



A Siemens Business

MagNet

Getting Started Guide

Software Version 7.9

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MagNet
Getting Started Guide

Chapter 1 – Welcome to MagNet

Welcome

MagNet provides state-of-the art visualization to help you easily build 2D and 3D models for magnetostatic, time-harmonic, transient or transient with motion analysis. Infolytica's leading edge technologies transparently generate the finite element mesh and quickly provide accurate field solutions.

The structures which can be simulated with MagNet include:

- Machines: DC, universal, 3-phase IM
- Actuators
- Solenoids
- Loudspeakers
- Transformers
- Sensors
- Recording heads

Learning MagNet

Your MagNet documentation package consist of this Getting Started Guide and a set of Tutorials in an electronic media format (i.e. PDF files), and also includes a comprehensive Help system.

Getting Started Guide	Tutorials
<ul style="list-style-type: none">• Installation instructions (please refer to MagNet_7_9_install.pdf)• Introduction to modeling	<ul style="list-style-type: none">• Magnetostatic, Time-harmonic, and Transient 2D and 3D tutorials

Additional help is available by visiting the Mentor Support website:

- Mentor Infolytica Resources (Knowledge Base articles)
<https://support.mentor.com/knowledge-base/MG601540>

Additional information

More information on the procedures and concepts of model building with MagNet is found in the Help included with each package.

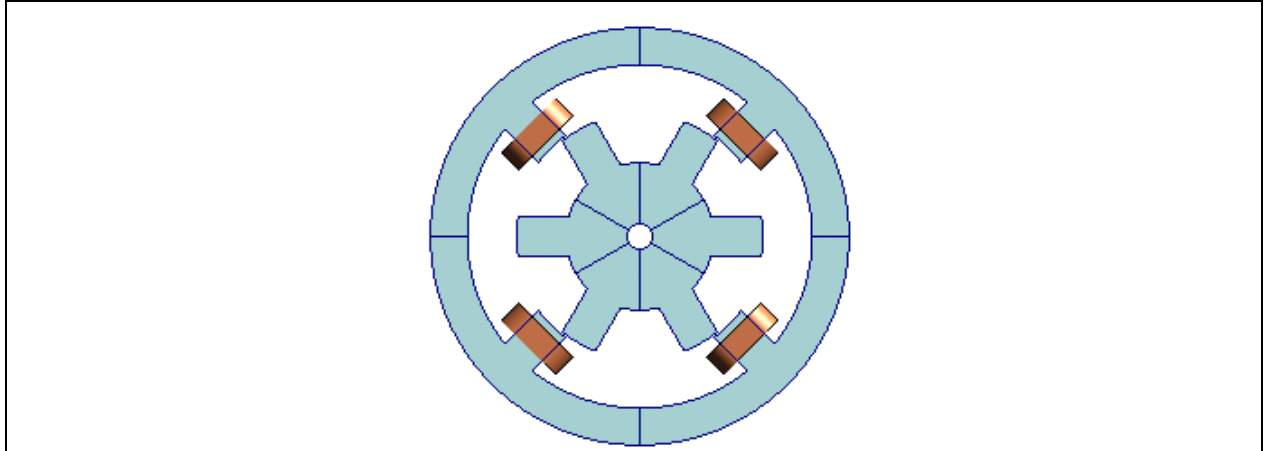
Note The MagNet Help menu provides easy access to the PDF versions of this Getting Started Guide and the Tutorials.

MagNet
Getting Started Guide

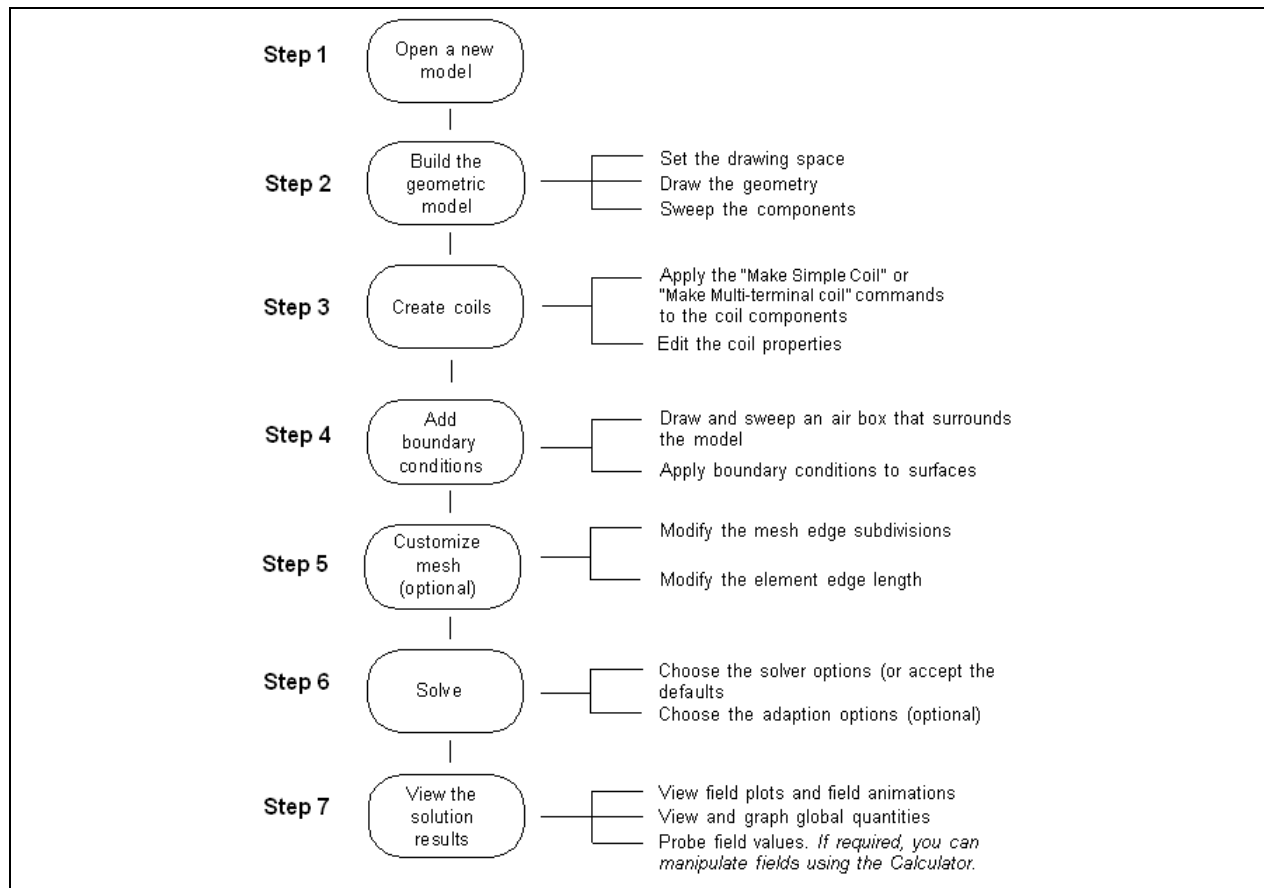
Chapter 2 – Model building with MagNet

Introduction to model building

A MagNet model is made from a geometric model to which boundary conditions and excitations are assigned. After the model is solved, field plots and numerical results are available for viewing. The finite element mesh of the model can be customized to increase solution accuracy.



Modeling flowchart



Geometric modeling

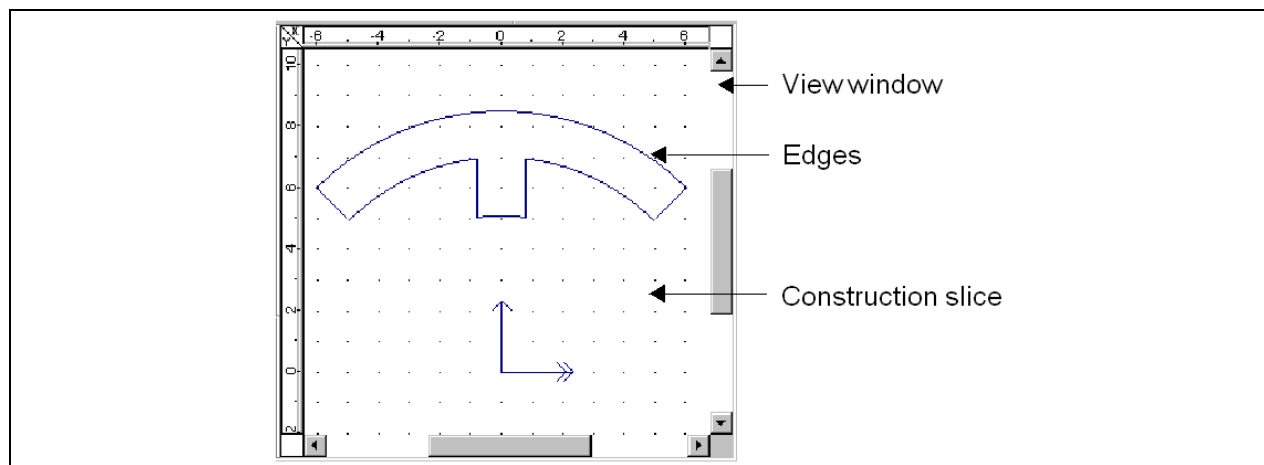
A MagNet model is made from geometry to which materials, boundary conditions, and excitations are assigned.

The geometric model is constructed from three basic building blocks:

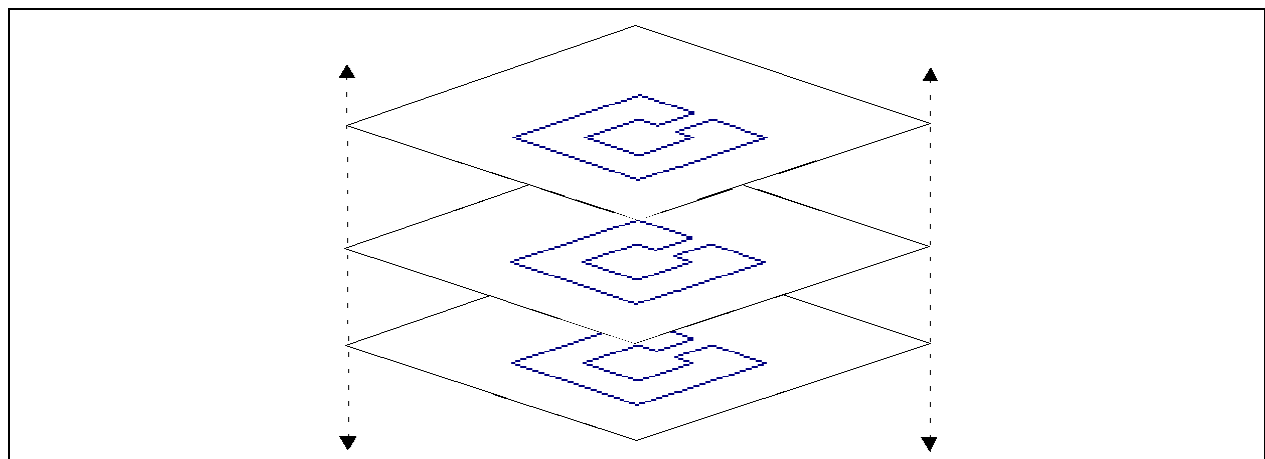
- Edges
- Surfaces
- Components

Edges

Edges are lines and arcs. They are drawn on the construction slice in the View window.

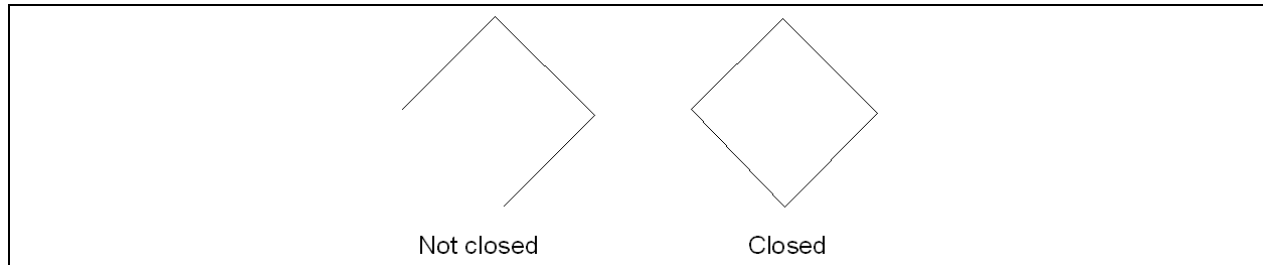


The construction slice is a two-dimensional editing plane that can be moved forward and backward in space. Edges drawn on the construction slice move with the slice and remain in view until they are intentionally removed by the user.



Surfaces

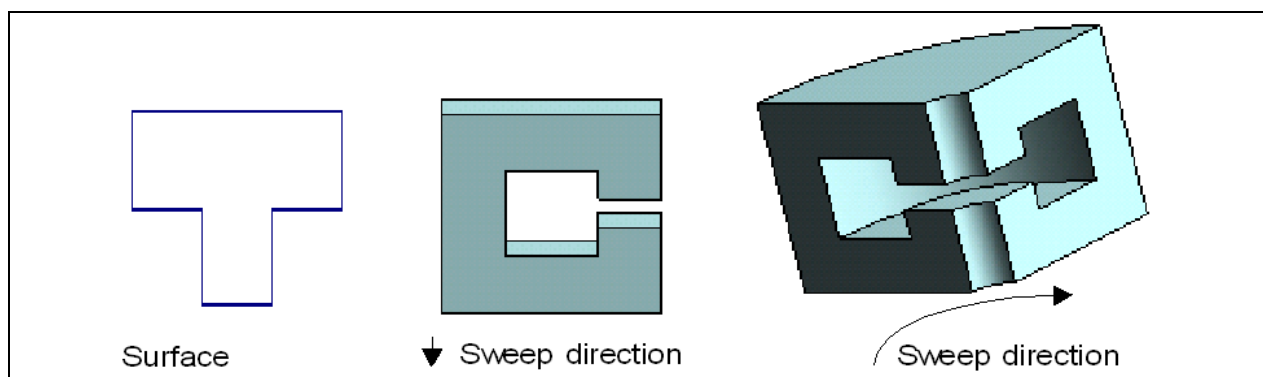
Edges are drawn to create surfaces. Surfaces are swept to create three-dimensional components. A surface must be “closed” before it can be swept to create a component.



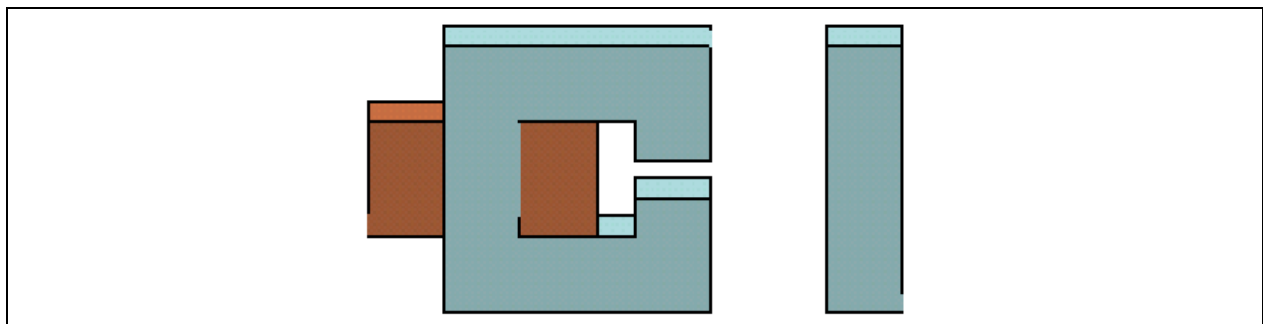
Components

Components can be swept in a positive or negative direction:

- For an arbitrary length
- In a circular arc through any angle

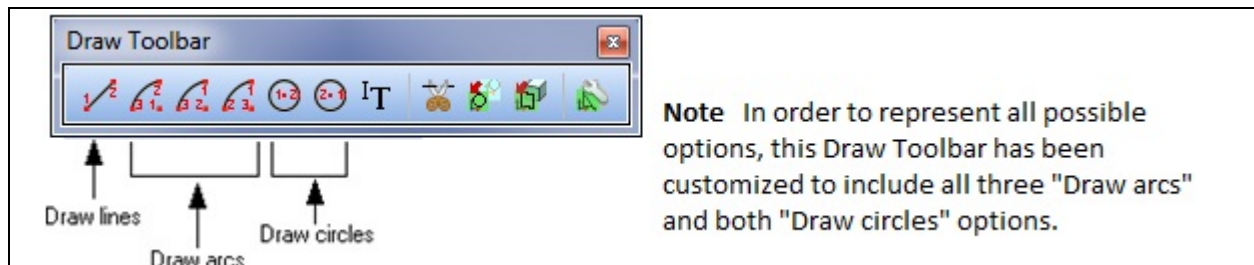


By drawing and sweeping surfaces, additional components are added to form an entire model.



Drawing edges

Edges are drawn using the Draw toolbar and either the mouse pointer or the Keyboard Input bar. You can draw lines, arcs, or circles.



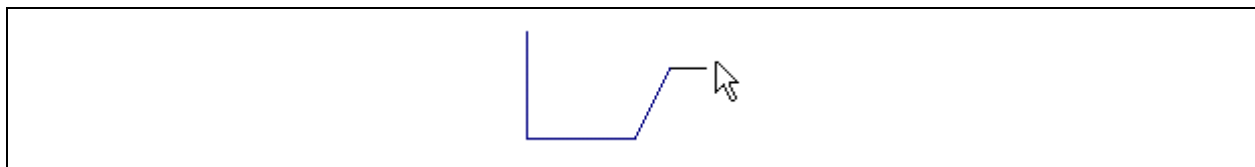
Edges are drawn on the construction slice.

Note Edges are saved with the model even if the user has not swept the geometry before closing.

Lines

Using the mouse pointer

Lines are drawn as polylines. That is, line drawing is continuous until you press ESC or double-click the mouse.



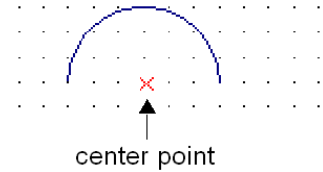
Using the Keyboard Input bar

Lines are entered as coordinate PAIRS. The last coordinate PAIR entered becomes the start coordinate PAIR of the next line. To stop drawing, or to begin a new line, press ESC on your keyboard.






Arcs

Note When drawing an arc using the mouse pointer or keyboard, ElecNet automatically adjusts the end point to have the same radius from the center point as does the start point.



Using the mouse pointer to draw an arc

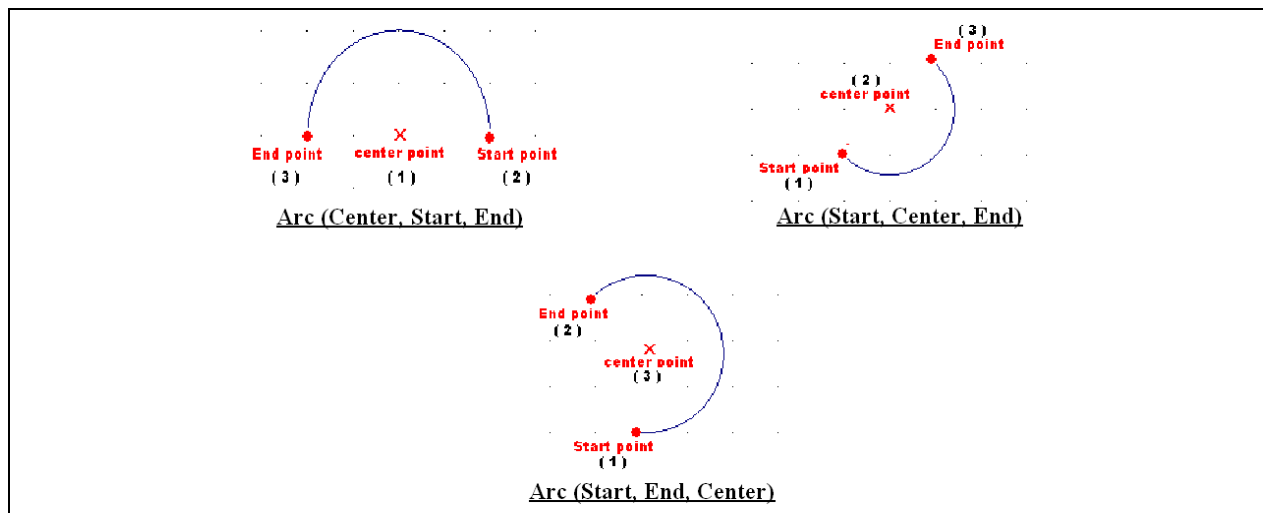
Three different methods exist, when using the mouse pointer, for drawing arcs in ElecNet.

- Arc (Center, Start, End) 
- Arc (Start, Center, End) 
- Arc (Start, End, Center) 

Note Arcs are drawn in a counter-clockwise direction.

Holding the Ctrl key down, while drawing the arc, inverts the direction of the arc. The arc is still created counter-clockwise; it is only the start and end points that are inverted.

A “rubber-band” line follows the movement of the mouse pointer.

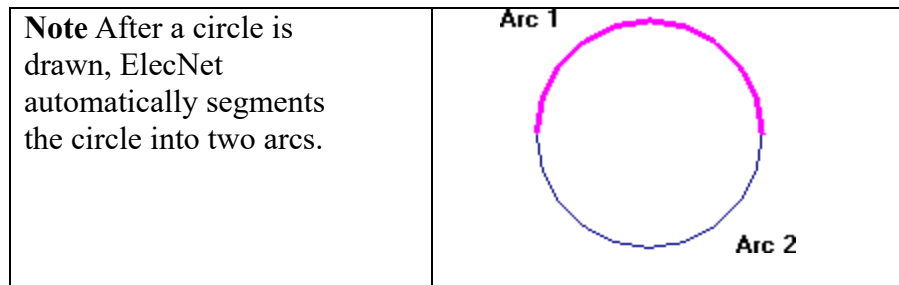


Using the Keyboard Input bar to draw an arc

Arcs are drawn by entering three coordinates, in the order that corresponds to one of the three chosen methods (see above for reference):



- Center point, Start point, End point
- Start point, Center point, End point
- Start point, End point, Center point

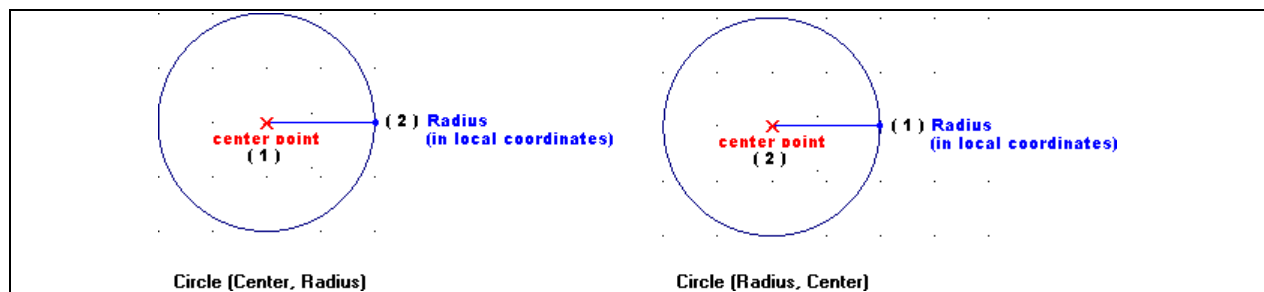
Circles



Using the mouse pointer to draw a circle

Two different methods exist, when using the mouse pointer, for drawing circles in ElecNet.

- Circle (Center, Radius) 
- Circle (Radius, Center) 



Note A “rubber-band” line follows the movement of the mouse pointer.

Using the Keyboard Input bar to draw a circle

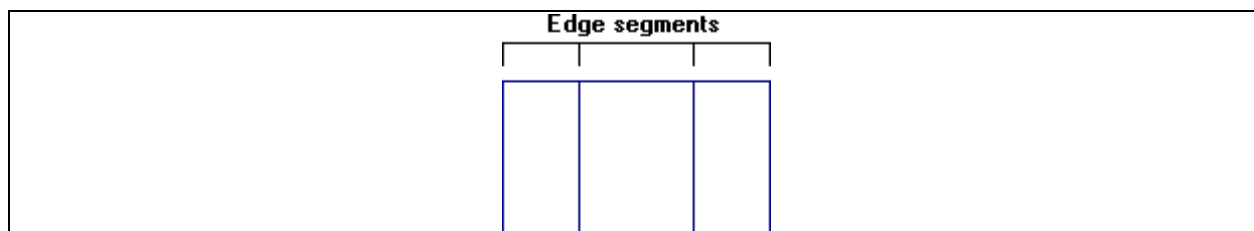
Circles are drawn by entering two coordinates, in the order that corresponds to one of the two chosen methods (see above for reference):

- Center point, Point on the radius of the circle
- Point on the radius of the circle, Center point



Segmenting edges

Edges are not automatically segmented at the point of intersection with other edges. Only when the user has selected the specific edges, and then clicked Segment Edges on the Model menu, do the lines segment.



Snap modes

The snap modes control the location of entry points made with the mouse pointer. There are seven snap modes: Grid, Endpoint, Intersection, Nearest, Center, Tangent, and Perpendicular.

None	Points appear exactly where the mouse pointer clicks in the display.
Grid	Snaps to the nearest grid point.
Endpoint	Snaps to the nearest endpoint of existing edges.
Intersection	Snaps to the nearest endpoint of existing edges or the intersection between existing edges.
Nearest	Snaps to the nearest point on existing edges – any point.
Center	Snaps to the nearest existing arc center.
Tangent	Snaps to the nearest point on Construction Slice, where edge being drawn becomes tangent.
Perpendicular	Snaps to the nearest point on Construction Slice, where edge being drawn becomes perpendicular.

Note *Tangent* and *Perpendicular* snap modes behave like *None* for the first point of an edge because a point alone cannot be tangent or perpendicular.

A line being drawn may also become tangent or perpendicular at its first point, if this point resides anywhere on an existing edge. Hence, using *Endpoint* for the first point, and *Tangent* or *Perpendicular* for the second point, allows prolonging an existing line or drawing a line perpendicular to it.

The snap mode stays in effect until a new snap mode is selected. Select *None* from the *Draw menu* to turn off the snap mode.

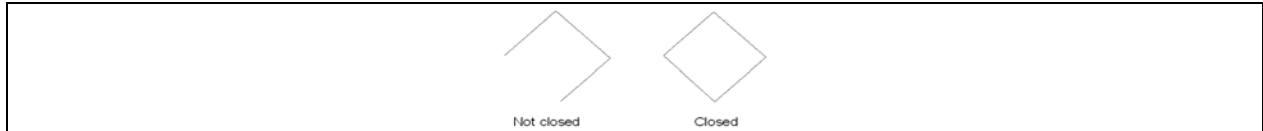
Creating surfaces

Surfaces are the basis of 3D components. Surfaces are 2D regions formed by:

- Edges drawn on the construction slice
- 2D faces of 3D components

Construction slice surfaces

Surfaces drawn on the construction slice must be “closed” before they can be selected.

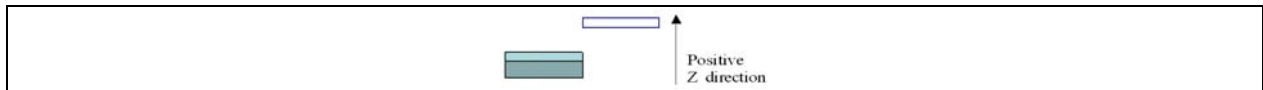


After a surface has been made into a component, the edges of the surface are duplicated in the component. The original edges remain on the construction slice.

Note To remove the construction slice edges, select all of the edges and then click *Delete* on the Edit menu.

Moving edges with the construction slice

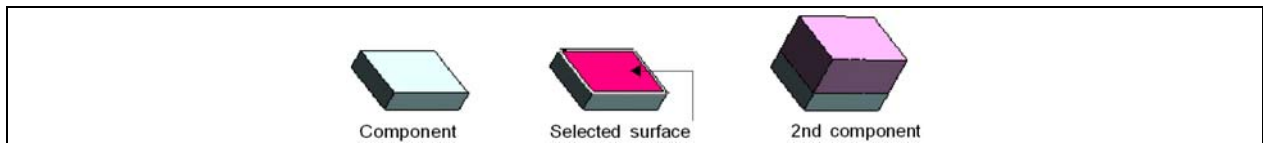
Edges can only exist on the construction slice. If the construction slice is repositioned, all edges move with the construction slice. For example, in the diagram below, the construction slice, with edges, has been moved 2 meters in the positive Z direction.



Note Edges on the construction slice are saved with the model.

Component surfaces

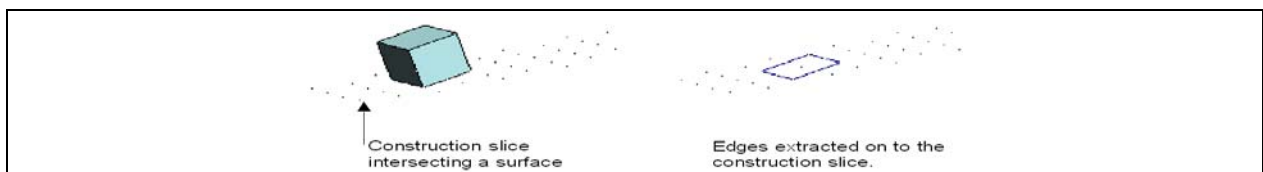
Components can also be created from the 2D surfaces of other components.



Extracting edges

After a surface has been made into a component, the edges of the surface are duplicated in the component. You can copy the edges of a component’s surface to the construction slice using the Extract Edges command.

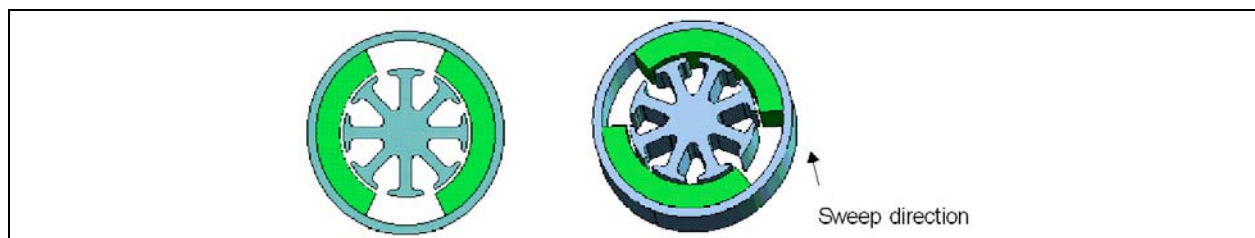
Note The construction slice must intersect the surface.



Creating components

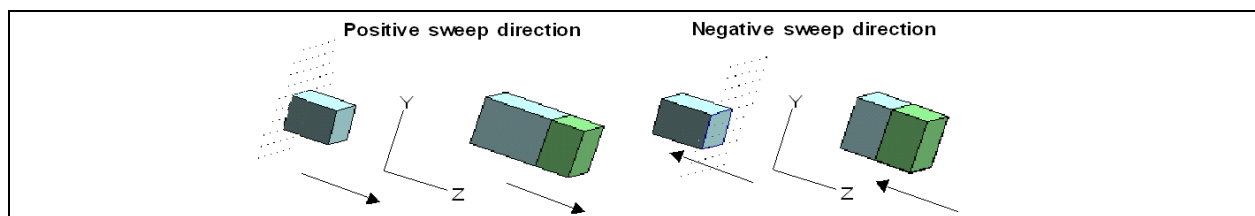
Components are created from surfaces (see “Creating surfaces” on page 9) or using the CSG Modeling technique (see page 12). Components can be swept in either a linear or rotational direction.

Note When using the Extrusion modeler, all the components of the model, except for coil components, must be swept in the same linear or rotational direction.



Default sweep direction

The default sweep direction for a component is positive (sweeping out of the construction slice or out from the surface of a component).

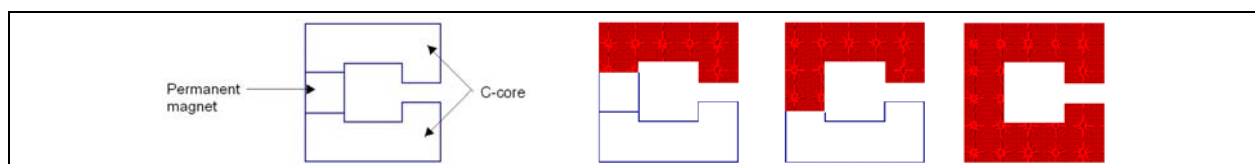


Creating multiple components simultaneously

More than one surface can be selected to create a component.

Note When multiple components are created simultaneously, all components share the same material and sweep distance. You can later change the properties of any component in the Component property and parameter pages.

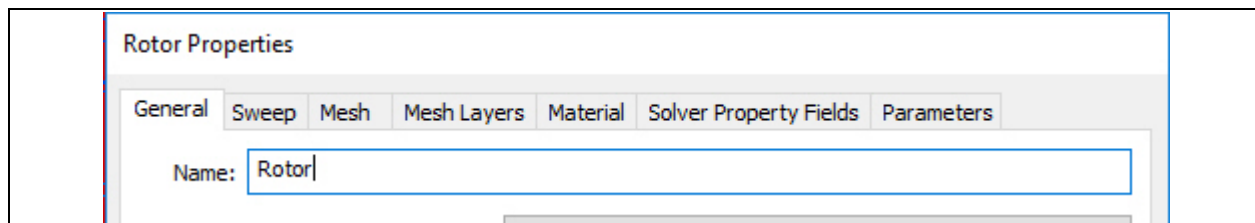
In the C-core model below, three surfaces exist. One surface is for the permanent magnet, and the other two surfaces form the C-core. You can sweep all three surfaces at the same time. To select all three surfaces, hold down the SHIFT key while selecting each surface. After all the surfaces are selected, you can use the Make Component tool.



Tip When you press SHIFT or CTRL as you select objects, every object you click on remains selected. Pressing CTRL as you select objects also enables you to click on an object a second time to de-select the object.

Changing component properties

The properties of a component are changed in the Component Properties dialog, which consists of six pages (General, Sweep, Mesh, Mesh Layers, Material, and Parameters).

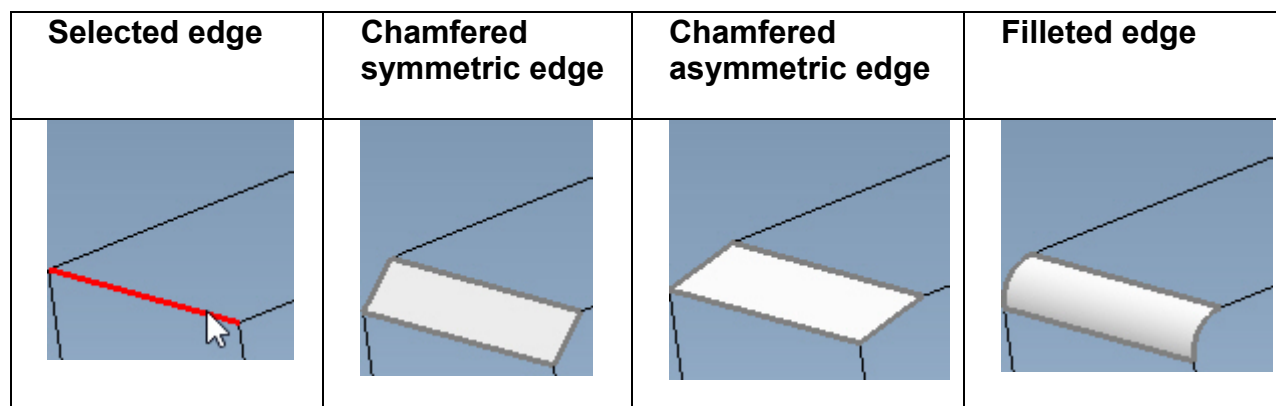


You can change the following properties:

- Name
- Polynomial order (3D models only)
- Initial Temperature
- Enable/Disable the component
- Sweep distance
- Material
- Material direction
- Maximum element size
- Curvature Refinement minimum element size
- Curvature Refinement angle
- Mesh Layer type (Uniform, Logarithmic, User-defined)
- Parameters for:
 - Position of the starting surface of the component
 - Geometric position
 - Angle of the start and end surfaces (3D models only)
 - etc.

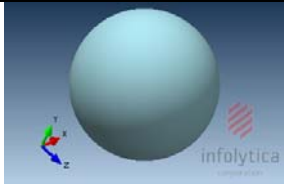
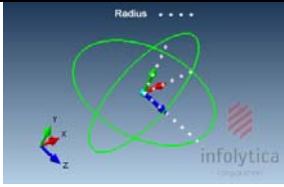
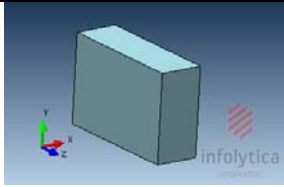
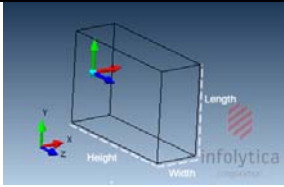
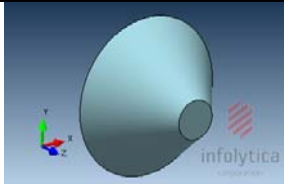
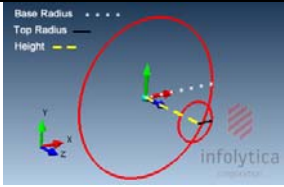
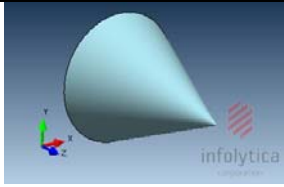
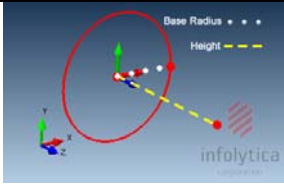
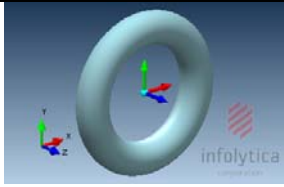
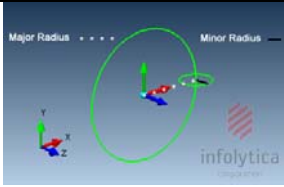
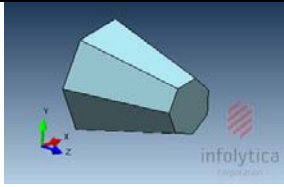
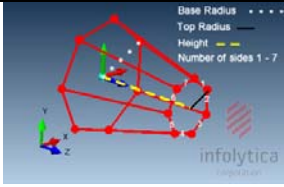
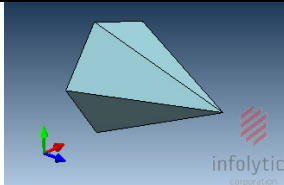
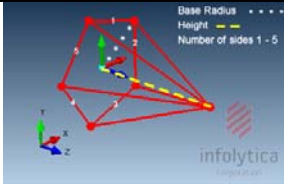
Modifying component edges (chamfer or fillet)

This feature allows you to modify your model at the component level by selecting an edge, or edges, and transforming them to a chamfer or rounded edge.



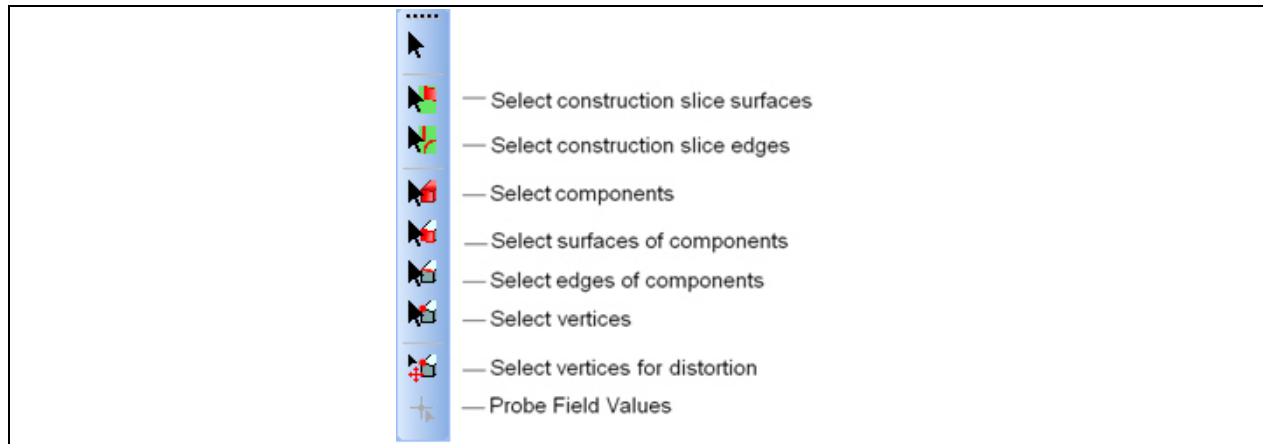
Creating components using the CSG Modeling technique

Various shapes and forms can easily be created using a modeling technique known as Constructive Solid Geometry, or CSG.

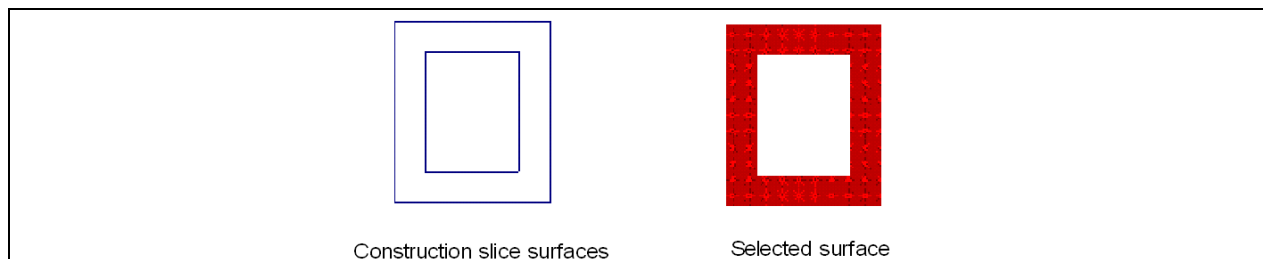
Sphere		
Rectangular Block		
Cylinder		
Cone		
Torus		
Prism		
Pyramid		

Selecting edges, surfaces, and components

Objects are selected with the mouse pointer using one of the selection tools on the Edit menu or Selection toolbar, or by creating a selection box.

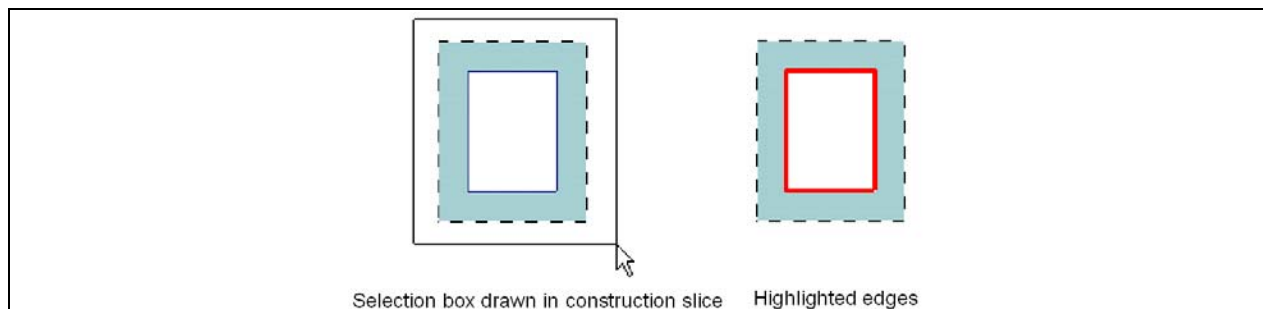


An object must be selected before a property or action can be applied to it. For example, a construction slice surface must be selected before it can be made into a component. The object is highlighted when it is selected.



Selection box

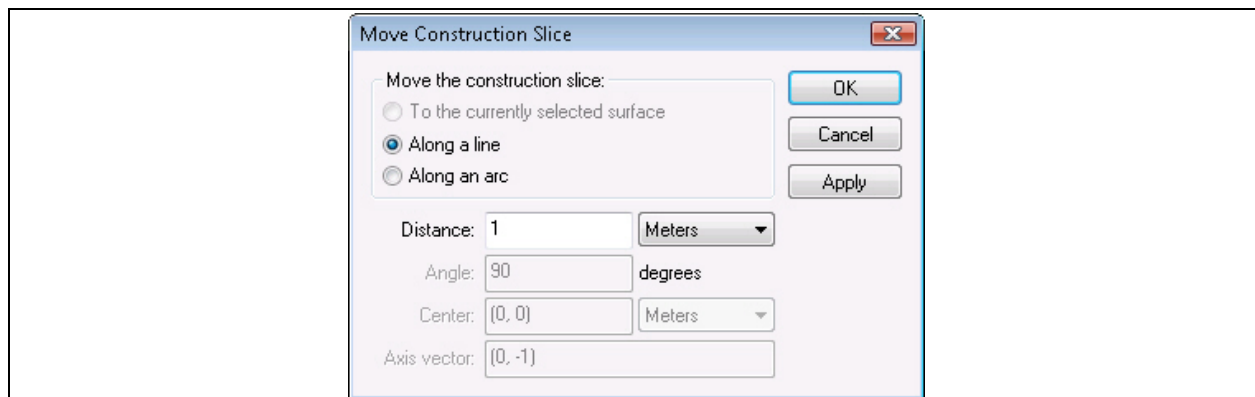
You can draw a selection box to highlight several objects at once. A selection box is also useful to highlight only certain items. For example, to find all the available edges on the construction slice, you can draw a selection box (using the select Construction Slice Edges selection tool) to highlight the edges.



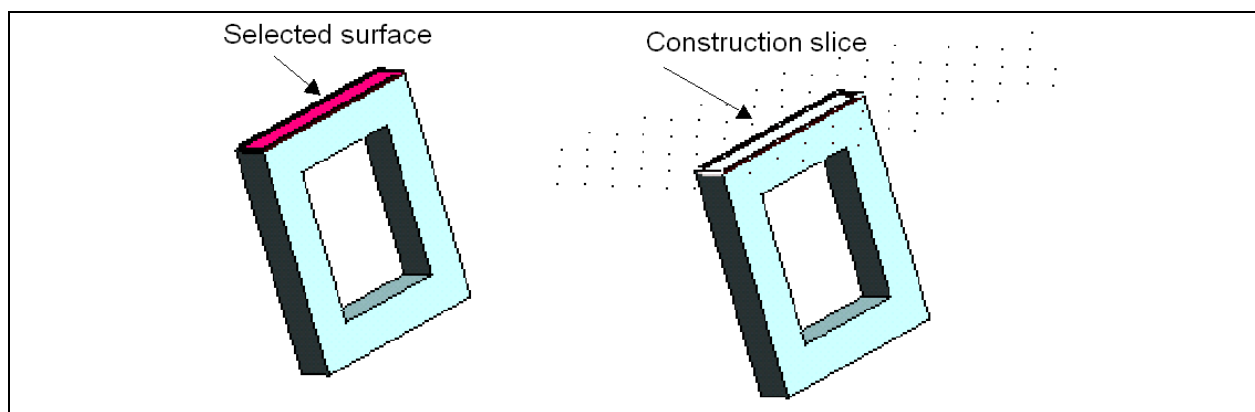
Positioning the construction slice

The construction slice is a two-dimensional editing plane in the *View* window that can be moved forward and backward in space.

The initial position of the construction slice is in the XY plane of the global XYZ coordinate system. The slice is first located at $Z=0$. The construction slice can be moved forward and backward using the *Move Construction Slice* dialog box. This dialog is accessed from either the *Draw* toolbar or the *Draw* menu.

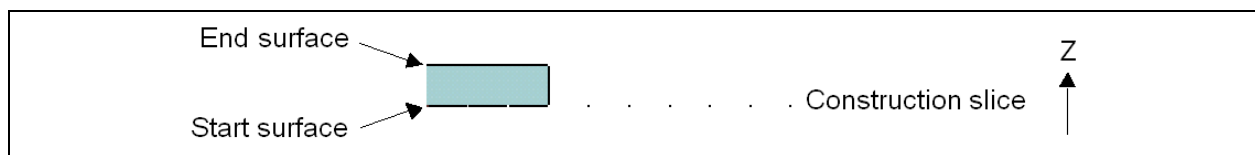


The construction slice can also be moved to a selected surface of a component.



When a component is swept, the start surface of the component begins on the construction slice. The end surface of the component is determined by the sweep distance set in the *Make Component* dialog.

Note The construction slice does not move when the component is swept.



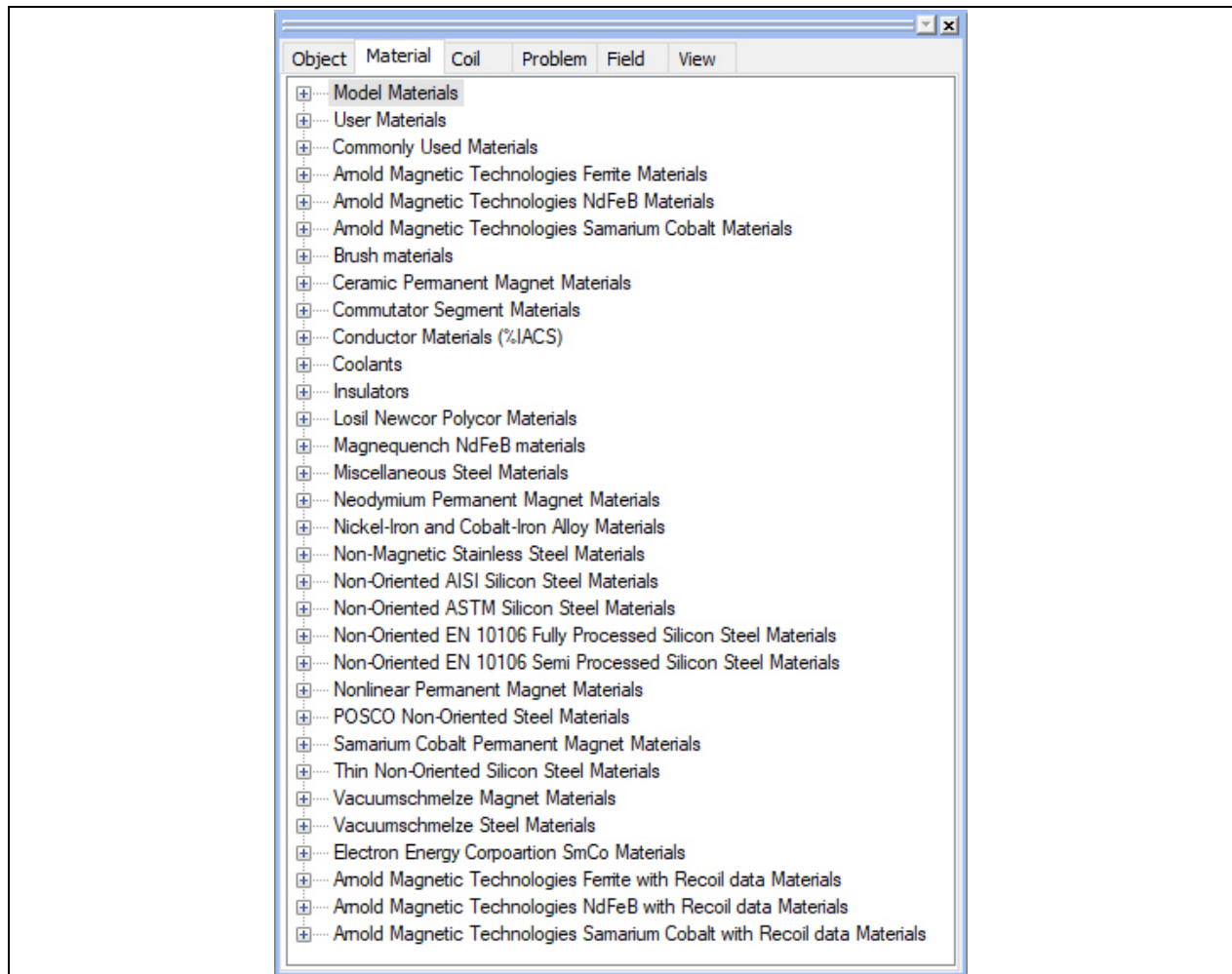
Materials

Materials are added to the component during the sweeping process.

- The Model Materials library lists all materials assigned to the device.
- The User Defined Materials library contains material that you have created or modified.
- The Materials page contains hundreds of pre-defined materials (sorted by database) that can be applied to the model, including magnetic steels, and ceramic and rare earth permanent magnet materials. Each material can be assigned to several categories.

Note Any of these pre-defined materials can be modified to make a user-defined material; you must first copy the pre-defined material to the User-defined materials library and then make the appropriate changes in the Material Property dialog.

The contents of the material library are shown in the Material page of the Project bar.



Boundary conditions

Boundary conditions define the behavior of the magnetic field at the boundaries of the model. Boundary conditions are applied to surfaces of the model, or to surfaces of an air box that represents an artificial outer boundary that surrounds the model. Conditions of symmetry can also be represented by using the appropriate boundary condition.

MagNet provides six boundary conditions:

Field Normal: Constrains to zero the tangential component of the field. The field is made normal (perpendicular) to the boundary.

Flux Tangential: Constrains to zero the normal component of the magnetic flux density. The flux is made to flow tangential to (along side) the boundary. The Flux Tangential boundary condition is applied by default to all surfaces of the model that are not assigned the Flux Tangential boundary condition.

Even Periodic: If symmetry conditions exist, you can use the Even Periodic boundary condition to model sections of linear or rotary machines that have an even number of poles. The mesh nodes on one plane of symmetry are related to the mesh nodes on the other side.

Odd Periodic: If symmetry conditions exist, you can use the Odd Periodic boundary condition to model sections of linear or rotary machines that have an odd number of poles. The mesh nodes on one plane of symmetry are related to the mesh nodes on the other side.

Surface Impedance: Uses a calculated value, or a specified value, to represent the Ohmic loss of a conducting component, and assigns the value as a boundary condition to the selected surface.

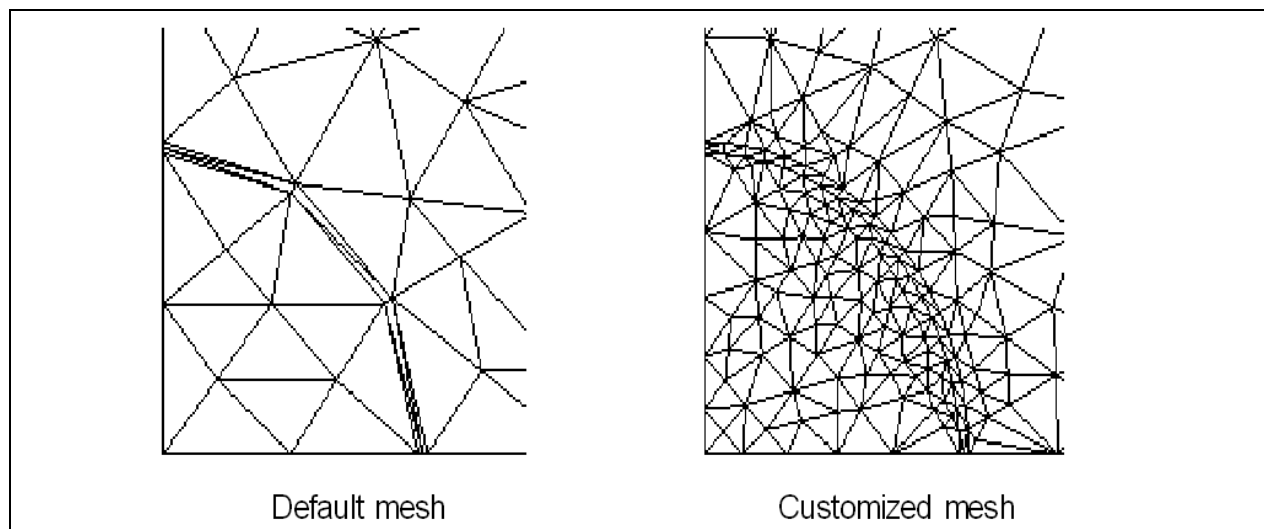
Thin Plate: Thin plates are implemented in MagNet as a surface property. The user can assign a surface property to the face(s) of component(s).

Finite element mesh

In the finite element method of analysis, the model is divided into a mesh of elements. The field inside each element is represented by a polynomial with unknown coefficients. The finite element analysis is the solution of the set of equations for the unknown coefficients.

The accuracy of the solution depends upon the nature of the field and the size of the mesh elements. In regions where the direction or magnitude of the field is changing rapidly, high accuracy requires small elements or high polynomial orders (or a combination of both).

MagNet provides you with control over the size of the mesh elements. You can change the size of the elements for the entire model, or only in areas of interest.



Adaption

MagNet's adaption process automatically identifies the areas of the mesh most in need of improvement and refines the mesh (h-adaption), or increases the polynomial order of the elements (p-adaption), in those areas.

MagNet's adaption is controlled by adaption options that are set before solving begins. These options determine:

- the type of adaption method (h-adaption or p-adaption)
- the percentage of elements of the mesh that are refined during each adaption step
- the adaption convergence tolerance
- the maximum number of adaption steps

The Adaption Options are set in the *Adaption Options* properties page.

Solving the model

MagNet solves Maxwell's equations to find the magnetic field within the model. The solution can be Magnetostatic, Time-harmonic, Transient, or Transient with motion for either 2D or 3D models.

MagNet also offers an adaption process that automatically identifies and refines the areas of the mesh most in need of refinement to improve the quality of the solution.

The computed magnetic fields are viewed as shaded, arrow, or contour plots or as field animations. In addition, MagNet automatically extracts from the field solution certain parameters of interest (depending on the solution type).

Static

- Total magnetic stored energy and co-energy
- Force and torque on each body
- Flux linking each coil
- Ohmic loss in each conducting component
- Iron loss for each enabled component
- Current in each coil and circuit component

Time-harmonic

- Time-averaged magnetic stored energy
- Time-averaged force and torque on each body
- RMS total flux linking each coil -- (*real and imaginary or magnitude and phase*)
- Time-averaged ohmic loss in each conducting component
- Iron loss for each enabled component
- RMS net current through each voltage-driven coil and circuit component
-- (*real and imaginary or magnitude and phase*)
- RMS net voltage drop across each current-driven coil and circuit component
-- (*real and imaginary or magnitude and phase*)

Transient

- Instantaneous magnetic stored energy and co-energy
- Instantaneous force and torque on each body
- Instantaneous flux linking each coil
- Time-averaged ohmic loss in each conducting component
- Time-averaged iron loss for each enabled component
- Instantaneous net current through each voltage-driven coil and circuit component
- Instantaneous net voltage across each current-driven coil and circuit component

Transient 2D/3D with Motion *(Same as Transient, plus the following)*

- Magnetic Force/Torque
- Load Force/Torque
- Net Force/Torque
- Position
- Speed
- Acceleration
- Mass
- Center of gravity
- Moment of Inertia

Third-Party Information

This section provides information on open source software (OSS) and third-party software that may be included in the MagNet product.

This software application may include NLOpt version 2.4.2, and is distributed on an "AS IS" basis, WITHOUT WARRANTY OF ANY KIND, either express or implied. You can view all license and copyright information in the C:\Program Files\Infolytica\MagNet 7.9 (64-bit)\User Documentation\legal OSS_5193_DocumentationRequirements.txt file.

The latest version of the End-User License Agreement is available on-line at:
www.mentor.com/eula

IMPORTANT INFORMATION

USE OF ALL SOFTWARE IS SUBJECT TO LICENSE RESTRICTIONS. CAREFULLY READ THIS LICENSE AGREEMENT BEFORE USING THE PRODUCTS. USE OF SOFTWARE INDICATES CUSTOMER'S COMPLETE AND UNCONDITIONAL ACCEPTANCE OF THE TERMS AND CONDITIONS SET FORTH IN THIS AGREEMENT. ANY ADDITIONAL OR DIFFERENT PURCHASE ORDER TERMS AND CONDITIONS SHALL NOT APPLY.

END-USER LICENSE AGREEMENT ("Agreement")

This is a legal agreement concerning the use of Software (as defined in Section GRA) and hardware (collectively "Products") between the company acquiring the Products ("Customer"), and the Mentor Graphics entity that issued the corresponding quotation or, if no quotation was issued, the applicable local Mentor Graphics entity ("Mentor Graphics"). Except for license agreements related to the subject matter of this license agreement which are physically signed by Customer and an authorized representative of Mentor Graphics, this Agreement and the applicable quotation contain the parties' entire understanding relating to the subject matter and supersede all prior or contemporaneous agreements. If Customer does not agree to these terms and conditions, promptly return or, in the case of Software received electronically, certify destruction of Software and all accompanying items within five days after receipt of Software and receive a full refund of any license fee paid.

1. ORDERS, FEES AND PAYMENT.

- 1.1. To the extent Customer (or if agreed by Mentor Graphics, Customer's appointed third party buying agent) places and Mentor Graphics accepts purchase orders pursuant to this Agreement (each an "Order"), each Order will constitute a contract between Customer and Mentor Graphics, which shall be governed solely and exclusively by the terms and conditions of this Agreement, any applicable addenda and the applicable quotation, whether or not those documents are referenced on the Order. Any additional or conflicting terms and conditions appearing on an Order or presented in any electronic portal or automated order management system, whether or not required to be electronically accepted, will not be effective unless agreed in writing and physically signed by an authorized representative of Customer and Mentor Graphics.
- 1.2. Amounts invoiced will be paid, in the currency specified on the applicable invoice, within 30 days from the date of such invoice. Any past due invoices will be subject to the imposition of interest charges in the amount of one and one-half percent per month or the applicable legal rate currently in effect, whichever is lower. Prices do not include freight, insurance, customs duties, taxes or other similar charges, which Mentor Graphics will state separately in the applicable invoice. Unless timely provided with a valid certificate of exemption or other evidence that items are not taxable, Mentor Graphics will invoice Customer for all applicable taxes including, but not limited to, VAT, GST, sales tax, consumption tax and service tax. Customer will make all payments free and clear of, and without reduction for, any withholding or other taxes; any such taxes imposed on payments by Customer hereunder will be Customer's sole responsibility. If Customer appoints a third party to place purchase orders and/or make payments on Customer's behalf, Customer shall be liable for payment under Orders placed by such third party in the event of default.
- 1.3. All Products are delivered FCA factory (Incoterms 2010), freight prepaid and invoiced to Customer, except Software delivered electronically, which shall be deemed delivered when made available to Customer for download. Mentor Graphics retains a security interest in all Products delivered under this Agreement, to secure payment of the purchase price of such Products, and Customer agrees to sign any documents that Mentor Graphics determines to be necessary or convenient for use in filing or perfecting such security interest. Mentor Graphics' delivery of Software by electronic means is subject to Customer's provision of both a primary and an alternate e-mail address.

2. **GRANT OF LICENSE.** The software installed, downloaded, or otherwise acquired by Customer under this Agreement, including any updates, modifications, revisions, copies, documentation, setup files and design data ("Software") are copyrighted, trade secret and confidential information of Mentor Graphics or its licensors, who maintain exclusive title to all Software and retain all rights not expressly granted by this Agreement. Except for Software that is embeddable ("Embedded Software"), which is licensed pursuant to separate embedded software terms or an embedded software supplement, Mentor Graphics grants to Customer, subject to payment of applicable license fees, a nontransferable, nonexclusive license to use Software solely: (a) in machine-readable, object-code form (except as provided in Subsection 4.2; (b) for Customer's internal business purposes; (c) for the term of the license; and (d) on the computer hardware and at the site authorized by Mentor Graphics. A site is restricted to a one-half mile (800 meter) radius. Customer may have Software temporarily used by an employee for telecommuting purposes from locations other than a Customer office, such as the employee's residence, an airport or hotel, provided that such employee's primary place of employment is the site where the Software is authorized for use. Mentor Graphics' standard policies and programs, which vary depending on Software, license fees paid or services purchased, apply to the following: (a) relocation of Software; (b) use of Software, which may be limited, for example, to execution of a single session by a single user on the authorized hardware or for a restricted period of time (such limitations may be technically implemented through the use of authorization codes or similar devices); and (c) support services provided, including eligibility to receive telephone support, updates, modifications, and revisions. For the avoidance of doubt, if

Customer provides any feedback or requests any change or enhancement to Products, whether in the course of receiving support or consulting services, evaluating Products, performing beta testing or otherwise, any inventions, product improvements, modifications or developments made by Mentor Graphics (at Mentor Graphics' sole discretion) will be the exclusive property of Mentor Graphics.

3. BETA CODE.

- 3.1. Portions or all of certain Software may contain code for experimental testing and evaluation (which may be either alpha or beta, collectively "Beta Code"), which may not be used without Mentor Graphics' explicit authorization. Upon Mentor Graphics' authorization, Mentor Graphics grants to Customer a temporary, nontransferable, nonexclusive license for experimental use to test and evaluate the Beta Code without charge for a limited period of time specified by Mentor Graphics. Mentor Graphics may choose, at its sole discretion, not to release Beta Code commercially in any form.
- 3.2. If Mentor Graphics authorizes Customer to use the Beta Code, Customer agrees to evaluate and test the Beta Code under normal conditions as directed by Mentor Graphics. Customer will contact Mentor Graphics periodically during Customer's use of the Beta Code to discuss any malfunctions or suggested improvements. Upon completion of Customer's evaluation and testing, Customer will send to Mentor Graphics a written evaluation of the Beta Code, including its strengths, weaknesses and recommended improvements.
- 3.3. Customer agrees to maintain Beta Code in confidence and shall restrict access to the Beta Code, including the methods and concepts utilized therein, solely to those employees and Customer location(s) authorized by Mentor Graphics to perform beta testing. Customer agrees that any written evaluations and all inventions, product improvements, modifications or developments that Mentor Graphics conceived or made during or subsequent to this Agreement, including those based partly or wholly on Customer's feedback, will be the exclusive property of Mentor Graphics. Mentor Graphics will have exclusive rights, title and interest in all such property. The provisions of this Subsection 3.3 shall survive termination of this Agreement.

4. RESTRICTIONS ON USE.

- 4.1. Customer may copy Software only as reasonably necessary to support the authorized use. Each copy must include all notices and legends embedded in Software and affixed to its medium and container as received from Mentor Graphics. All copies shall remain the property of Mentor Graphics or its licensors. Except for Embedded Software that has been embedded in executable code form in Customer's product(s), Customer shall maintain a record of the number and primary location of all copies of Software, including copies merged with other software, and shall make those records available to Mentor Graphics upon request. Customer shall not make Products available in any form to any person other than Customer's employees and on-site contractors, excluding Mentor Graphics competitors, whose job performance requires access and who are under obligations of confidentiality. Customer shall take appropriate action to protect the confidentiality of Products and ensure that any person permitted access does not disclose or use Products except as permitted by this Agreement. Customer shall give Mentor Graphics written notice of any unauthorized disclosure or use of the Products as soon as Customer becomes aware of such unauthorized disclosure or use. Customer acknowledges that Software provided hereunder may contain source code which is proprietary and its confidentiality is of the highest importance and value to Mentor Graphics. Customer acknowledges that Mentor Graphics may be seriously harmed if such source code is disclosed in violation of this Agreement. Except as otherwise permitted for purposes of interoperability as specified by applicable and mandatory local law, Customer shall not reverse-assemble, disassemble, reverse-compile, or reverse-engineer any Product, or in any way derive any source code from Software that is not provided to Customer in source code form. Log files, data files, rule files and script files generated by or for the Software (collectively "Files"), including without limitation files containing Standard Verification Rule Format ("SVRF") and Tcl Verification Format ("TVF") which are Mentor Graphics' trade secret and proprietary syntaxes for expressing process rules, constitute or include confidential information of Mentor Graphics. Customer may share Files with third parties, excluding Mentor Graphics competitors, provided that the confidentiality of such Files is protected by written agreement at least as well as Customer protects other information of a similar nature or importance, but in any case with at least reasonable care. Customer may use Files containing SVRF or TVF only with Mentor Graphics products. Under no circumstances shall Customer use Products or Files or allow their use for the purpose of developing, enhancing or marketing any product that is in any way competitive with Products, or disclose to any third party the results of, or information pertaining to, any benchmark.
- 4.2. If any Software or portions thereof are provided in source code form, Customer will use the source code only to correct software errors and enhance or modify the Software for the authorized use, or as permitted for Embedded Software under separate embedded software terms or an embedded software supplement. Customer shall not disclose or permit disclosure of source code, in whole or in part, including any of its methods or concepts, to anyone except Customer's employees or on-site contractors, excluding Mentor Graphics competitors, with a need to know. Customer shall not copy or compile source code in any manner except to support this authorized use.
- 4.3. Customer agrees that it will not subject any Product to any open source software ("OSS") license that conflicts with this Agreement or that does not otherwise apply to such Product.
- 4.4. Customer may not assign this Agreement or the rights and duties under it, or relocate, sublicense, or otherwise transfer the Products, whether by operation of law or otherwise ("Attempted Transfer"), without Mentor Graphics' prior written consent and payment of Mentor Graphics' then-current applicable relocation and/or transfer fees. Any Attempted Transfer without Mentor Graphics' prior written consent shall be a material breach of this Agreement and may, at Mentor Graphics' option, result in the immediate termination of the Agreement and/or the licenses granted under this Agreement. The terms of this Agreement, including without limitation the licensing and assignment provisions, shall be binding upon Customer's permitted successors in interest and assigns.
- 4.5. The provisions of this Section 4 shall survive the termination of this Agreement.

5. **SUPPORT SERVICES.** To the extent Customer purchases support services, Mentor Graphics will provide Customer with updates and technical support for the Products, at the Customer site(s) for which support is purchased, in accordance with Mentor Graphics' then current End-User Support Terms located at <http://supportnet.mentor.com/supportterms>.
6. **OPEN SOURCE SOFTWARE.** Products may contain OSS or code distributed under a proprietary third party license agreement, to which additional rights or obligations ("Third Party Terms") may apply. Please see the applicable Product documentation (including license files, header files, read-me files or source code) for details. In the event of conflict between the terms of this Agreement (including any addenda) and the Third Party Terms, the Third Party Terms will control solely with respect to the OSS or third party code. The provisions of this Section 6 shall survive the termination of this Agreement.
7. **LIMITED WARRANTY.**
- 7.1. Mentor Graphics warrants that during the warranty period its standard, generally supported Products, when properly installed, will substantially conform to the functional specifications set forth in the applicable user manual. Mentor Graphics does not warrant that Products will meet Customer's requirements or that operation of Products will be uninterrupted or error free. The warranty period is 90 days starting on the 15th day after delivery or upon installation, whichever first occurs. Customer must notify Mentor Graphics in writing of any nonconformity within the warranty period. For the avoidance of doubt, this warranty applies only to the initial shipment of Software under an Order and does not renew or reset, for example, with the delivery of (a) Software updates or (b) authorization codes or alternate Software under a transaction involving Software re-mix. This warranty shall not be valid if Products have been subject to misuse, unauthorized modification, improper installation or Customer is not in compliance with this Agreement. MENTOR GRAPHICS' ENTIRE LIABILITY AND CUSTOMER'S EXCLUSIVE REMEDY SHALL BE, AT MENTOR GRAPHICS' OPTION, EITHER (A) REFUND OF THE PRICE PAID UPON RETURN OF THE PRODUCTS TO MENTOR GRAPHICS OR (B) MODIFICATION OR REPLACEMENT OF THE PRODUCTS THAT DO NOT MEET THIS LIMITED WARRANTY. MENTOR GRAPHICS MAKES NO WARRANTIES WITH RESPECT TO: (A) SERVICES; (B) PRODUCTS PROVIDED AT NO CHARGE; OR (C) BETA CODE; ALL OF WHICH ARE PROVIDED "AS IS."
- 7.2. THE WARRANTIES SET FORTH IN THIS SECTION 7 ARE EXCLUSIVE. NEITHER MENTOR GRAPHICS NOR ITS LICENSORS MAKE ANY OTHER WARRANTIES EXPRESS, IMPLIED OR STATUTORY, WITH RESPECT TO PRODUCTS PROVIDED UNDER THIS AGREEMENT. MENTOR GRAPHICS AND ITS LICENSORS SPECIFICALLY DISCLAIM ALL IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE AND NON-INFRINGEMENT OF INTELLECTUAL PROPERTY.
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9. **THIRD PARTY CLAIMS.**
- 9.1. Customer acknowledges that Mentor Graphics has no control over the testing of Customer's products, or the specific applications and use of Products. Mentor Graphics and its licensors shall not be liable for any claim or demand made against Customer by any third party, except to the extent such claim is covered under Section 10.
- 9.2. In the event that a third party makes a claim against Mentor Graphics arising out of the use of Customer's products, Mentor Graphics will give Customer prompt notice of such claim. At Customer's option and expense, Customer may take sole control of the defense and any settlement of such claim. Customer WILL reimburse and hold harmless Mentor Graphics for any LIABILITY, damages, settlement amounts, costs and expenses, including reasonable attorney's fees, incurred by or awarded against Mentor Graphics or its licensors in connection with such claims.
- 9.3. The provisions of this Section 9 shall survive any expiration or termination of this Agreement.

10. INFRINGEMENT.

- 10.1. Mentor Graphics will defend or settle, at its option and expense, any action brought against Customer in the United States, Canada, Japan, or member state of the European Union which alleges that any standard, generally supported Product acquired by Customer hereunder infringes a patent or copyright or misappropriates a trade secret in such jurisdiction. Mentor Graphics will pay costs and damages finally awarded against Customer that are attributable to such action. Customer understands and agrees that as conditions to Mentor Graphics' obligations under this section Customer must: (a) notify Mentor Graphics promptly in writing of the action; (b) provide Mentor Graphics all reasonable information and assistance to settle or defend the action; and (c) grant Mentor Graphics sole authority and control of the defense or settlement of the action.
- 10.2. If a claim is made under Subsection 10.1 Mentor Graphics may, at its option and expense: (a) replace or modify the Product so that it becomes noninfringing; (b) procure for Customer the right to continue using the Product; or (c) require the return of the Product and refund to Customer any purchase price or license fee paid, less a reasonable allowance for use.
- 10.3. Mentor Graphics has no liability to Customer if the action is based upon: (a) the combination of Software or hardware with any product not furnished by Mentor Graphics; (b) the modification of the Product other than by Mentor Graphics; (c) the use of other than a current unaltered release of Software; (d) the use of the Product as part of an infringing process; (e) a product that Customer makes, uses, or sells; (f) any Beta Code or Product provided at no charge; (g) any software provided by Mentor Graphics' licensors who do not provide such indemnification to Mentor Graphics' customers; (h) OSS, except to the extent that the infringement is directly caused by Mentor Graphics' modifications to such OSS; or (i) infringement by Customer that is deemed willful. In the case of (i), Customer shall reimburse Mentor Graphics for its reasonable attorney fees and other costs related to the action.
- 10.4. THIS SECTION 10 IS SUBJECT TO SECTION 8 ABOVE AND STATES THE ENTIRE LIABILITY OF MENTOR GRAPHICS AND ITS LICENSORS, AND CUSTOMER'S SOLE AND EXCLUSIVE REMEDY, FOR DEFENSE, SETTLEMENT AND DAMAGES, WITH RESPECT TO ANY ALLEGED PATENT OR COPYRIGHT INFRINGEMENT OR TRADE SECRET MISAPPROPRIATION BY ANY PRODUCT PROVIDED UNDER THIS AGREEMENT.

11. TERMINATION AND EFFECT OF TERMINATION.

- 11.1. If a Software license was provided for limited term use, such license will automatically terminate at the end of the authorized term. Mentor Graphics may terminate this Agreement and/or any license granted under this Agreement immediately upon written notice if Customer: (a) exceeds the scope of the license or otherwise fails to comply with the licensing or confidentiality provisions of this Agreement, or (b) becomes insolvent, files a bankruptcy petition, institutes proceedings for liquidation or winding up or enters into an agreement to assign its assets for the benefit of creditors. For any other material breach of any provision of this Agreement, Mentor Graphics may terminate this Agreement and/or any license granted under this Agreement upon 30 days written notice if Customer fails to cure the breach within the 30 day notice period. Termination of this Agreement or any license granted hereunder will not affect Customer's obligation to pay for Products shipped or licenses granted prior to the termination, which amounts shall be payable immediately upon the date of termination.
- 11.2. Upon termination of this Agreement, the rights and obligations of the parties shall cease except as expressly set forth in this Agreement. Upon termination of this Agreement and/or any license granted under this Agreement, Customer shall ensure that all use of the affected Products ceases, and shall return hardware and either return to Mentor Graphics or destroy Software in Customer's possession, including all copies and documentation, and certify in writing to Mentor Graphics within ten business days of the termination date that Customer no longer possesses any of the affected Products or copies of Software in any form.
12. **EXPORT.** The Products provided hereunder are subject to regulation by local laws and European Union ("E.U.") and United States ("U.S.") government agencies, which prohibit export, re-export or diversion of certain products, information about the products, and direct or indirect products thereof, to certain countries and certain persons. Customer agrees that it will not export or re-export Products in any manner without first obtaining all necessary approval from appropriate local, E.U. and U.S. government agencies. If Customer wishes to disclose any information to Mentor Graphics that is subject to any E.U., U.S. or other applicable export restrictions, including without limitation the U.S. International Traffic in Arms Regulations (ITAR) or special controls under the Export Administration Regulations (EAR), Customer will notify Mentor Graphics personnel, in advance of each instance of disclosure, that such information is subject to such export restrictions.
13. **U.S. GOVERNMENT LICENSE RIGHTS.** Software was developed entirely at private expense. The parties agree that all Software is commercial computer software within the meaning of the applicable acquisition regulations. Accordingly, pursuant to U.S. FAR 48 CFR 12.212 and DFAR 48 CFR 227.7202, use, duplication and disclosure of the Software by or for the U.S. government or a U.S. government subcontractor is subject solely to the terms and conditions set forth in this Agreement, which shall supersede any conflicting terms or conditions in any government order document, except for provisions which are contrary to applicable mandatory federal laws.
14. **THIRD PARTY BENEFICIARY.** Mentor Graphics Corporation, Mentor Graphics (Ireland) Limited, Microsoft Corporation and other licensors may be third party beneficiaries of this Agreement with the right to enforce the obligations set forth herein.
15. **REVIEW OF LICENSE USAGE.** Customer will monitor the access to and use of Software. With prior written notice and during Customer's normal business hours, Mentor Graphics may engage an internationally recognized accounting firm to review Customer's software monitoring system and records deemed relevant by the internationally recognized accounting firm to confirm Customer's compliance with the terms of this Agreement or U.S. or other local export laws. Such review may include FlexNet (or successor product) report log files that Customer shall capture and provide at Mentor Graphics' request. Customer shall make records available in electronic format and shall fully cooperate with data gathering to support the license review. Mentor Graphics shall bear the expense of any such review unless a material non-compliance is

revealed. Mentor Graphics shall treat as confidential information all information gained as a result of any request or review and shall only use or disclose such information as required by law or to enforce its rights under this Agreement. The provisions of this Section 15 shall survive the termination of this Agreement.

16. **CONTROLLING LAW, JURISDICTION AND DISPUTE RESOLUTION.** The owners of certain Mentor Graphics intellectual property licensed under this Agreement are located in Ireland and the U.S. To promote consistency around the world, disputes shall be resolved as follows: excluding conflict of laws rules, this Agreement shall be governed by and construed under the laws of the State of Oregon, U.S., if Customer is located in North or South America, and the laws of Ireland if Customer is located outside of North or South America or Japan, and the laws of Japan if Customer is located in Japan. All disputes arising out of or in relation to this Agreement shall be submitted to the exclusive jurisdiction of the courts of Portland, Oregon when the laws of Oregon apply, or Dublin, Ireland when the laws of Ireland apply, or the Tokyo District Court when the laws of Japan apply. Notwithstanding the foregoing, all disputes in Asia (excluding Japan) arising out of or in relation to this Agreement shall be resolved by arbitration in Singapore before a single arbitrator to be appointed by the chairman of the Singapore International Arbitration Centre ("SIAC") to be conducted in the English language, in accordance with the Arbitration Rules of the SIAC in effect at the time of the dispute, which rules are deemed to be incorporated by reference in this section. Nothing in this section shall restrict Mentor Graphics' right to bring an action (including for example a motion for injunctive relief) against Customer in the jurisdiction where Customer's place of business is located. The United Nations Convention on Contracts for the International Sale of Goods does not apply to this Agreement.
17. **SEVERABILITY.** If any provision of this Agreement is held by a court of competent jurisdiction to be void, invalid, unenforceable or illegal, such provision shall be severed from this Agreement and the remaining provisions will remain in full force and effect.
18. **MISCELLANEOUS.** This Agreement contains the parties' entire understanding relating to its subject matter and supersedes all prior or contemporaneous agreements. Any translation of this Agreement is provided to comply with local legal requirements only. In the event of a dispute between the English and any non-English versions, the English version of this Agreement shall govern to the extent not prohibited by local law in the applicable jurisdiction. This Agreement may only be modified in writing, signed by an authorized representative of each party. Waiver of terms or excuse of breach must be in writing and shall not constitute subsequent consent, waiver or excuse.