
- The coloration of elements for faceted mesh displays (see "Faceted Option," below.)

The following sections describe the quality types available in GAMBIT and the correspondence between quality types and the mesh element types described in the previous section.

Quality Type Definitions

GAMBIT provides the following mesh quality-type specifications:

- Area
- Aspect Ratio
- Diagonal Ratio
- Edge Ratio
- EquiAngle Skew
- EquiSize Skew
- MidAngle Skew
- Stretch
- Taper
- Volume
- Warpage

The following sections summarize the definitions and characteristics of each of the specifications listed above.

Area

The Area specification applies only to 2-D elements and represents mesh quality on the basis of element area.

Aspect Ratio

The Aspect Ratio applies to triangular, tetrahedral, quadrilateral, and hexahedral elements and is defined differently for each element type. The definitions are as follows.

Triangular and Tetrahedral Elements

For triangular and tetrahedral elements, the Aspect Ratio \( Q_{AR} \) is defined as:

\[
Q_{AR} = f \left( \frac{R}{r} \right)
\]

where \( f \) is a scaling factor, and \( r \) and \( R \) represent the radii of the circles (for triangular elements) or spheres (for tetrahedral elements) that inscribe and circumscribe, respectively, the mesh element. For triangular elements, \( f = 1/2 \); for tetrahedral elements, \( f = 1/3 \).
Using the Global Control Toolpad

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Specifying the Element Type

When you select the Display elements option, GAMBIT displays two-dimensional (face) and/or three-dimensional (volume) elements in the graphics window. GAMBIT allows you to customize the mesh display so that only specified types of elements are displayed. To specify the element type, you must specify two parameters:

- **Class**
- **Shape**

The class specification determines whether GAMBIT displays face elements or volume elements. The shape specification determines which element shapes are included in the set of displayed elements.

**Class**

For the purposes of displaying the mesh, there are two classes of elements:

- **2D Element**
- **3D Element**

Each class is associated with its own set of available element shapes (see below). To specify a class, left-click the class option button in the Display Type field and select either the 2D Element or 3D Element option.

**Shape**

When you select an element class, GAMBIT displays a set of options selector buttons that represent the element shapes available for the specified class. The option selector buttons are located at the right side of the class option button.

The following table shows the element shapes corresponding to each element class.

<table>
<thead>
<tr>
<th>Element Class</th>
<th>Shape</th>
<th>Selector Button</th>
</tr>
</thead>
<tbody>
<tr>
<td>2D Element</td>
<td>Quadrilateral</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Triangle</td>
<td></td>
</tr>
<tr>
<td>3D Element</td>
<td>Hexahedron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Tetrahedron</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Prism</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wedge</td>
<td></td>
</tr>
</tbody>
</table>

When you display mesh elements by means of the **Examine Mesh** form, GAMBIT displays only those elements the shapes of which match the current element-type specifications. For example, if you specify a plane cut according to the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class</td>
<td>3D Element</td>
</tr>
<tr>
<td>Shape</td>
<td>Hexahedron, Wedge</td>
</tr>
</tbody>
</table>

GAMBIT displays only those volume elements that meet both of the following criteria:

- Intersected by the specified plane
- In the shape of either a brick or a wedge

Similarly, if you specify a plane cut according to the following parameters:

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category</td>
<td>2D Element</td>
</tr>
<tr>
<td>Shape</td>
<td>Quad</td>
</tr>
</tbody>
</table>

GAMBIT displays only those face elements that are intersected by the specified plane and possess a quadrilateral shape (see Figure 5-24).
By definition,

\[ Q_{AR} \geq 1 \]

where \( Q_{AR} = 1 \) describes an equilateral element.

**Quadrilateral and Hexahedral Elements**

For quadrilateral and hexahedral elements, \( Q_{AR} \) is defined as:

\[ Q_{AR} = \frac{\max(e_1, e_2, ..., e_n)}{\min(e_1, e_2, ..., e_n)} \]

where \( e_i \) is the average length of the edges in a coordinate direction \((i)\) local to the element (see Figure 5-25) and \( n \) is the total number of coordinate directions associated with the element. For quadrilateral elements, \( n = 3 \); for hexahedral elements, \( n = 4 \).

![Figure 5-25: Aspect Ratio (Q_{AR})—quadrilateral element](image)

Again, by definition,

\[ Q_{AR} \geq 1 \]

where \( Q_{AR} = 1 \) describes an equilateral element.

**Diagonal Ratio**

The Diagonal Ratio \( (Q_{DiR}) \) applies only to quadrilateral and hexahedral elements and is defined as follows:

\[ Q_{DiR} = \frac{\max(d_1, d_2, ..., d_n)}{\min(d_1, d_2, ..., d_n)} \]

where the \( d_i \) are the lengths of the element diagonals. For quadrilateral elements, \( n = 2 \); for hexahedral elements, \( n = 4 \).

By definition,

\[ Q_{DiR} \geq 1 \]

The higher the value of \( Q_{DiR} \), the less regularly shaped is its associated element. For square quadrilateral elements and cubic hexahedral elements, \( Q_{DiR} = 1 \).

**Edge Ratio**

The Edge Ratio \( (Q_{Edr}) \) is defined as follows:

\[ Q_{Edr} = \frac{\max(s_1, s_2, ..., s_n)}{\min(s_1, s_2, ..., s_n)} \]

where \( s_i \) represents the length of the element edge \( i \), and \( n \) is the total number of edges associated with the element.

By definition,

\[ Q_{Edr} \geq 1 \]

The higher the value of \( Q_{Edr} \), the less regularly shaped is its associated element. For equilateral element shapes, \( Q_{Edr} = 1 \).

**EquiAngle Skew**

The EquiAngle Skew \( (Q_{EAS}) \) is a normalized measure of skewness that is defined as follows:

\[ Q_{EAS} = \max \left\{ \frac{\theta_{max} - \theta_{min}}{180 - \theta_{min}}, \frac{\theta_{max} - \theta_{min}}{\theta_{min}} \right\} \]
where \( \theta_{ma} \) and \( \theta_{m} \) are the maximum and minimum angles (in degrees) between the edges of the element, and \( \theta_{e} \) is the characteristic angle corresponding to an equilateral cell of similar form. For triangular and tetrahedral elements, \( \theta_{e} = 60 \). For quadrilateral and hexahedral elements, \( \theta_{e} = 90 \).

By definition,

\[
0 \leq Q_{EAS} \leq 1
\]

where \( Q_{EAS} = 0 \) describes an equilateral element, and \( Q_{EAS} = 1 \) describes a completely degenerate (poorly shaped) element.

**NOTE:** For pyramidal mesh elements, \( Q_{EAS} \) is equal to its maximum value for any of the five faces of the mesh element. In an ideal pyramidal mesh element, all four triangular faces are equilateral and the base of the pyramid is a square.

Table 5-1 outlines the overall relationship between \( Q_{EAS} \) and element quality.

<table>
<thead>
<tr>
<th>( Q_{EAS} )</th>
<th>Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>( Q_{EAS} = 0 )</td>
<td>Equilateral (Perfect)</td>
</tr>
<tr>
<td>( 0 &lt; Q_{EAS} \leq 0.25 )</td>
<td>Excellent</td>
</tr>
<tr>
<td>( 0.25 &lt; Q_{EAS} \leq 0.5 )</td>
<td>Good</td>
</tr>
<tr>
<td>( 0.5 &lt; Q_{EAS} \leq 0.75 )</td>
<td>Fair</td>
</tr>
<tr>
<td>( 0.75 &lt; Q_{EAS} \leq 0.9 )</td>
<td>Poor</td>
</tr>
<tr>
<td>( 0.9 &lt; Q_{EAS} &lt; 1 )</td>
<td>Very poor (sliver)</td>
</tr>
<tr>
<td>( Q_{EAS} = 1 )</td>
<td>Degenerate</td>
</tr>
</tbody>
</table>

In general, high-quality meshes contain elements that possess average \( Q_{EAS} \) values of 0.1 (2-D) and 0.4 (3-D).

---

**EquiSize Skew**

The EquiSize Skew \( Q_{EVS} \) is a measure of skewness that is defined as follows:

\[
Q_{EVS} = \frac{(S_{eq} - S)}{S_{eq}}
\]

where \( S \) is the area (2-D) or volume (3-D) of the mesh element, and \( S_{eq} \) is the maximum area (2-D) or volume (3-D) of an equilateral cell the circumscribing radius of which is identical to that of the mesh element.

By definition,

\[
0 \leq Q_{EVS} \leq 1
\]

where \( Q_{EVS} = 0 \) describes an equilateral element, and \( Q_{EVS} = 1 \) describes a completely degenerate (poorly shaped) element.

The relationship between \( Q_{EAS} \) and mesh quality shown in Table 5-1, above, applies to values of \( Q_{EVS} \), as well. In general, high-quality meshes contain elements that possess average \( Q_{EVS} \) values of 0.1 (2-D) and 0.4 (3-D).

**NOTE:** The EquiSize Skew quality metric applies only to triangular and tetrahedral elements. If you select the EquiSize Skew quality metric, and the mesh contains elements other than triangles and tetrahedra, GAMBIT evaluates the non-triangular and non-tetrahedral elements using the EquiAngle Skew quality metric.

**MidAngle Skew**

The MidAngle Skew \( Q_{MAS} \) applies only to quadrilateral and hexahedral elements and is defined by the cosine of the maximum angle (\( \Theta \)) formed between the bisectors of the element edges (quadrilateral) or faces (hexahedral) (see Figure 5-26).
For quadrilateral elements,\[ Q_{MAS} = \cos \theta \]

For hexahedral elements,\[ Q_{MAS} = \max[\cos \theta_1, \cos \theta_2, \cos \theta_3] \]

where \( \theta_1, \theta_2, \) and \( \theta_3 \) are the three angles computed from the face-bisecting lines of the element.

By definition,\[ 0 \leq Q_{MAS} \leq 1 \]

where \( Q_{MAS} = 0 \) describes an equilateral element, and \( Q_{MAS} = 1 \) describes a completely degenerate (poorly shaped) element.

**Stretch**

The Stretch quality metric \( (Q_s) \) applies only to quadrilateral and hexahedral elements and is defined as follows:

\[ Q_s = 1 - \frac{K \min(s_1, s_2, \ldots, s_n)}{\max(d_1, d_2, \ldots, d_m)} \]

where \( d_i \) is the length of diagonal \( i \), \( s_j \) is the length of the element edge \( j \), and \( n \) and \( m \) are the total numbers of diagonals and edges, respectively. For quadrilateral elements, \( n = 2 \), \( m = 4 \), and \( K = 2 \); for hexahedral elements, \( n = 4 \), \( m = 12 \), and \( K = 3 \).
Using the Global Control Toolpad

THE GAMBIT GUI

Each vector, \( \mathbf{T} \), can be resolved into components, \( \mathbf{T}_x \), that are parallel to the bisectors of the mesh element. For quadrilateral elements, there are two such components for each vector; for hexahedral elements, there are three. The \( \text{Taper} \) quality metric \( (Q_T) \) is defined as the normalized maximum of all such components for the element.

By definition,

\[
0 \leq Q_T \leq 1
\]

where \( Q_T = 0 \) describes an equilateral element, and \( Q_T = 1 \) describes a completely degenerate (poorly shaped) element.

**Volume**

The Volume specification applies only to 3-D elements and represents mesh quality in terms of mesh element volumes.

**Warpage**

The Warpage \( (Q_w) \) applies only to quadrilateral elements and is defined as follows:

\[
Q_w = \frac{Z}{\min(a,b)}
\]

where \( Z \) is the deviation from a best-fit plane that contains the element, and \( a \) and \( b \) are the lengths of the line segments that bisect the edges of the element.

By definition,

\[
0 \leq Q_w \leq 1
\]

where \( Q_w = 0 \) describes an equilateral element, and \( Q_w = 1 \) describes a completely degenerate (poorly shaped) element.

**Element Types vs. Quality Types**

Each element type is associated with a unique set of available quality types. Table 5-2 summarizes the correspondence between mesh element types and the quality types described above. (Shaded boxes in the table represent quality types that are available for each corresponding element type.)

---

### Table 5-2: Mesh element type vs. quality type

<table>
<thead>
<tr>
<th>Element Type</th>
<th>2-D Element</th>
<th>3-D Element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality Type</td>
<td>![Quality Type Buttons]</td>
<td>![Quality Type Buttons]</td>
</tr>
<tr>
<td>Area</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Aspect Ratio</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Diagonal Ratio</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Edge Ratio</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>EquiAngle Skew</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>EquiSize Skew</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>MidAngle Skew</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Stretch</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Taper</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Volume</td>
<td>![X]</td>
<td>![X]</td>
</tr>
<tr>
<td>Warpage</td>
<td>![X]</td>
<td>![X]</td>
</tr>
</tbody>
</table>

To specify a quality type, click the **Quality Type** option button and select the quality type from the option menu.

**NOTE:** The **Quality Type** option menu includes only those quality types that are common to all currently selected element types. For example, if you specify the element type to include only 2D Element rectangles, the **Quality Type** option menu includes all quality types except **Volume**. If you specify the element type to include both of the 2D Element shapes (rectangles and triangles), the **Quality Type** option menu includes only six options: **Area**, **Aspect Ratio**, **Edge Ratio**, **EquiAngle Skew**, **EquiSize Skew**, and **MidAngle Skew**.
Specifying the Display Mode

Display Mode specifications determine the appearance of the mesh display. To specify the display mode, you must specify the following parameters:

- Enabled quadrants
- Appearance

The quadrant specification determines which graphics window quadrants are affected by the current specifications on the Examine Mesh form. The appearance specification determines the manner in which the mesh elements are displayed in each enabled quadrant.

Specifying the Enabled Quadrants

The quadrant specification field consists of a set of five command buttons that are identical to the quadrant command buttons used to enable and disable general graphics operations in each of the quadrants. For a description of the use of quadrant command buttons, see Section 5.4.1, above.

Specifying the Appearance

GAMBIT provides the following options with respect to the appearance of the displayed mesh:

- Wire
- Faceted

The Wire option specifies that GAMBIT displays a wireframe view of the mesh. The Faceted option specifies that GAMBIT renders the mesh display in either a colored, shaded, or hidden view. Neither option is exclusive of the other.

Wire Option

When you select the Wire option, GAMBIT displays all lines corresponding to the edges of all displayed mesh elements.

Faceted Option

When you select the Faceted option, GAMBIT renders all displayed mesh elements to illustrate their shape, location, and/or quality characteristics. There are three Faceted rendering suboptions, each of which is mutually exclusive of the others:

- Quality
- Shade
- Hidden

Quality Suboption

When you select the Quality suboption, GAMBIT renders the faces of all displayed mesh elements as follows:

- Color to represent the quality of the element with respect to the currently specified quality criterion as displayed on the scale at the bottom of the Examine Mesh form (see “Specifying the Quality Type,” above)
- Shade to reflect the position of the face with respect to the light source

If you rotate the model by means of the mouse, the colors of the element faces change to reflect changes in the position of each element face with respect to the light source. (For a description of the procedures and specifications required to modify the position and brightness of the light source, see “Modify Lights,” above.)

Shade Suboption

When you select the Shade suboption, GAMBIT renders the faces of all displayed mesh elements in shades of gray to reflect the position of each face with respect to the light source.

Hidden Suboption

When you select the Hidden suboption, GAMBIT displays a wireframe view of the mesh but hides all lines that are concealed behind displayed mesh element faces.
Using the Examine Mesh Form

The Examine Mesh form allows you to specify the type of mesh elements displayed and the display mode for those elements. It includes the following specifications:

**Display Type:**

- **Plane** displays a plane cut through the mesh. The cut can represent either a zero-thickness plane or mesh elements defined in relation to those intersected by the plane (see "Plane Option," above).

- **Sphere** displays a spherical cut through the mesh. The cut can represent either a zero-thickness spherical shell or mesh elements defined in relation to those intersected by the shell (see "Sphere Option," above).

- **Range** displays all mesh volume elements possessing quality values within a specified range for one of several available mesh quality criteria (see "Range Option," above).

**3D Element** specifies the class of elements to be displayed. Element classes include face elements (2D Element) and volume elements (3D Element).

**2D Element** specifies 2D Element shapes.

- **Wire** specifies 3D Element shapes.

**Quality Type:**

allows you to specify the quality criterion that determines which elements are displayed by means of the Range option and the coloration of elements for faceted mesh displays. (See "Specifying the Quality Type," above.)

**Display Mode:**

allows you to specify the display mode for changes in mesh display. Changes made by means of the Examine Mesh form are applied only to enabled quadrants.

- **Wire** specifies a wireframe view of the displayed mesh elements.

- **Faceted** specifies a faceted rendering of all displayed mesh element faces.

**Faceting Type:**

colors each mesh element face to represent its quality and shades each mesh element face to reflect its current position with respect to the light source. (NOTE: Element colors change slightly when you reorient the model.)

- **Shade** shades the mesh elements to create a three-dimensional rendering of the mesh.

- **Hidden** displays a wireframe view of the model but hides all lines that are concealed behind other elements in the current mesh specification and orientation.
Cut Type:

- Display Cut
  displays a zero-thickness planar or spherical cut through the mesh.

- Display Elements
  displays elements defined in relation to the plane or spherical shell.

Cut Orientation

contains slider bars that allow you to specify the orientation of a plane cut or the radius and location of the center of a spherical cut. The Cut Orientation field also includes radio buttons that allow you to specify the region of elements to be displayed by means of the Display elements option.

Plane Cut Slider Bars

The plane-cut slider bars (see below) allow you to change the position of the cut plane in the x (X), y (Y), and z (Z) directions.

To change the location of the cut plane, left-click one of the slider boxes and drag it to a new location on its slider bar. GAMBIT repositions the plane according to the final position of the slider box.

The plane-cut sliders also allow you to change the orientation of the cut plane with respect to the coordinate planes. The X, Y, and Z sliders orient the cut plane perpendicular to the x, y, or z coordinate planes, respectively, of the active coordinate system. To change the orientation of the cut plane, left-click the appropriate slider.

Spherical Cut Slider Bars

The spherical-cut slider bars allow you to change the location of the center of the cutting sphere in the x (X), y (Y), and z (Z) directions and to specify the radius (R) of the sphere.

To change the location of the sphere center, left-click one of the X, Y, or Z slider boxes and drag it to a new location on the slider bar. To change the sphere radius, left-click the R slider box and drag it to its new location.

Display Elements Suboption Radio Buttons

When you select the Display Elements option (see above), GAMBIT displays three radio buttons above the Cut Orientation slider bars. The radio buttons allow you to specify the region of mesh elements to be displayed.

The options specified by means of the radio buttons are as follows.

<table>
<thead>
<tr>
<th>Option</th>
<th>Plane Cut</th>
<th>Spherical Cut</th>
</tr>
</thead>
<tbody>
<tr>
<td>-</td>
<td>negative coordinate direction</td>
<td>outside</td>
</tr>
<tr>
<td>0</td>
<td>intersection</td>
<td>intersection</td>
</tr>
<tr>
<td>+</td>
<td>positive coordinate direction</td>
<td>inside</td>
</tr>
</tbody>
</table>

For both the plane-cut and spherical-cut options, the 0 option specifies that only those elements intersected by the specified plane or spherical shell are displayed.

For plane cuts, the - and + options display all elements located in the negative and positive coordinate directions, respectively, relative to the elements intersected by the plane. For spherical cuts, the - and + options specify the display of elements inside and outside, respectively, those elements intersected by the spherical shell.
5.5 Help Menu

The Help command allows you to access online documentation by means of the local web browser and to display information on the current version of the program. When you click Help on the menu bar, GAMBIT opens the Help command menu. The Help command menu includes the following options:

- Quick
- Table of Contents
- About

The Quick option accesses context-sensitive online help. The Table of Contents option allows you to browse the entire suite of GAMBIT documentation by means of a hyperlinked table of contents. The About option displays information regarding the currently running version of GAMBIT.

5.5.1 Quick

When you select Quick from the Help menu, GAMBIT changes the appearance of the cursor to represent a hand with a pointing finger. To access the online documentation associated with any component currently displayed on the GUI, left-click on the component. When you do so, GAMBIT launches the local web browser and opens and displays documentation associated with the component. For example, to view documentation related to a currently open specification form, such as the Create Real Brick form, perform the following operations.

<table>
<thead>
<tr>
<th>Step</th>
<th>Location</th>
<th>Action</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Main menu bar</td>
<td>Click Help</td>
<td>Opens the Help command menu</td>
</tr>
<tr>
<td>2</td>
<td>Help command menu</td>
<td>Click Quick</td>
<td>Selects the context-sensitive help option</td>
</tr>
<tr>
<td>3</td>
<td>Create Real Brick specification form</td>
<td>Click anywhere on the form</td>
<td>Launches the local browser (or accesses any currently open browser) and opens the file containing documenta- tion pertaining to the form</td>
</tr>
</tbody>
</table>

5.5.2 Table of Contents

When you select Table of Contents from the Help menu, GAMBIT launches the local web browser and opens a file that constitutes a hyperlinked table of contents for the entire GAMBIT documentation suite. To locate a subject of interest in the GAMBIT online help document, use the hyperlinked table of contents to navigate through GAMBIT online documentation.

5.5.3 About

When you select the About option from the Help menu, GAMBIT opens a form that displays information related to the currently running version of the program (see below).
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