Chapter 5 - Model Construction

Flexibility is one of Visual’s most powerful attributes. Achieving maximal benefit of flexibility without over-complicating the data entry process can be quite challenging however.

A method was sought to provide a simple means of constructing lighting models to any level of complexity without compromising the speed with which more common or basic configurations can be entered.

The solution lies in a flexible, graphic-based system similar in function to CAD programs. The following chapter introduces the basic components of a Visual lighting model and describes the process by which they are created and located within the model space.
5.1 Constructing Background Objects

Background Objects are very useful for communicating visual information independent of the lighting analysis.

Background Objects can be invaluable as an aid in the construction of complex models. Lines may be initially placed so that their endpoints terminate at key locations in the model space. Solid Objects can then be added using the Endpoint Object Snap method so that the Lines essentially act as a skeletal map for construction.

Since Lines may be extended and trimmed (see Modify), this is often the easiest way to enter complex geometry such as multiple sloped planes. Lines used as a construction aid are easily erased or made invisible once the model has been completed.

A common use for Background Lines is to represent ceiling grid. The Lines can be made Inactive (but still Visible) to disallow selection of them while moving Luminaires but Luminaires may be placed with the Intersection Object Snap and moved into the center of a "tile". See Placing and Orienting Luminaires.
5.1.1 Arcs

**Arcs** are Circle segments constructed in Visual by selecting start and end *coordinates*, and a "bulge" vector.

To construct an **Arc**, select the command from the **Reference panel** of the **Construct tab** in the **Ribbonbar**.

Select the **Arc** start and end *coordinates* by either navigating the mouse crosshairs to the appropriate coordinate location, entering the *coordinates* numerically at the **Command Line**, or by selecting an object using one of the **Object Snap** methods.

After both start and end points are specified, Visual displays the "bulge" vector that is tangent to the **Arc** at the endpoint.

Visual also draws the implied **Arc** to show the result prior to final *coordinate* selection.

Moving the mouse to the opposite side of the line connecting the start and end points will cause the mirror-image **Arc** to be drawn.

Left-click to select the *coordinate* location that results in the desired **Arc** and end the command.

While executing the command, **Color**, **Weight**, and **Style** can be selected from the **Properties tab** in the **Ribbonbar** that will automatically be shown. See **Using the Color Dialog** for information on selecting **Color**.

Remember that construction of any object can occur in different **planes** by pressing the **Tab** key.
5.1.2 Axis

Visual can draw numbered axes to allow for coordinate identification in the Design Environment and when making a printed Page in Print Editor.

The Axis button can be found on the Construct tab of the Ribbonbar.

To create an Axis, select the Base Point with the mouse, keyboard, or Object Snap.

Movement of the mouse in the command shows the implied Axis that will be drawn in the Active Plane.

Axis Increment indicates how far apart Axis tick marks and labels are created.

At right, the Axis command has been used to draw an Axis from the (0,0,0) origin in each of the x, y, and z cardinal directions.

Select the endpoint of the Axis line with the mouse, keyboard, or Object Snap. Visual automatically ends the command and draws the Axis.

The Global Axis option restricts the Visual Axis to being parallel with one of the Cartesian axes. Axis labels are coincident with the X, Y, or Z-dimension related to that spot on the Axis.

The Relative Axis option allows for an Axis to be placed such that labels are based on zero being the Base Point of the Axis as specified and labelling is independent of global (X,Y,Z) coordinates. The Axis can be applied at any angle in the Active Plane.
At right, the global *coordinates* are indicated for each Relative *Axis*, which then aligns with the *Global Axis* example above.

After creation, *Layer*, *Color*, and visibility *Properties* can be modified. *Label*, line, and tick mark use the same *Color* for each *Axis*.

The most common use for an *Axis* would be in conjunction with the insertion of a *Luminaire Locations* table on a printed *page* to allow for the end-user to discern (x,y) *coordinates of pole* locations related to site lighting projects.
5.1.3 Circles

Background Circles can be drawn in Visual.

The buttons for Background Circles can be found in the Construct panel on the Home tab of the Ribbonbar or in the Reference panel on the Construct tab.

Color, Weight, and Style can be selected from the Properties tab in the Ribbonbar that will automatically be shown. See Using the Color Dialog for information on selecting Color. See Lines and Polylines for information on Weight and Style.

Examples shown here are drawn with a Weight of "3".

To construct a Circle, specify the coordinates of the first vertex (the center of the circle) using the mouse, keyboard, or Object Snap. In the command, moving the mouse causes Visual to draw the implied radius vector and the implied Circle showing what will be created when the command is completed. Specify the radius. To end the command, right-click the mouse or press Enter.

During any command, Undo will remove the last specified coordinate (vertex).

Background Circles can be converted to Solids if necessary. See Converting Object Types. (Note that in the example at right, the Background object has a Line Width of 3.)

Remember that construction of any object can occur in different planes by pressing the Tab key.
5.1.4 Lines and Polylines

**Lines** and **Polylines** are constructed in an identical fashion and the separation of the two in Visual is purely semantics.

**Polylines** are a connected series of **Line** segments. A **vertex** is the connection of two segments.

**Lines** are single segments with a start and an end point.

To construct a **Line** or **Polyline**, click the **Line** button in the **Construct panel** of the **Home tab** or in the **Reference panel** of the **Construct tab** in the **Ribbonbar**.

Specify the **coordinates** of the first **vertex** using the mouse, keyboard, or **Object Snap**.

Specify additional **coordinates** as necessary.

Right-click the mouse or press **Enter** to end the command.

Even when **Polylines** appear to be closed (as at right), Visual does not consider them to be closed and therefore **Polygons**. The **Polygon** command must be used to make **Polygons**.

While executing the command, **Color**, **Weight**, and **Style** can be selected from the **Properties tab** in the **Ribbonbar** that will automatically be shown. See **Using the Color Dialog** for information on selecting **Color**.

**Line Weight** can be changed by selecting from one of the five values in the drop-down list. Values are the width in pixels the line will be drawn regardless of **Zoom** value.
The available **Styles** for **Lines** and **Polylines** are shown at right.

![Line Types]

Remember that construction of any object can occur in different *planes* by pressing the *Tab* key.
5.1.5 Polygons

Background Polygons can be created in Visual.

The buttons for Background Polygons can be found in the Construct panel on the Home tab of the Ribbonbar or in the Reference panel on the Construct tab.

Color, Weight, and Style can be selected from the Properties tab in the Ribbonbar that will automatically be shown. See Using the Color Dialog for information on selecting Color. See Lines and Polylines for information on Weight and Style.

Examples shown here are drawn with a Weight of “3”.

To construct a Polygon, specify the coordinates of the vertices using the mouse, keyboard, or Object Snap. In the command, moving the mouse causes Visual to draw two types of implied lines: the small-dash line connects the cursor to the first vertex and the large-dash line connects the cursor to the last vertex specified. Visual also shows the implied connection between the first and last vertices to illustrate the result if the command is ended. To end the command, right-click the mouse or press Enter.

During any command, Undo will remove the last specified coordinate (vertex).

Background Polygons can be converted to Solids if necessary. See Converting Object Types. (Note that in the example at right, the Background object has a Line Width of 3.)

Remember that construction of any object can occur in different planes by pressing the Tab key.
5.1.6 Rectangles

Background Rectangles can be drawn in Visual.

The buttons for Background Rectangles can be found in the Construct panel on the Home tab of the Ribbonbar or in the Reference panel on the Construct tab.

Color, Weight, and Style can be selected from the Properties tab in the Ribbonbar that will automatically be shown. See Using the Color Dialog for information on selecting Color. See Lines and Polylines for information on Weight and Style.

Examples shown here are drawn with a Weight of “3”.

To construct a Rectangle, specify the coordinates of the first vertex using the mouse, keyboard, or Object Snap. In the command, moving the mouse causes Visual to draw the implied Rectangle showing what will be created when the command is completed. To end the command, right-click the mouse or press Enter.

During any command, Undo will remove the last specified coordinate (vertex).

Background Rectangles can be converted to Solids if necessary. See Converting Object Types. (Note that in the example at right, the Background object has a Line Width of 3.)
5.1.7 Text

Background Text is useful for annotating features of a lighting model or describing particular aspects of a lighting design.

To add Background Text to a design, select the Text command from the Construct menu.

The Text Editor will appear.

Type the desired text into the editing area of the Text Editor.

Height can be specified in the same units as used in the Design Environment for other elements; feet or meters. To select the Height, choose one of the options from the drop-down menu or enter a value (integer or decimal) with the keyboard. The Height of the "tall" letters will be drawn to that size; for example "I", "t", or "d".

Left, Center, or Right Alignment can be chosen. Examples of the output are shown below.

The Wordwrap button will cause Text to be placed on multiple lines. Without this button active (gold), Visual will place all Text on one line.

Pressing the Enter key inserts a carriage return, and unlike most other commands, does not end the command, for obvious reasons.

Click the Insert button to continue.

Visual requires the specification of a line to know where to place the Text. Specify the first and second points with the mouse, the keyboard, or with Object Snap. Visual places the Text along that line. The specification of the second point ends the command automatically and places the text. (Visual does not draw the line once the text is placed.) Alternately, right-clicking the mouse ends the command and uses the default (0 degrees) orientation.

Visual will place Text at any angle specified by the implied line between the two points. For example, specifying the second point to the left of the first draws the Text inverted.

As mentioned above, Wordwrap can be set to Left (default), Center, or Right Alignment with respect to the two input points.

Text Color is set by the Layer on which it resides. Unlike other Background objects, Text does not have Color unto itself.
It is possible that characters entered into the Text Editor cannot be displayed by Visual. In that case, a substitute symbol is inserted instead. This is rare.

The "Visual font" is shown at right for reference.

Note that when importing CAD information in DWG or DXF format, any Text in the file is converted to the Visual font.

To place formatted text using typical fonts, colors, and other augmentation, see Text for information on placing text in the Print Editor.
5.2 Constructing Solid Objects

Solid Objects (Solids) are an important component of lighting system analysis.

Rooms, Structures, and Walls (or other more complex obstructions like modular furniture shown at right) can all have a dramatic impact on lighting system performance and it is frequently important to model these features to then take them into account in the calculation.

In Visual, such items are comprised of one or more Solid Objects in the form of Rectangles, Polygons, or Circles.

Solids can be constructed in a pre-grouped fashion as Rooms and Structures.

Visual creates Solid Objects with a coplanar front and back having the same properties. There is no need to create extra surfaces to have a correct model, as is the case in some other lighting software. A common wall can be created between two rooms without impacting the average noticeably in most cases if it is convenient. For example, a 60x40 room versus a 61x41 room will have 1% difference in average illuminance with the same lighting system, which is inside the 2% standard photometric test error. Imported CAD files almost always contain both sides of a given wall, and when an enclosed Room is created, Visual's algorithms calculate succinctly so the seeming duplication is not a detriment. See Rooms and Structures for more information.

Solids are created with a Surface Normal to discern the front face from the back face. This is stored in the object Properties and accessed with the Properties command. The Surface Normal is a unit vector indicating direction. (0,0,1) indicates the positive-Z direction. (0,1,0) indicates the positive-Y direction. (1,0,0) indicates the positive-X direction.

The Surface Normal is important in that Visual uses that information (which side is the front side) when for example a Calculation Zone is placed on a Solid. See Placing Calculation Zones on Existing Solid Objects.

The Surface Normal can be "Flipped" by modifying object Properties. See Solid Properties.

Solid Circles, Rectangles, and Polygons can be converted to Background objects if necessary. See Convert to Background. (Note that the resulting Background objects will have a Line Width of 1.)
It is important to select **Color** and **Reflectance** to align with the properties of the materials in the actual project. For example, 80% **Reflectance** is valid for a ceiling composed of higher end acoustic tile, but is certainly not appropriate for raw materials used in most "open to deck" scenarios or sprayed-on insulation, especially when an indirect *luminaire* is used. The default is 50% **Reflectance** for all **Solids**.

The choice of a **Color** is only necessary if **Color Rendering** is a desired output from Visual. Grayscale choices yield the same numeric results as "colored" choices, assuming the **Reflectance** value is the same.

The **Color** and **Reflectance** chosen for **Solids** is independent of the **Layer Color**. The **Layer Color** is used to provide user feedback in the **Design Environment** and the **Color** and **Reflectance** is used for calculation.

On the right, the objects with a black border have different **Color** (and therefore **Reflectance**) on the **Solids System Layer** (Color is **ByLayer**) and those with a green border are on a separate **Layer**, also with different **Color** (and **Reflectance**). In **Shaded Display Mode** shown at the bottom, borders (drawn in the **Layer Color**) are not shown. The gray, red, and blue all yield the same calculational result because they are all 50% **Reflectance**.

**Solid Objects** can be modeled to simply block the direct travel of light or reflect light diffusely. See **Solid Object Properties** for more information.

**Solids** can be modified to transmit light diffusely or transparently. See **Solid Object Properties** for more information.

The following section will detail the various methods used to construct and assign properties to **Solid Objects** along with some useful techniques for rapidly developing both common and complex architectural geometry.
5.2.1 Circles

The most basic means of entering Solid Objects (Solids and/or Surfaces) is by coordinate selection, building one surface at a time. Coordinates are identified, either graphically or by text coordinate entry at the Command Line, to define the location and orientation of each Solid Objects.

The button for Solid Circles can be found in the Solids panel on the Construct tab of the Ribbonbar.

Solid Circles share a similar interface in the Properties tab of the Ribbonbar that is shown upon command execution.

Solids can be named for later reference. If no name is user-defined, Visual will call all Solid Objects “Solid”. Naming objects can be useful, but it is not required.

The Color and Reflectance of Solids are tied together in Visual. Specifying a numeric Reflectance will cause Visual to choose the analogous gray shade to match. Clicking the Color button will launch the Color Dialog to allow for more detailed Color selection.

To construct a Solid Circle, specify the coordinates of the first vertex (the center of the circle) using the mouse, keyboard, or Object Snap. In the command, moving the mouse causes Visual to draw the implied radius vector and the implied Circle showing what will be created when the command is completed. Specify the radius. To end the command, right-click the mouse or press Enter.

Note that Visual creates faceted Circles based on system parameters. If large Circles are being created, it may be necessary to modify the parameter to yield a smooth Circle. See Drawing Aids Settings for more information.

See Constructing Solid Objects for important information about various parameters and behavior of Solid Objects.
5.2.2 Polygons

The most basic means of entering Solid Objects (Solids and/or Surfaces) is by coordinate selection, building one surface at a time. Coordinates are identified, either graphically or by text coordinate entry at the Command Line, to define the location and orientation of each Solid Objects.

The buttons for Solid Polygons can be found in the Construct panel on the Home tab of the Ribbonbar and in the Solids panel on the Construct tab.

Solids can be named for later reference. If no name is user-defined, Visual will call all Solid Objects “Solid”. Naming objects can be useful, but it is not required.

The Color and Reflectance of Solids are tied together in Visual. Specifying a numeric Reflectance will cause Visual to choose the analogous gray shade to match. Clicking the Color button will launch the Color Dialog to allow for more detailed Color selection.

To construct a Polygon, specify the coordinates of the vertices using the mouse, keyboard, or Object Snap. In the command, moving the mouse causes Visual to draw two types of implied lines: the small-dash line connects the cursor to the first vertex and the large-dash line connects the cursor to the last vertex specified. Visual also shows the implied connection between the first and last vertices to illustrate the result if the command is ended. To end the command, right-click the mouse or press Enter.

Solid Polygons cannot be self-crossing. Visual makes the determination at the completion of the command and provides a message box. All coordinate input during the command is lost; therefore careful selection of points should be made.

For example, the perimeter of a complex large parking lot is being traced with an Imported CAD file as reference. There can easily be an improper selection when Object Snap is used and the Polygon can be crossing without it being apparent.

See Constructing Solid Objects for important information about various parameters and behavior of Solid Objects.
5.2.3 Rectangles

The most basic means of entering **Solid Objects** (**Solids** and/or **Surfaces**) is by *coordinate* selection, building one surface at a time. *Coordinates* are identified, either graphically or by text *coordinate* entry at the **Command Line**, to define the location and orientation of each **Solid Objects**.

The buttons for **Solid Rectangles** can be found in the **Construct panel** on the **Home tab** of the **Ribbonbar** and in the **Solids panel** on the **Construct tab**. The **Solid Circles** button is only on the **Construct tab**.

**Solids** can be named for later reference. If no name is user-defined, Visual will call all **Solid Objects** "Solid". Naming objects can be useful, but it is not required.

The **Color** and **Reflectance** of **Solids** are tied together in Visual. Specifying a numeric **Reflectance** will cause Visual to choose the analogous gray shade to match. Clicking the **Color** button will launch the **Color Dialog** to allow for more detailed **Color** selection.

To construct a **Rectangle**, specify the *coordinates* of the first **vertex** using the mouse, keyboard, or **Object Snap**. In the command, moving the mouse causes Visual to draw the implied **Rectangle** showing what will be created when the command is completed. To end the command, right-click the mouse or press **Enter**.

See [Constrcuting Solid Objects](#) for important information about various parameters and behavior of **Solid Objects**.
5.2.4 Rooms and Structures

A large majority of projects will include Rooms and Structures that are Polygonal or Rectangular in plan view and will have flat ceilings and roofs. Visual includes the ability to quickly construct these Rooms and Structures that are a pre-Grouped collection of Solid Objects (Solids and/or Surfaces).

Rooms and Structures can be created in Polygonal or Rectangular form. The semantics of Surface Normals is the only difference: Rooms will have all normals pointed inward. Structures will have all normals pointed outward; this aids surface-based commands such as placing Calculation Zones.

Because of the orientation of normals, Rooms are normally used for Interior calculations and Structures used in Exterior calculations. Structures could be used to model details of an Interior project such as bookcases and desks.

The Room and Structure buttons can be found in the Construct panel of the Home tab and the Solids panel of the Construct tab in the Ribbonbar.

The Room button is dual function; the upper portion executes the command, the lower portion initiates a drop-down menu.

Once Polygonal has been chosen, the upper button portion will change to execute that command with the next press and the graphic is changed accordingly. Selecting Rectangular from the drop-down menu will revert the button to that mode.

The Structure button is dual function; the upper portion executes the command, the lower portion initiates a drop-down menu.

Once Polygonal or Wall has been chosen, the upper button portion will change to execute that command with the next press and the graphic is changed accordingly. Selecting one of the other commands from the drop-down menu will revert the button to that mode.

Rooms or Structures share a similar interface in the Properties tab of the Ribbonbar that is shown upon command execution. Note the similarities to single Solid construction.

Rooms and Structures can be named for later reference. If no name is user-defined, Visual will call the Grouped Solid Objects "Solid". Individual Surfaces are named "Floor", "Ceiling", and Wall x" accordingly. Naming objects can be useful, but it is not required.
The *Height* of the *Room* or *Structure* must be specified. Note that the *Height* last specified as input for the command will be used as the default (which can of course be changed) upon the next execution of the command; the idea being that heights of *Rooms* and *Structures* will be the same in most cases for a given project.

Parameters specified for one type of *Room* or *Structure* do not carry over to other types.

The *Color* and *Reflectance* of Ceiling, Walls, and Floor are chosen individually. Recall that *Color* and *Reflectance* and are tied together in Visual. Specifying a numeric *Reflectance* will cause Visual to choose the analogous gray shade to match. Clicking the *Color* button will launch the *Color Dialog* to allow for more detailed *Color* selection.

To construct a *Rectangular Room* or *Structure*, specify the coordinates of the first *vertex* using the mouse, keyboard, or *Object Snap*. In the command, moving the mouse causes Visual to draw the implied *Rectangle* showing what will be created when the command is completed. To end the command, right-click the mouse or press *Enter*.

To construct a *Polygonal Room* or *Structure*, specify the coordinates of the *vertices* using the mouse, keyboard, or *Object Snap*. In the command, moving the mouse causes Visual to draw two types of implied lines: the small-dash line connects the first point to the last specified point to illustrate the result if the command is ended and the large-dash line connects the cursor to the last *vertex* specified. To end the command, right-click the mouse or press *Enter*.

To construct a *Wall*, specify the coordinates of the *vertices* using the mouse, keyboard, or *Object Snap*. Visual will extrude the specified *polyline* to the *Height* chosen in the *Properties* tab. In the command, Visual will connect the mouse cursor to the last point specified with a solid line. Right-click the mouse or press *Enter* to end the command.

Note that these commands can be used when the *Active Plane* is set to Y-Z or X-Z. Extrusion (the effective operation that gives *Rooms* and *Structures* their *Height*) occurs in the positive direction perpendicular to the *Active Plane*. 


It is important to select **Color** and **Reflectance** to align with the properties of the materials in the actual project. For example, 80% **Reflectance** is valid for a ceiling composed of higher end acoustic tile, but is certainly not appropriate for raw materials used in most "open to deck" scenarios or sprayed-on insulation, especially when an indirect **luminaire** is used. The default values for **Rooms** are 80% ceiling, 50% wall, and 20% floor **Reflectance** (often referred to as "80/50/20"). **Structures** and **Walls** have 50% **Reflectance** for all **Solids**.

The choice of a **Color** is only necessary if **Color Rendering** is a desired output from **Visual**. Grayscale choices yield the same numeric results as "colored" choices, assuming the **Reflectance** value is the same.

The **Color** and **Reflectance** chosen for **Solids** is independent of the **Layer Color**. The **Layer Color** is used to provide user feedback in the **Design Environment** and the **Color** and **Reflectance** is used for calculation.

On the right, the objects with a black border have different **Color** (and therefore **Reflectance**) on the **Solids System Layer** (**Color** is **ByLayer**) and those with a green border are on a separate **Layer**, also with different **Color** (and **Reflectance**). In **Shaded Display Mode** shown at the bottom, borders (drawn in the **Layer Color**) are not shown. The gray, red, and blue all yield the same calculational result because they are all 50% **Reflectance**.

The **Solids** created by these commands are **Grouped**. See **Group** for more information. Note that **Solid Objects** are named "Floor", "Ceiling", and Wall x" accordingly.

**Rooms** and **Structures** can be modified with the **Properties** command just like single objects. When a **Room** or **Structure** is selected, **Visual** displays the associated **Solids** in the **Surfaces** section of the **Sidebar** (as shown at right). See **Ribbonbar Properties Tab** for information on object modification and how **Single Selection** and **Multiple Selection** impact selection of **Grouped** objects when editing **Properties**.

Note that **Rooms** and **Structures** can be created, **Exploded**, and modified as part of the process of **drawing** more complex models. For example, a **Structure** could be created mimicking a column then **Exploded**, the top and bottom (ceiling and floor) **Erased**, and then the objects re-**Grouped** for later ease of use. See **Modify**.