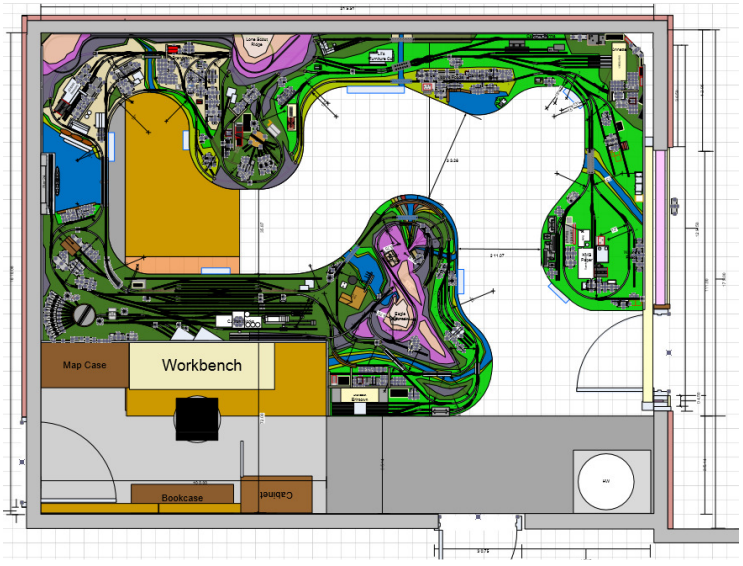
Model Train Track Planning with Microsoft® Office Visio®



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Model Train Track Planning with Microsoft® Office Visio®

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Published in the United States of America

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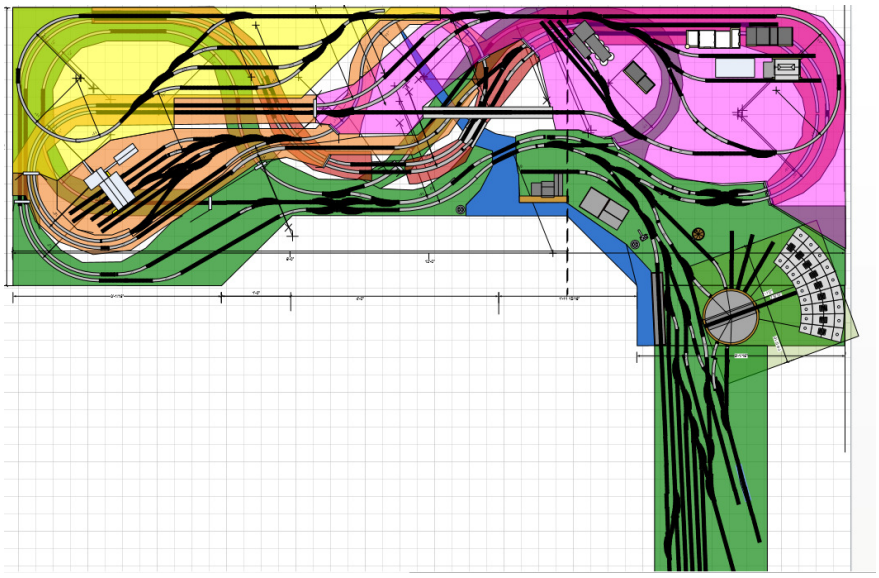
Visio® Based Model Railroad Track Planning

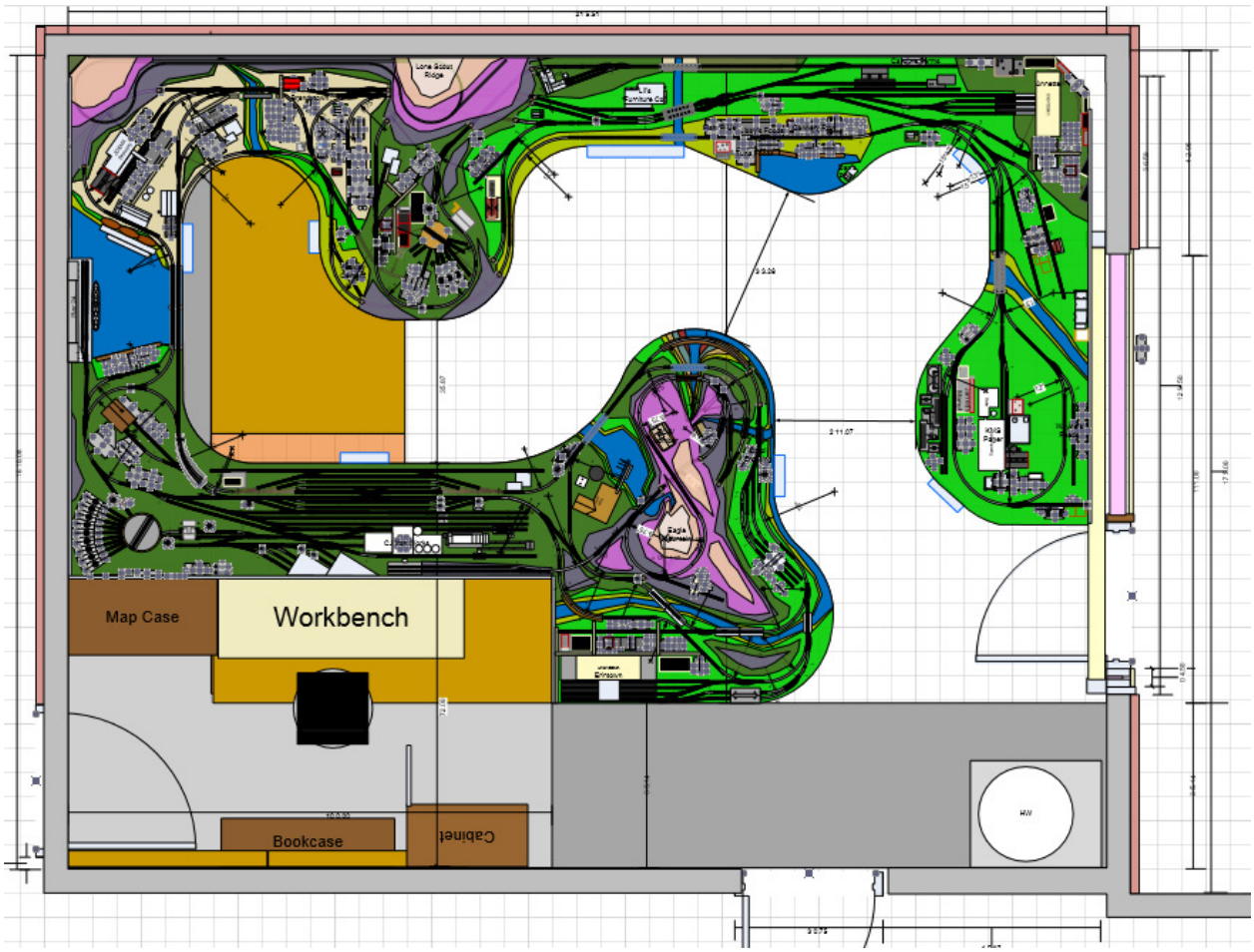
Layout planning or planning modifications has traditionally been a daunting task that requires sitting for hours with a pencil, drawing templates and a very large eraser. As a software Engineer by profession, it is my natural tendency to look to the computer for providing solutions to the design and development of a layout track plan. In the pursuit of that perfect layout to fit the available space, there are multiple CAD programs that allow for the development in 2D and 3D track plans. This tutorial is to present a route that may not have been fully explored to designing and laying out a track plan.

Microsoft®, the very large software company from the Pacific Northwest, has a 2D drawing package, called Office Visio® that may be the answer to designing the next modification or full track plan for your layout. My journey of track planning and development has been the culmination of many years using the standard pencil and paper and drawing packages for various layouts. I had a full plan and started building the benchwork for an 8 ft. x 14 ft. upstairs storage room.



Then fate stepped in and I am currently back in the design phase. This time for a new layout that will occupy a 17 ft. x 22 ft. single car garage, which more than tripled the available square footage. This re-planning allowed for the addition of new large industries in line with recent kit purchases. On the flip side, it increased the amount of benchwork, track, wiring, scenery and everything else that a layout entails. To accommodate a new layout for the additional space I returned to a drawing package that I have used for work: Visio®. I use the Visio® Professional version as that is what I have available, but for any version of Visio® the methods described in this tutorial are valid.

Why not one of the train CAD packages? The answer is fairly simple: 1. The need is for a computer based 2D drawing package that is with the budget (Through an employee purchase program it was only $9 USD). 2. It does not encompass a monstrous learning curve to be able to use like most track CAD programs.3. The tool is required allow for an accurate (to Scale) drawing of the layout and the room the layout will occupy. 4. The tool must be able to be modified to the scale/gauge of the track that will be used in the layout.5. And lastly, it must be something I have available to me and not a new purchase.



Visio® presents a drawing canvas that is capable of being configured to a specific architect's drawing scale. This allows for the 2D drawing to accurately depict the real world in a scale representation. For the purposes of this introduction to the tool, all dimensions will be in US rather than metric units.

The section Introduction to Visio® covers learning how to use Visio® starting with how to open the application and configure it to match a specific room's dimensions for the layout. The tutorial starts with defining how an HO layout will be used to fit into a 10 ft. x 10 ft. room using HO Code 100 Snap Track®.

Once the room organization has been defined, the basic shape of the layout is constructed by introducing the drawing functions of Visio®. You will learn how to use these operations to build a base layout shape for the tutorial layout.

Upon completion of building the base shape the real power of Visio® for track planning starts to take shape. The tutorial instructs you how to build shape

stencils that are used to quickly drag and drop track, switches and building shapes into the layout.

Terrain, tunnels and rivers are introduced utilizing functions in Visio® allow you to build a 2D top down view of these constructs on the layout.

In addition to laying out the track the tutorial includes instructions on how to take the track plan and convert it to a control panel schematic diagram. In addition to the schematic, instructions are included on how to represent lamps and toggle switches on the schematic diagram.

A description the benchwork to support the example is presented in a way as to allow you to construct L-Girder benchwork.

Additional chapters include how to generate an inventory of track or buildings from the layout plan and how to generate accurate measurements of items on the layout. Lastly, I have included 1°, 2° and 3° rise charts for quick reference.

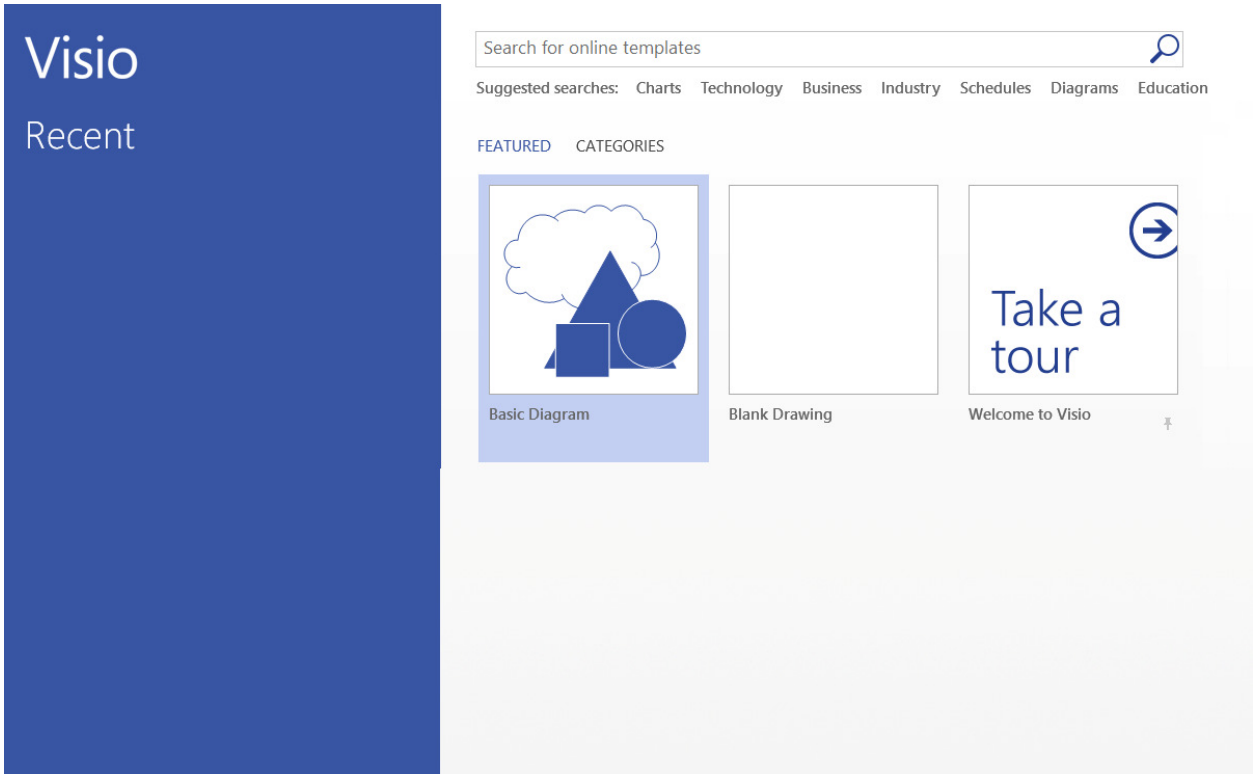
The tutorial layout will occupy a 10 ft. x 10 ft. room and will be in HO Scale using either flex track or Code 100 Snap Track. The methods that are described here will work for any gauge, size or shape of room or layout. Additionally, the techniques will work for any manufacturer's track, scale, or products that can be drawn in a top-down 2D representation. So let's get started.

-Eric Smith

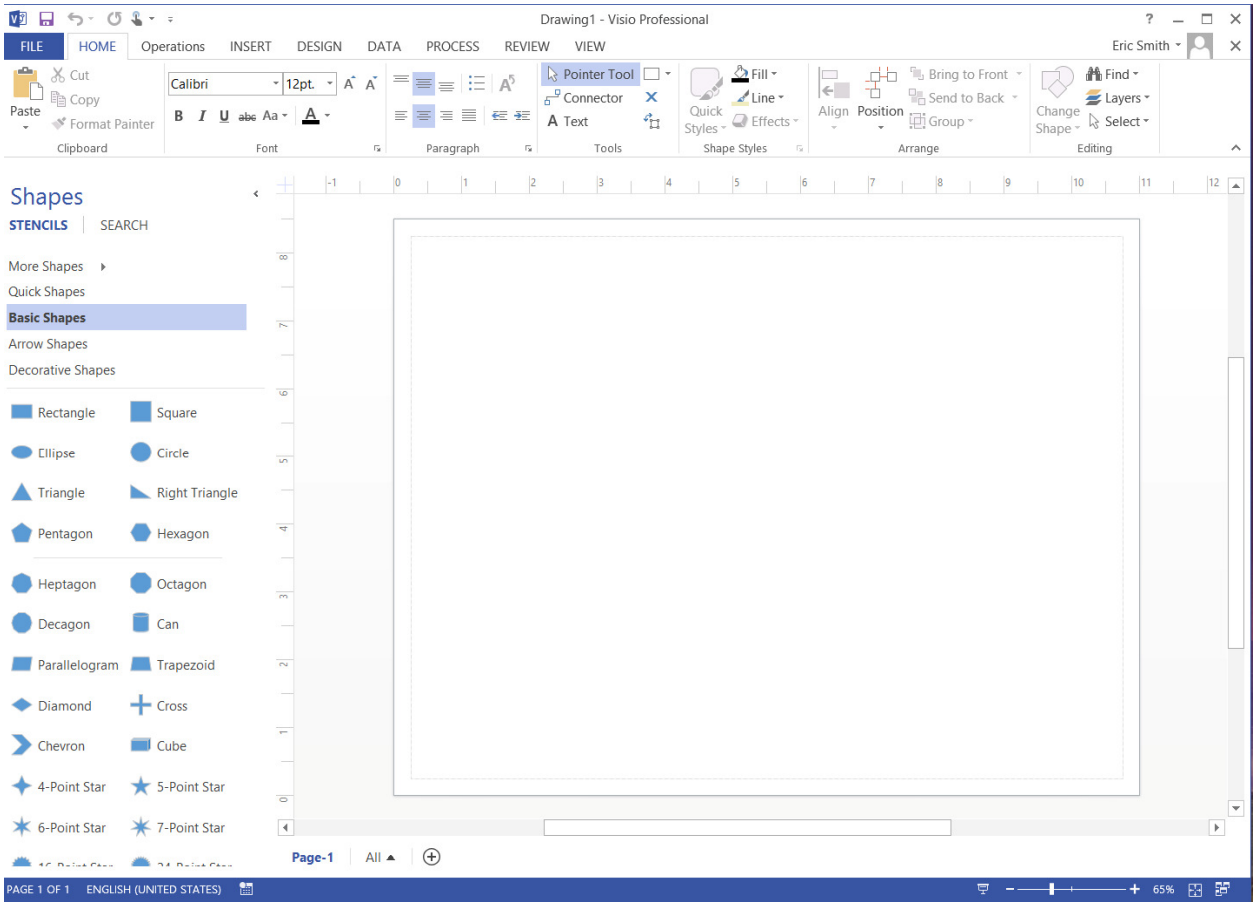
August 2016

Introduction to Visio®

Open the Visio® application from the PC. Visio® will present a screen to allow the user to select the type of drawing that is to be used. This selection represents the stencils that are standard for the type of drawing to be produced. Since one purpose of this write up is to show how to develop a stencil specific for the drawing of track plans, the Basic Diagram is where to begin. A Single click on the Basic Diagram icon will bring up a selection dialog for either Metric Units or US Units. This tutorial will use US measurement units.



The canvas for the basic open screen is for a single page of paper. As items are moved outside of this single page, Visio® will add additional pages to the display canvas automatically.



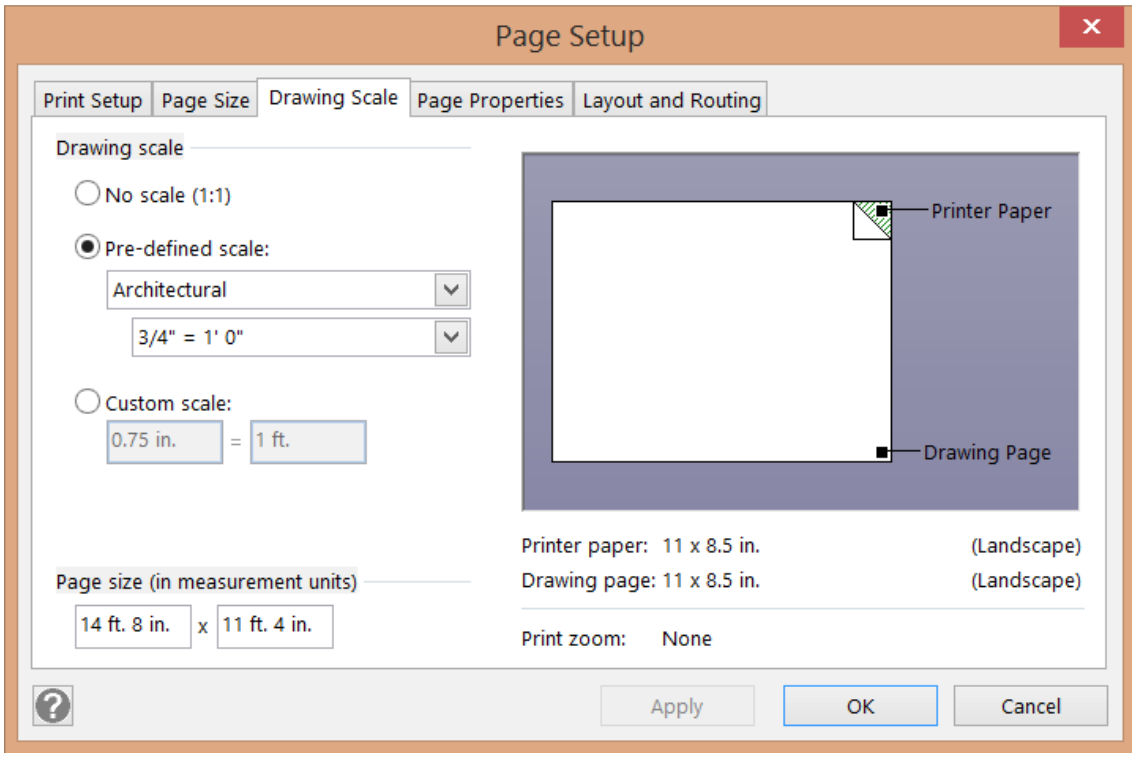
For this tutorial, a single page is a piece of 8.5” x 11” US letter paper. The horizontal and vertical rulers around the drawing canvas represent the size of the drawing itself. Along the left side is the shapes and stencils toolbox. The Stencil/Shapes toolbox is one of the more powerful capabilities for use in the model railroad track planning. The Shapes toolbox allows for a drag and drop capability of objects onto the drawing canvas. Simply select one of the objects from the toolbox by holding down the left mouse button and drag it from the toolbox onto the canvas. This creates an instance of that object into the canvas. Repeating this action with other toolbox entries allows for the creation of complex diagrams.

To help with the drawing it is recommended that the “Theme” not be applied to any elements drawn in the canvas. This feature defines a default fill color and inserts a shadow to the objects created in the drawing canvas. Using the Design tab select the “More” theme selection from the themes scroll bars. This is represented by a down arrow with a line on top of it. A list of themes that can be applied to the drawing will be displayed appended to the bottom of the smaller

theme selection toolbox. Uncheck the selection at the bottom of the list for “Apply Themes to New Shapes”. All shapes drawn will now use a default outline of black and a fill color of white.

The first step is to put the canvas in a viewing mode appropriate to the physical dimensions of the room. For simplicity this tutorial will use a 10 ft. x 10 ft. room. To set the canvas size, select the View tab and then Page Setup from the View toolbar. This will bring up a dialog box that allow for the definition of drawing scale of the canvas by selecting “Drawing Scale” in the “Page Setup” Dialog box. Selecting the “Pre-defined scale” radio button will allow for the selection from 2 pull down selection boxes. The first pull-down selection box is the type of scale and the second is the actual scale for the drawing based on the size of the paper.

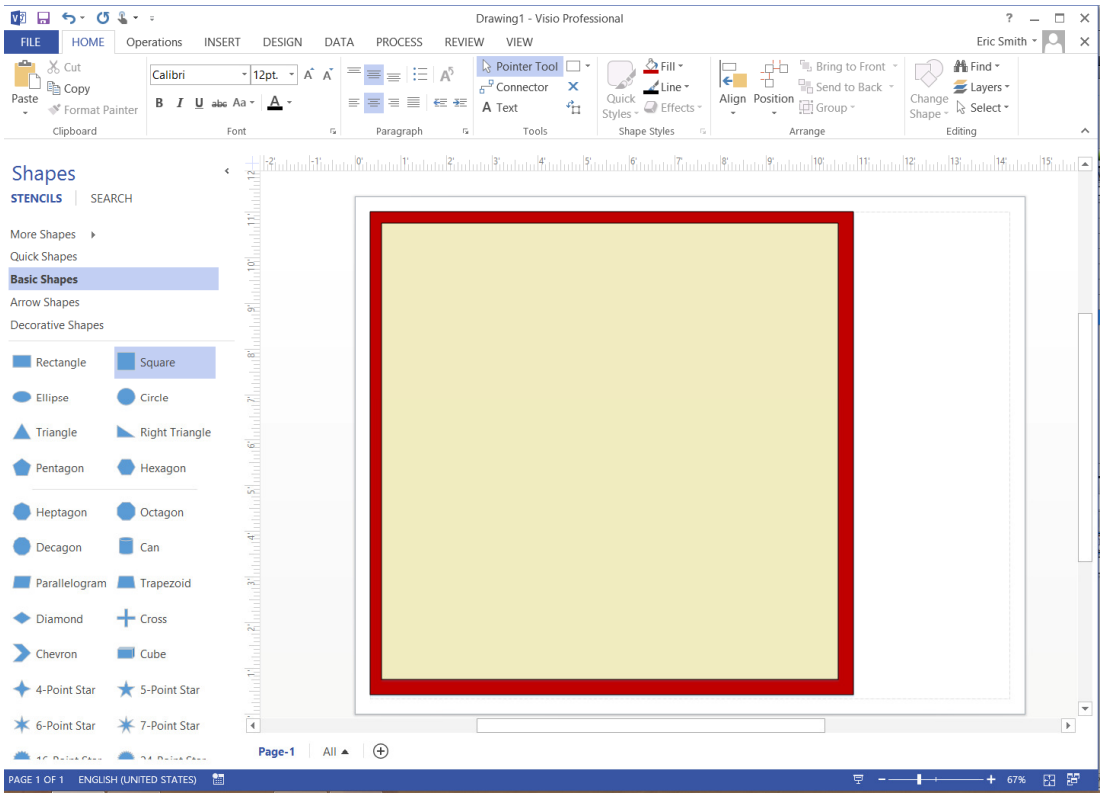
In the lower left of the “Page Setup” dialog box is the Page size (in measurement units). The page size in measurement units can be modified by changing the scale from 3/32” = 1’0” to another value. To appropriately represent the 10 ft. x 10 ft. room, a scale of ¾” = 1’0” can be used. This sets the page size to 14 ft. 8 in. x 11 ft. 4 in. which is enough to represent the room and any walls for the 10 ft. x 10 ft. room. Pressing the “OK” button will set these values for the drawing canvas.



When the Page Setup Dialog box closes, the canvas rulers along the top and left side now represent the drawing scale of the size of the canvas in feet.

To draw the room, select a square from the shapes tool box and drag it to the canvas. This will generate a 2 ft. x 2 ft. square on the canvas centered where the mouse is released. By moving the square around before releasing the left mouse button, the square can be positioned appropriately close to the top left of the drawing. This rectangle represents the “perimeter” of the room, and in the US wall studs are 3.5 in. with approx. 0.5 in. of sheetrock. For this tutorial, assume that the sheetrock has not been applied, but that the studs are exposed. Adding the stud size value, 10 ft. + 3 ½ in. + 3 ½ in., will make the size of the perimeter of this rectangle to 10 ft. 7 in x 10 ft. 7 in. To draw the room outline, select the lower right small white drag box on the square shape and drag the shape until the size (as shown at the bottom of the screen) indicates the box is 10 ft. 7 in. x 10 ft. 7 in.

The room is drawn by instancing another square from the shapes toolbox and sizing it to 10 ft. x 10 ft. Do not worry that the two do not form what looks like a room, what is important at this step is to get the shapes in the correct horizontal and vertical dimensions.



Select the Home tab from the top menu to bring up the “Shape Styles” toolbox entry. This selection box contains the options to change the color of the box in addition to the line around the outside of the box. It is possible to change the 2nd created box to match the color of the flooring in the room by selecting this option. Press on the small downward pointing triangle next to the “Fill” bucket and select a color. A personal preference is to set the color of the first rectangle to a brick color or gray to represent the wall. Set the color of the second rectangle to a one representative of the carpet or flooring in the room.

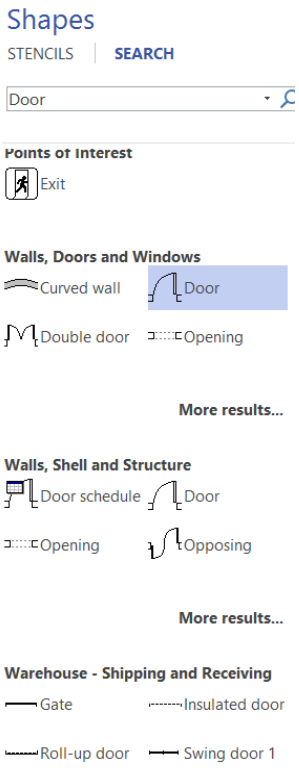
The “Line selection” option in the “Shape Styles” toolbox allows for the changing of the outline around the boxes. Set this value to “Black” for delineation between the squares. Do this for both squares.

Currently the two squares representing the room are not aligned correctly. The “Arrange” toolbox entry on the Home tab provides a mechanism to remedy this situation. Pressing on both of the existing boxes with the left mouse button held down allows for the selection of both squares. Note: select the background “wall” first then the floor. The order is important as the align tool works relative to the first object on the screen selected. Select the “Align” pull down (the downward triangle under the word “Align”) so that the squares can be aligned to the center and to the middle in successive selections. This is accomplished by selecting “Arrange”-“Align”-“Align Center” and then “Arrange”-“Align”-“Align Middle”.

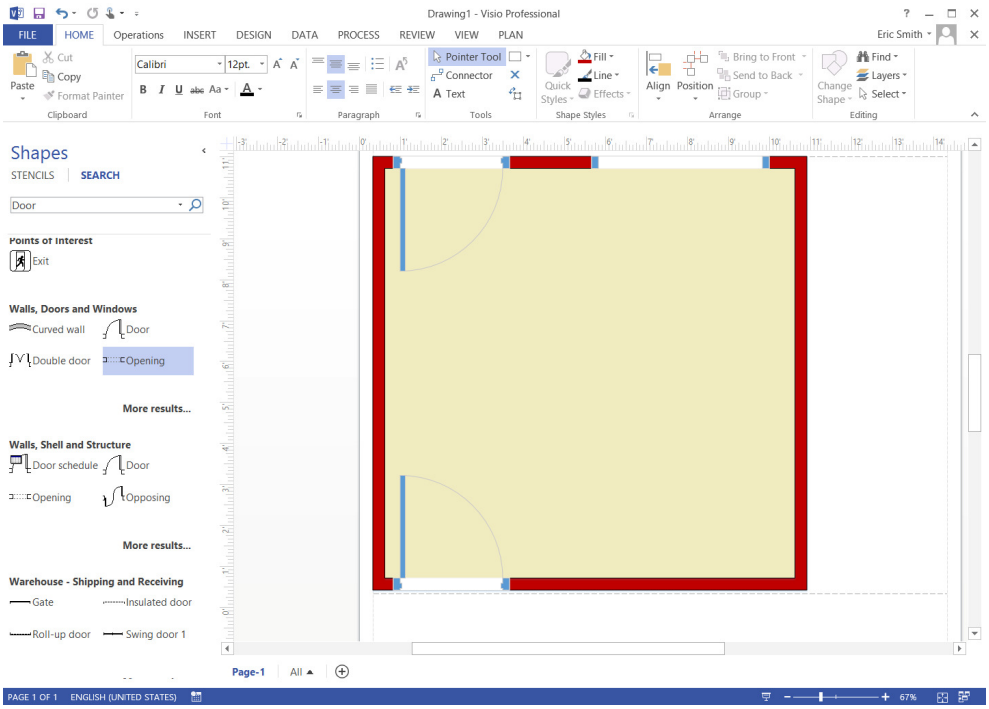
All rooms have some sort of egress to the room, a door a window or stairs. For this demonstration, assume the room has a door into the room, a closet door directly across from the entry door, and a 4 ft. window on the same wall as the closet. To draw these items for the room, Visio® already has some pre-defined shapes for doors and windows. Select “Search” under the “Shapes” title on the left of the canvas above the stencil toolbox. This will bring up a search text entry box to allow for the selection of pre-defined stencils. Entering the word “Door” and pressing enter will cause Visio® to search and display a list of shapes that are in this category.

The “Walls, Doors and Windows” subtitle contains a door that is The “Walls, Doors and Windows” subtitle contains a door that is configurable to meet the requirements of the room. Dragging the “Door” icon onto the canvas instantiates/creates one door in the drawing. The door comes into the canvas in a

“standard configuration of 2 ft. 6 in. in size. With the door still selected, press the right mouse button to bring up the option to reverse the door from a right opening to a left opening. Next drag the door into the lower left corner of the room into the gray portion of the wall. Align the door with the inside line of the door aligned with the inside of the room. The door thickness can be reduced by selecting the center white selection box of the door and dragging it up to match the size of the wall. If the door is more than 30 in., a right mouse click and selecting properties of the door will allow for accurate dimensioning of the door opening. The process of inserting, reversing the opening and placement of the door can be done to put in the closet door on the opposite wall.



A window is represented in the Shapes toolbox as an “Opening” from the “Walls, Doors and Windows” subtitle. Just like the door, the opening can be adjusted to fit the correct size and placement on the wall.



If the door or window is not on a horizontal wall, but on a vertical wall select the door with a left mouse button. A circular arrow will appear above the selected

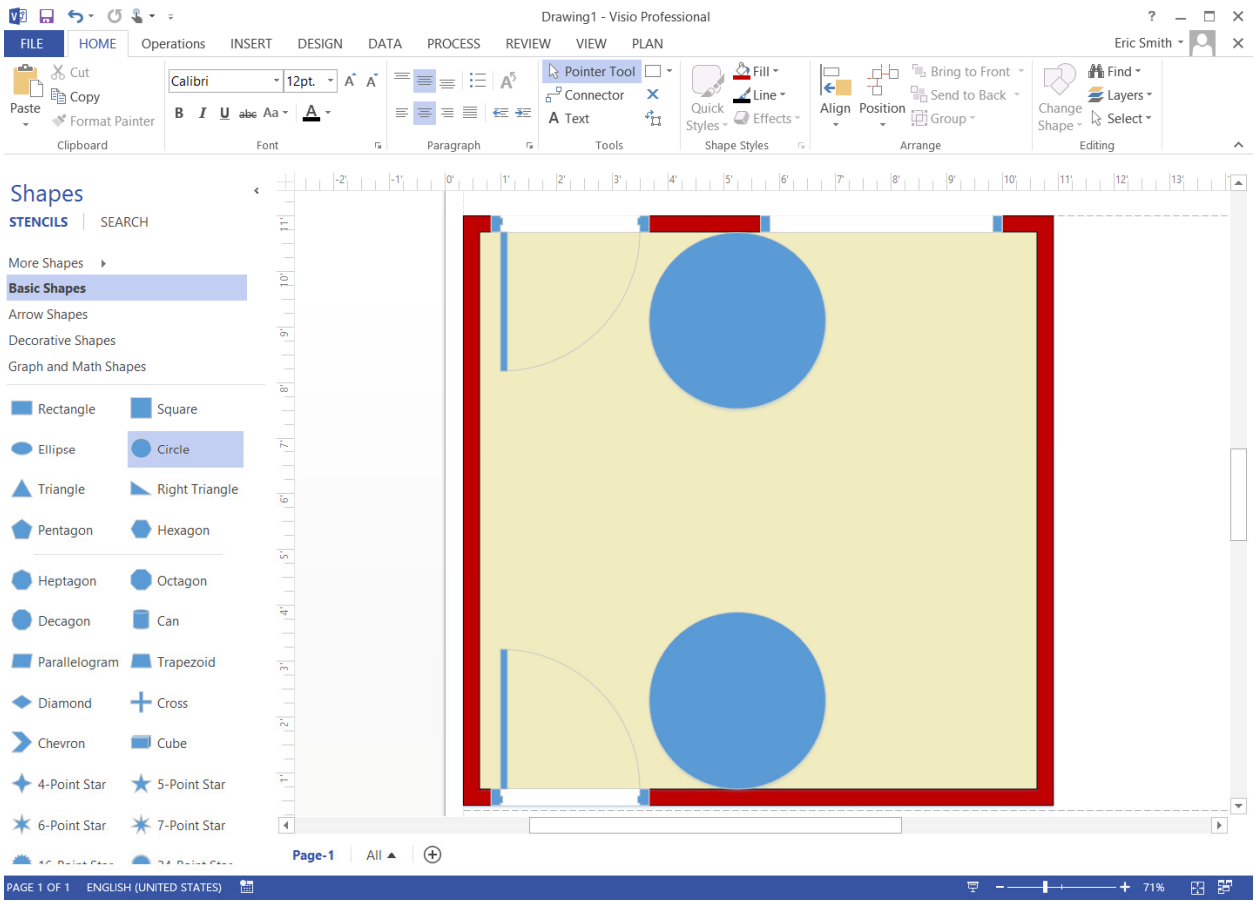
object. This circular arrow, and the line from it to a small circle in the center of the shape, represents a rotation mechanism for the object. The circular arrow is used to rotate the shape and the small circle is used to represent the center of the rotation. Clicking on the circular arrow changes the cursor to represent the rotation control of the shape. Holding down the left mouse button and moving the mouse left or right will rotate the shape. Rotating very close to the center of rotation of the object will increment the rotation in steps of 15º. Moving away from the center of rotation and moving the mouse left or right will rotate the shape in smaller increments starting at 10º, next 5º, then 1º and finally 0.1º. This will work for all shapes and groups of shapes in Visio®.

Congratulations! The room has been set up. So from the File menu or the small disk icon above the File menu tab, save the layout plan with the name of "Visio® Layout Tutorial". The next step is draw the basic shape of the layout and to put on track.

The Layout – the Basic Shape

In this tutorial room there are basically 3 walls that can be utilized for the layout. The layout is a HO Scale modified figure-8 that travels around the layout covering as much of the room as possible. The minimum radius curve is limited to be 15 in. in special cases, but 17 in. will be the normal radius. This will restrict how much track can be put down and how much space is available in the room for other activities, such as a workbench.

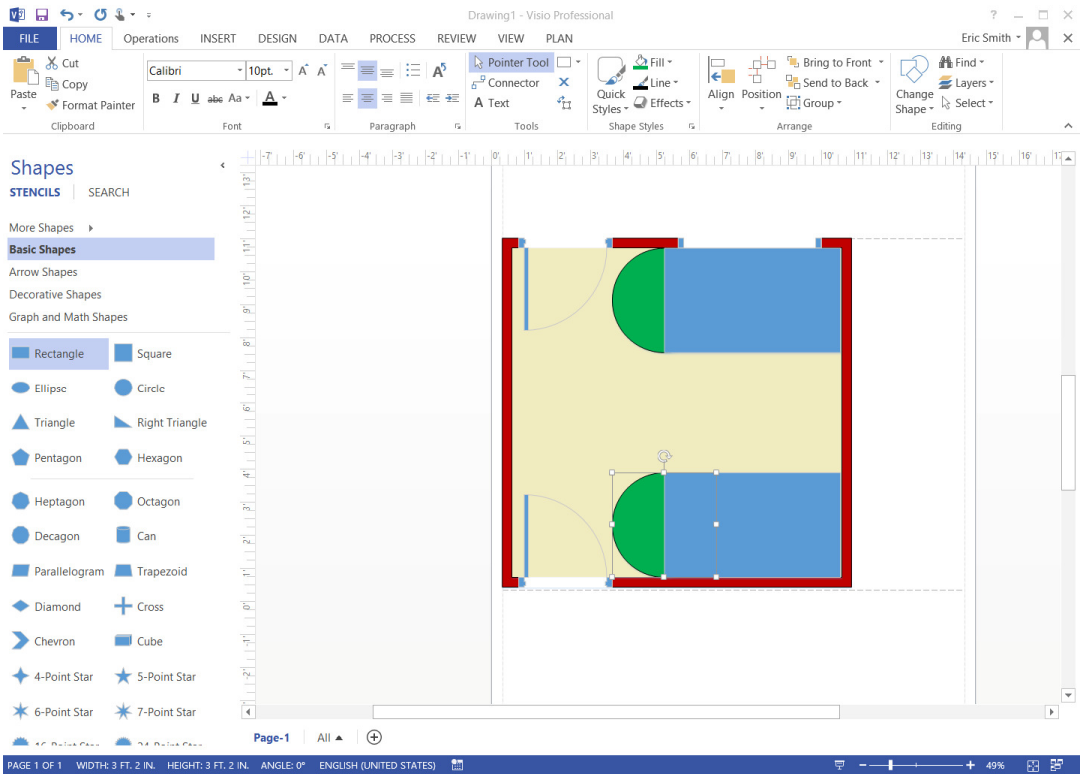
Starting with the underlying layout base, there will be a 2 in. distance from any track to the edge or wall. That means that the 34 in. required for a 17 in. radius circle now becomes 38 in. Drag a circle from the Basic Shapes stencil on the left of the display canvas and size it to 3 ft. 2 in. using the up and down arrows move the circle to the wall just under the window, but clear of the closet door until it touches the wall. Using the copy and paste, make a copy of the circle and place it on the opposite wall next to the entry door.



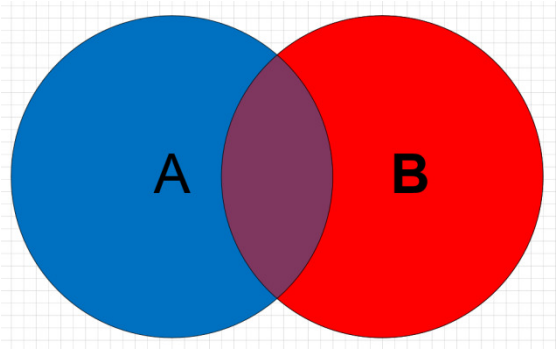
To make the circles align vertically correctly, select both of the circles while holding down the shift key on the keyboard. A rectangle will be drawn surrounding the selected circles to show the boundaries of the circles. Using the "Arrange"-"Align"-"Align Left" command will make sure that the circles are at the same position relative to one another on the left side.

After the circles have been placed and aligned, it is time to start creating what will be the layout base for the track plan. Select a rectangle from the Shapes and position it approximately at the top center of the top circle. Using the right center and the bottom center white selection boxes of the rectangle drag (increase the rectangle in size horizontally and vertically) to the right and downward until the bottom of the rectangle touches the wall to the right and the bottom of the circle to the left. Repeat this rectangle addition for the bottom of the layout.

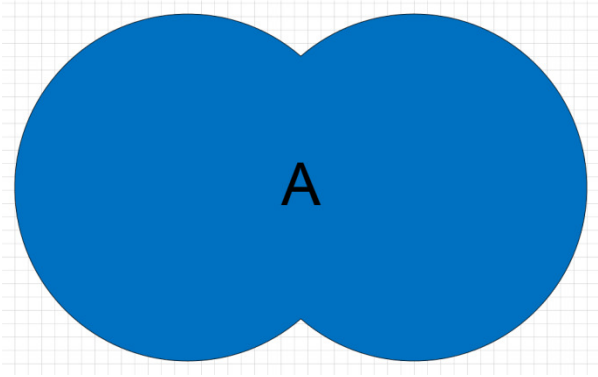
Since this is the base layer of the layout it is nice to color it something like grass green or a brown for dirt. Use the mechanisms previously described to select a color for the objects representing the layout on the screen. In order to understand how some of the mechanisms in Visio® work, make the color of the circle a different color than the rectangle.



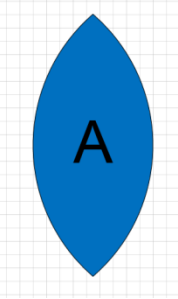
Visio® supports the concept of “Operations” on objects that allow for the merging or removal of various parts of an object in the canvas. These operations are some of the most power tools available for generating up the shapes for a Model Railroad layout. Operations can best be thought of as Venn or Set diagrams and the possible logical representations of changes to the sets in the diagram.



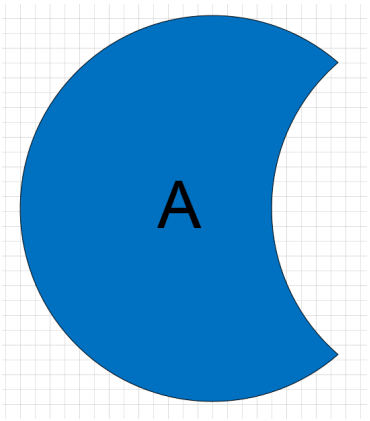
A union operation on a set is the combination of both of the objects.



The intersection of a set is the point where the objects overlap.



The subtraction of one set is shown by the resulting portion of the set minus the point where the two sets intersect and the other set.



To utilize the various set manipulation mechanisms, it is easiest if the pull down menu for the operations is located on the Home tab. To add this, right mouse click in the white area to the right of the existing menu options that contains "Style Shapes, Tools, etc." Select "Customize the Ribbon…" from this pull down menu. This displays the Visio® Options for customizing the ribbon. On this dialog, select the Main Tabs from the pull down and Open the "Home" menu by selecting the small "+" in the box beside the checkbox for Home. This shows the list of tool bar options that exist across the "Home" tab on the top of the screen. Select the Home in this list. It will have a highlight color to reflect the selection.

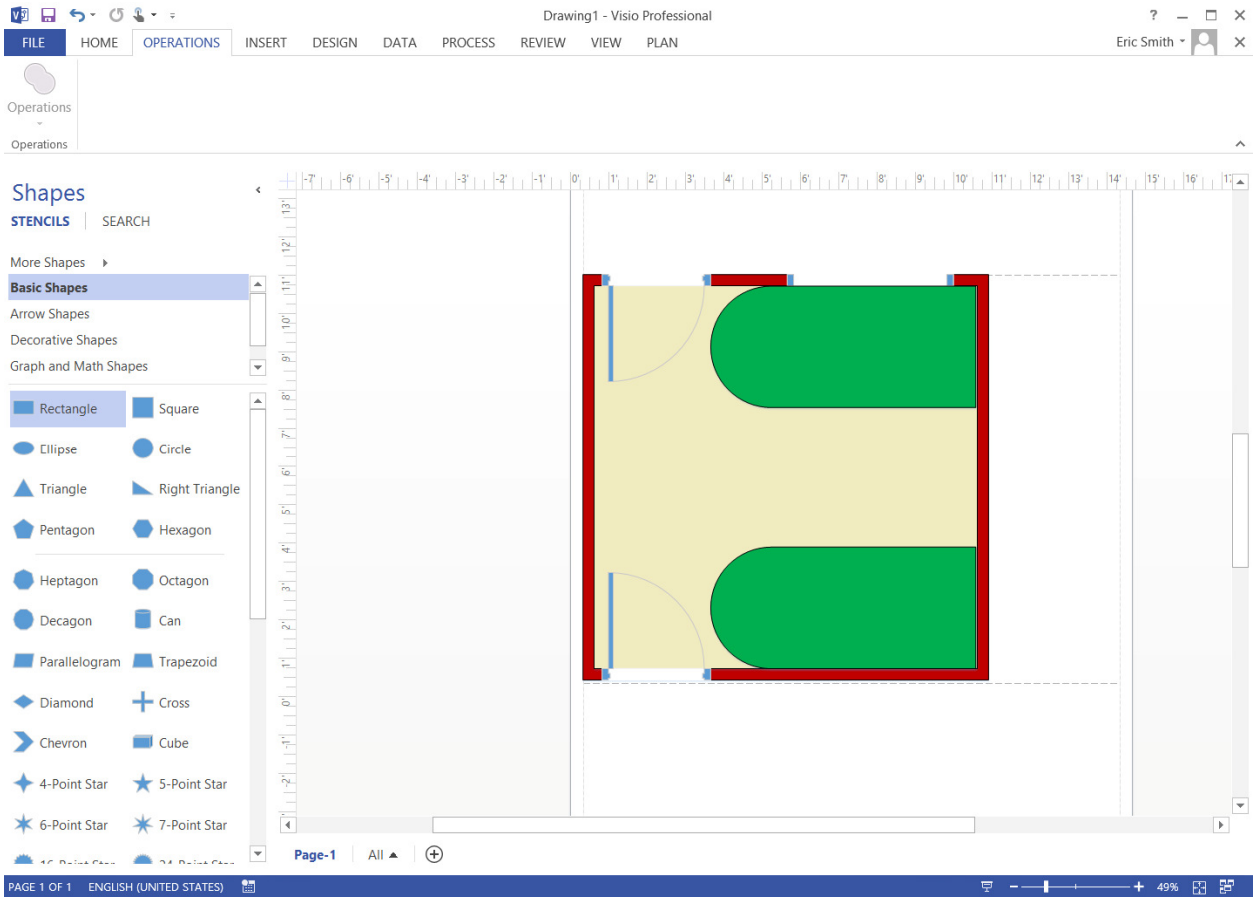
In the left pull down: "Choose commands from:" instead of "Popular Commands" select "All Commands". The entire list of commands available to use in Visio® are listed. Scroll down until "Operations" is shown and highlight it and then press the "Add>>" button in the middle of the dialog box. Press "OK" and the list of Operations is not on the Home menu for selection.

The Operations menu consists of selections to manipulate multiple objects as functions of the Venn diagram modification operations. The two I use are Union and Subtract. I rarely use the others if at all and then only "Intersect". The "Union" allows for the merging of multiple objects into a single object. The "Subtract" option allows for the removal of one object from another. To see these operations, an object must be selected from the canvas. Otherwise the menu is grayed out indicating it is not a valid command.

On the "Operations" menu, the Union operation allows for the merging together of multiple objects into a single object on the screen. To do this multiple objects must be selected concurrently. To select multiple objects, the "Shift" key is used in conjunction with a left mouse click. An example of this is to first select one of

the rectangles with a left mouse click. Press and hold the shift key down and select the circle that is under the rectangle with another left mouse click. At this point both object are “highlighted” with a border around them and common white “selection” boxes.

The order the objects are selected is important for operation commands, because the properties such as color and border color, line thickness, etc. of the first selected object will be passed onto the new object. With both of the objects selected, use the “Union” Operation from the “Operations” pull down menu. A single “Half-Pill” shape will be produced that has the first selected object’s color. Repeat this procedure for the other circle and rectangle.

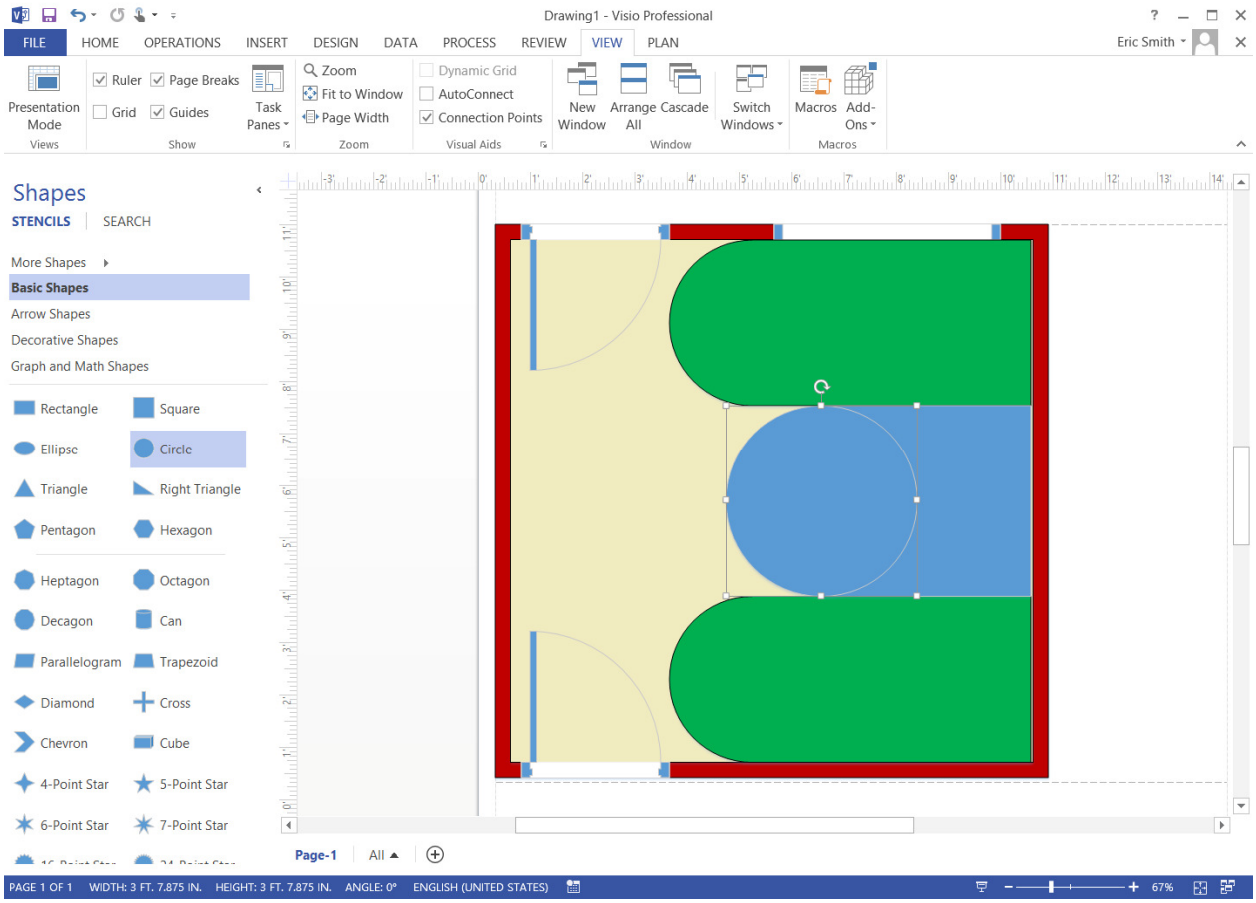


For this layout the normal minimum radius selected is to be limited to 17 in. Using this limit, care must be taken to accommodate the curvature from each of the 2 parts that have already been created. Instantiate/drag a rectangular area that connects the top and the bottom pill shapes already created. This is done by dragging a rectangle between the other rectangles along the wall. Make this

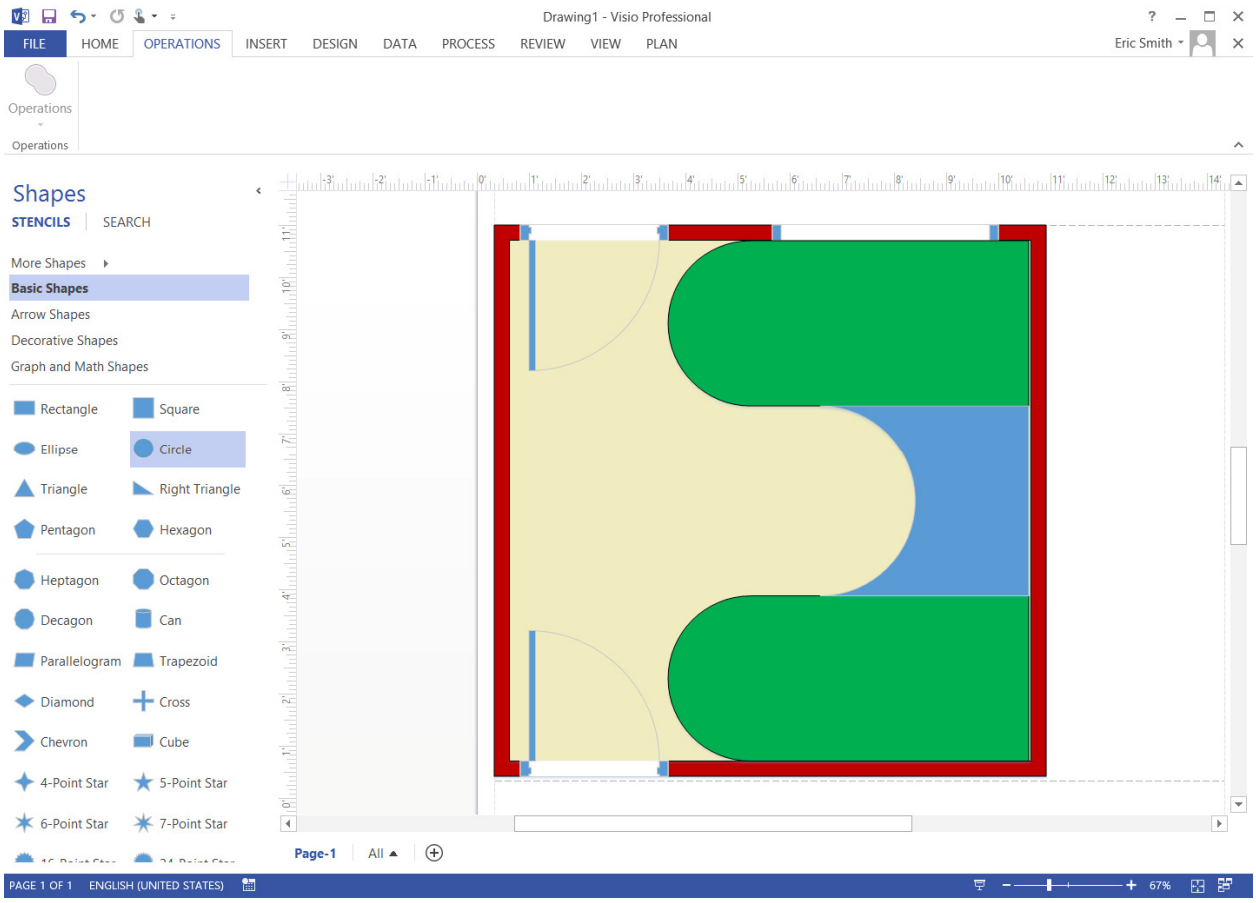
rectangle 4 ft. wide and if everything was correct with the generation of the other rectangles, it will be 3 ft. 8 in. in height. Note that 3 ft. is a little wide for this connecting section and it would be nice to generate smooth curves between the sections already generated. This can be done by the use of the “Subtract” operation.

To build the concaved curvature between the two half-pill shapes drag a circle from the shape in between the two pill shapes and expand its size to exactly touch the top and bottom of the two layout halves.

Slide the circle to the right until the center selection boxes line up with the left edge of the 4ft. x 3 ft. 8 in. rectangle using the arrow keys.



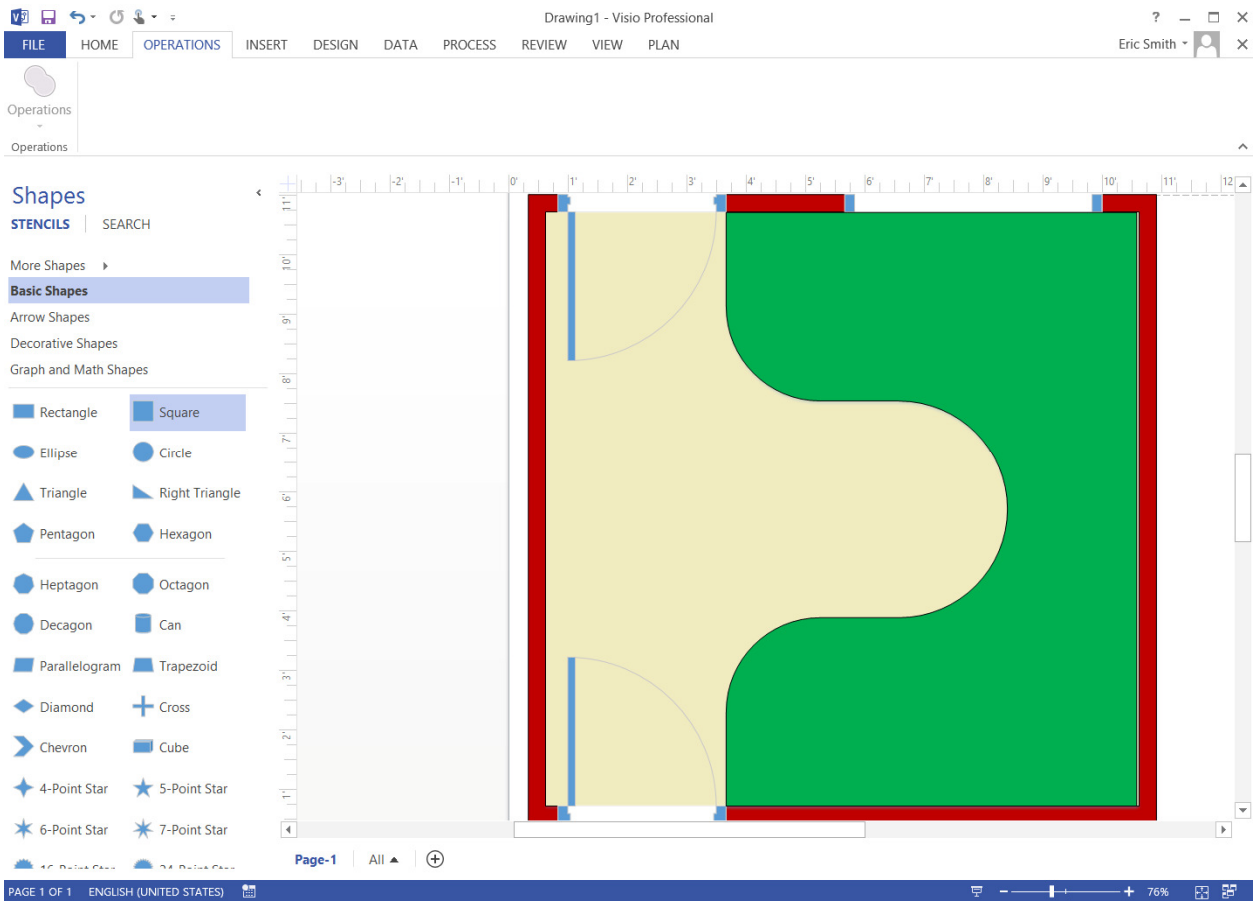
De-select the circle and select the underlying rectangle. This is because for the subtract operation, the first shape selected gets subsequent shapes subtracted from it. Hold down the “Shift” key and select the circle. Using the Operation subtract, remove the circle from the rectangle.



There are now 3 objects on the screen that should be one, representing the base of the layout. This is done by use of the Union command combining the 3 objects together. In the same manner as the merging of the original circle and rectangles, use the Union command to combine the base layout objects. Once again order is important to keep the color of the first select object.

At this point, a “base” layout structure should appear in the canvas that is representative in size (Feet Horizontally x Feet Vertically) of the proposed layout.

The only problem with this base layout is the curvature at the end of each end of the layout. There is a little wasted space in between the layout and the doors to the room and the closet. The addition and merging of rectangles that fill this gap on each side corrects this problem.



This is another one of those good spots in the tutorial to save the layout to the disk. Use either the “File” menu or the floppy disk icon above the File menu to save the layout plan.

Layers

It is now time to start on planning the track for the layout. However, some caution must be takes so as to not disturb what has already been generated. The way to do this by the creation of layers representing the various components that have been drawn onto the canvas. Select everything in the canvas by pressing Control-A. Note: Keep the Layout shape separate by holding the “Shift” key down and “de-selecting” the base layout portion of the drawing.

On the “Home” tab toolbar is the “Editing” menu. In this option is a “Layers” pull down. From this menu select “Assign to Layer”. This brings up the “Layer” dialog box. Since some of the items place into the drawing already have layer definitions, select “None” from the buttons on the right side of the dialog box. Next assign the “room” objects (The walls, the doors, window, etc.) to a “New” layer designated as “Room”. To do this select the “New” button on the right, which will bring up the New Layer Name box. Enter the word “Room”, and select “OK”. In the Layer Dialog, a new layer name is now present with the name “Room” checked. Select “OK” to close the Layer Dialog.

Next select the Layout base and repeat the Layer assignment but with a separate layer titled “Layout”.

There are two distinct layers that have been created to represent the room and the base layout. These areas need to be protected so that when new items are placed onto the canvas these will not be disturbed, and cannot be selected. To accomplish this, select the “Layers” dropdown again, but this time select Layer Properties. The “Layer Properties” dialog box will be shown with all of the layers that were shown from the “Assign to Layer” dialog. In this dialog is the capability to make a layer not visible, and to lock it from being selected or changed. Select the lock for both the Layout and the Room layers and press “OK”.

What has been created to this point cannot be selected or modified until it has become “unlocked” by reversing the “Lock” in the “Layer Properties”.

Congratulations! The room and the base layout have been set up.

Note: Be sure and save often so that changes are not lost.

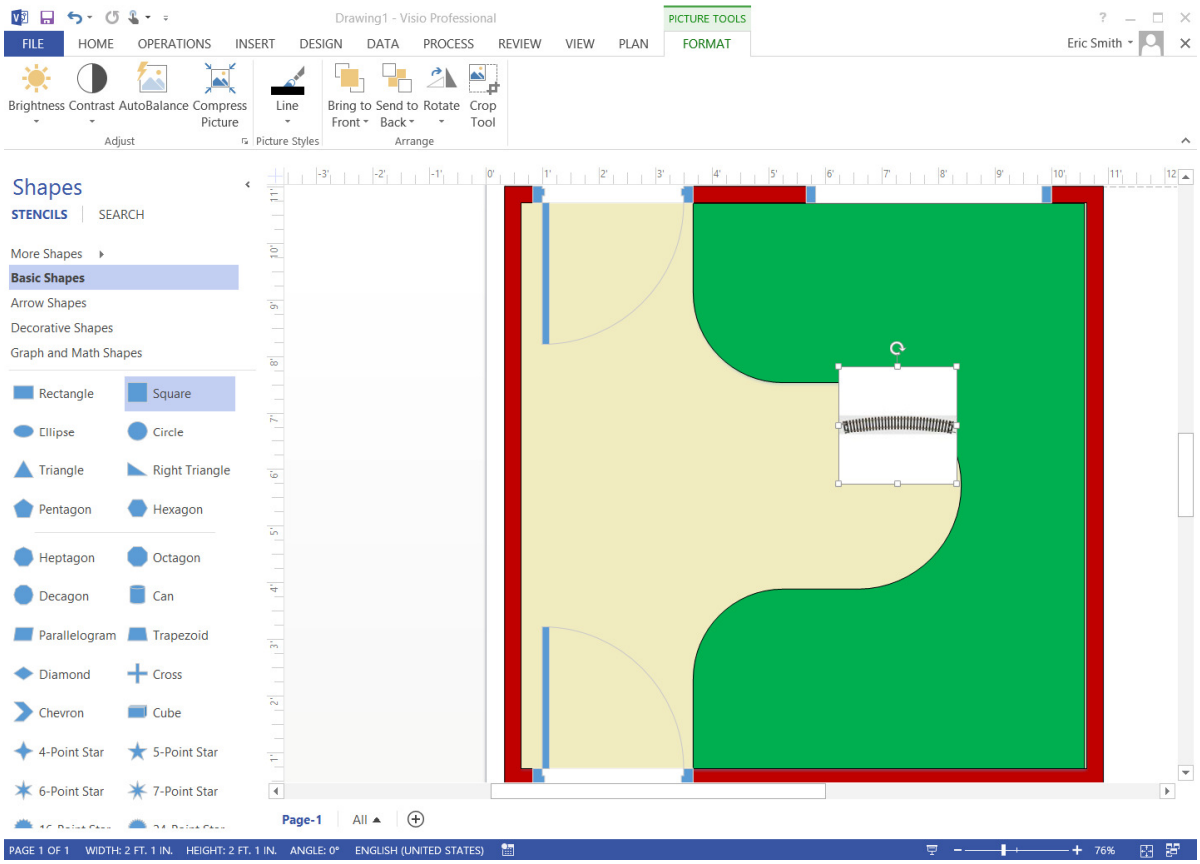
Custom Shapes/Stencils

With the room and the base layout defined, it is time to start actually putting something representing track onto the layout. To do this, it is necessary to define a custom stencil that represents different track elements. As part of this tutorial, all track will be either flex track (in exact curve radii) or will be Snap Track® for HO. The Code 100 track comes in:

- Straight
    - 9 in.
    - 6 in.
    - 3 in.
    - 2 ½ in.
    - 2 in.
    - 1 ½ in.
    - 1 in.
    - ¾ in.
- 15 in. Radius
    - ½ 15 in. Radius
- 18 in. Radius
    - 1/3 18 in. Radius
    - ½ 18 in. Radius
- 22 in. Radius
- 24 in. Radius
- Turnout
    - Left #4 Switch
    - Right #4Switch
- Track crossings
    - 19º
    - 25º
    - 30º
    - 45º
    - 60º
    - 12 ½º

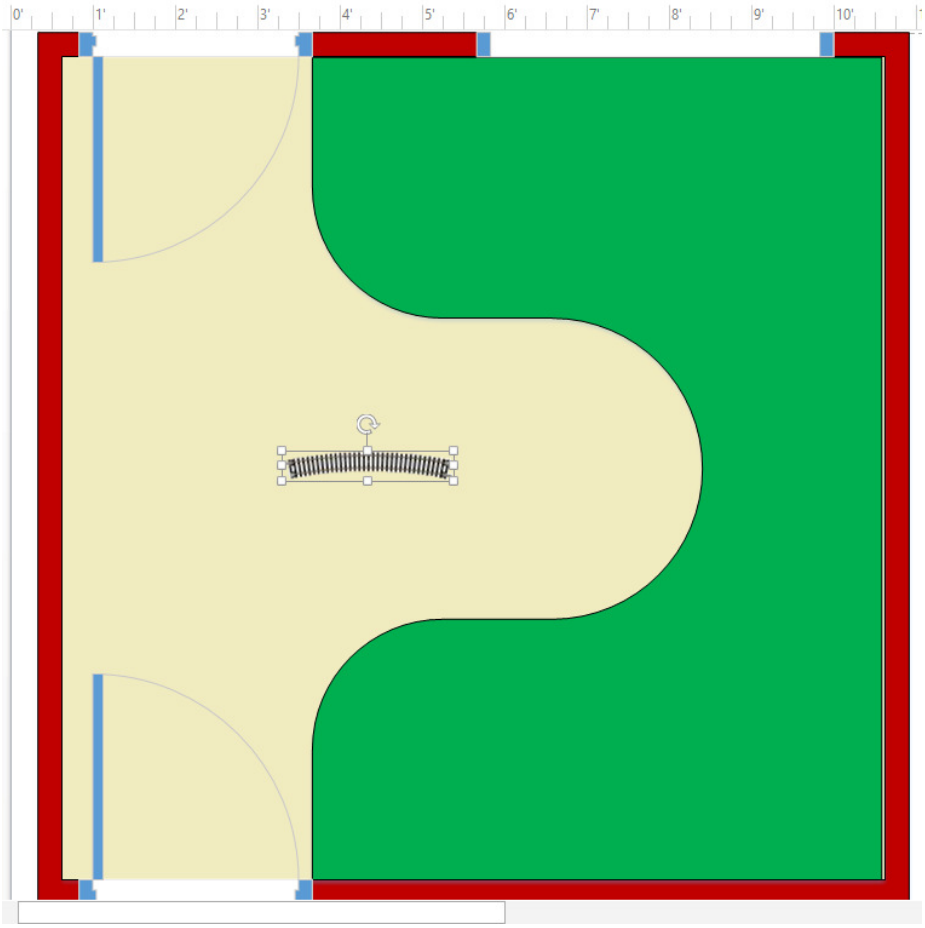
The first step in using the stencils/shapes for the laying out of a track plan is to define a stencil specifically for the track scale being developed. One of the fastest ways to start this process is to get a predefined scale stencil for Visio®. At the time of the writing of this tutorial, very few stencils exist for access from the internet. Some do exist, and the best known is a stencil library from LGB for their G Scale track. For the purpose of this tutorial, the steps defined will create a new stencil/shape library that can be used to accurately represent the track for a specific scale. Keep in mind that all of the techniques are appropriate to all track manufacturers and track scales.

In the definition of a new stencil the easiest method is to use a picture as the actual object or to use a picture to create the object. A web image search for HO Code 100 track will present pictures on that can be used to accomplish this task.. If there is access to photo editing software, such as Photoshop it makes this task much easier by cropping out any of the image around the actual track that are not representative of the track itself.



From this image it can be seen that the picture was inserted of a 24 in. Radius track picture that is 2 ft. 1 in. in length and height. The radius of the curve is measured from the center of the curve which means this piece of track in the picture is over twice the size necessary to represent the actual track.

If it is possible to edit the picture and remove or make transparent, the area surrounding the track that is preferred such that only the track is present. Through “Insert” tab, a photo of the track can be added to the canvas.



Through experimentation shrinking and rotating the inserted image, relative to a 24 in. radius circle, it is able to determine that the width of the track image needs to be set at 9.4 in. Which matches up to the math of 1/16 of the circumference of a 24 in. radius circle. To properly size the image draw a rectangle that is 9.4 in. in width. From the “Shape Styles”-“Fill” select “No Fill” for the rectangle. Select the image of the track again and using the white selection handle (only on the corners) resize the picture such that the track fits exactly inside the size of the rectangle.

For Snap Track the follow number of track sections make a complete circle:

15 in. radius = 12 track sections

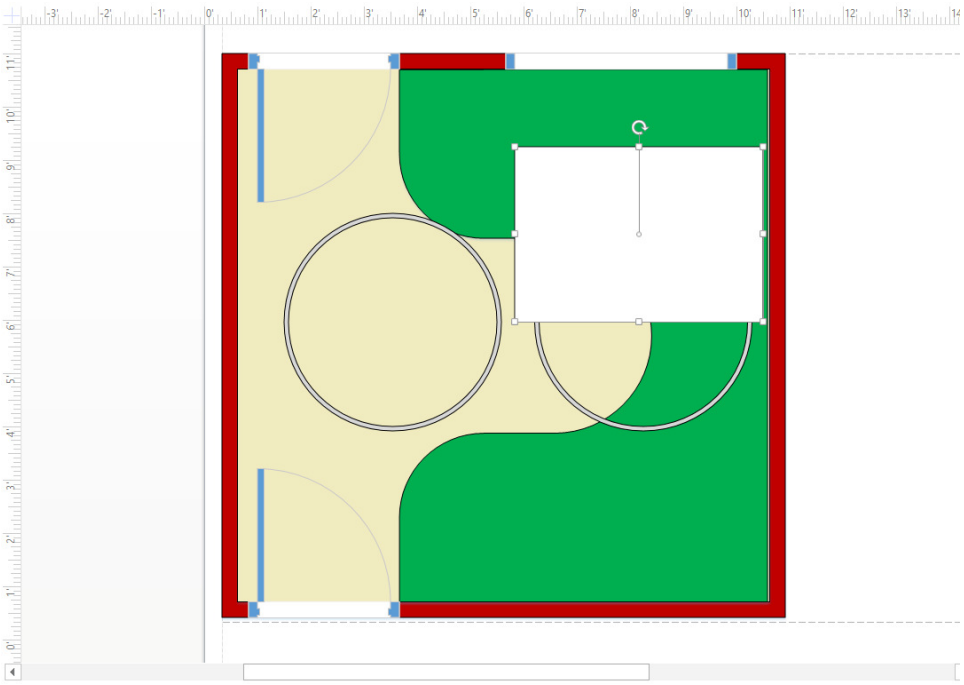
18 in. radius = 12 track sections

22 in. radius = 16 track sections

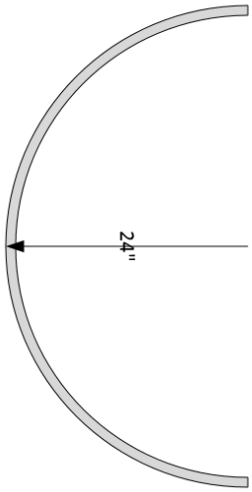
24 in. radius = 16 track sections

Another option is to build a virtual piece of track by using the subtraction operation on a circle representing the track. This is preferred to show larger curvatures without having to put each piece of track and aligning them into the plan. The way to do this is to draw two circles that represent the outer radius of the size of the track and then another representing the inside of the track. For the 24 in. track, this is 24 ½ in. outer and 23 ½ in. for the inside. After these two circles are centered in the alignment, then it is possible to subtract the inner circle from the outer circle which will represent a ring of the track including ties.

This method can be used to represent ½, ¼, and 1/8 of the radius of the curve. To create these subtract the rectangles that have been placed appropriately as to only leave the desired curvature portion once the subtraction has occurred. To do this copy the ring of track and paste it into the canvas. Draw a rectangle that is larger than ½ of the size of track.



Select the track ring first and then subtract the rectangle from the circle. This will leave a half circle of the track. Color these partial radii with a medium gray so that they will stand out against the layout base background and kind of look like ballast. With the half circle selected, just start typing the radius of the curve “24”. This will automatically start the text entry for the object. To end the text entry press the Escape “Esc” key. It is useful to know where the center of the circle resides for transferring the track plan to the actual layout. This is represented by drawing a line from right center to the left center of the half circle. Put an arrow on that line using the “Shape Styles”-“Line”-“Arrow” that points from the starting/center of the circle to the outer radius of the shape at the center point of the curvature.



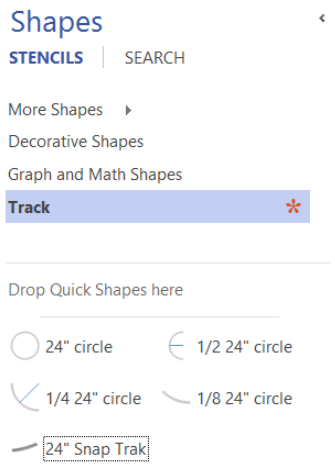
To create a ¼ version, copy the ½ circle by the copy and paste method. Next draw another rectangle that is larger than ½ of the copied portion of the track circle. Select the rotate arrow on this rectangle and rotate it to 45^{o} with an edge of the rectangle passing through the center of the circle. Subtract the rectangle from the ½ circle by the Operation methods previously described. This leaves a track representation of 1/8 of 24 in. circle. If the track picture sizing was done appropriate, copying and pasting 2 of the track pieces will exactly match up to the 1/8 curve.

Five different objects should be on the screen to represent the 24 in. radius track. This is the perfect time to create a stencil for the track. From the “Shapes” tool box on the left of the canvas select the “More Shapes”. Almost to the bottom of this menu is the “New Stencil (US units)” option. Selecting this option will cause a new Stencil to be created in the stencils list with a large red Asterisk and the title “Drop Quick Shapes here” underneath it. To add the 24 in. curve shapes select them from the canvas and drag them one at a time into the stencil area. Each will be removed from the canvas and now be present in the Stencil Shape menu named with the title “Master” and a numerical value. A right mouse click on the new stencil entry will bring up a menu that will allow for the renaming of the stencil entity.

Rename each shape appropriate to the radius and curvature:

- 24 in radius
- ½ 24 in. radius
- ¼ 24 in. radius
- 1/8 24 in. radius
- 24 in. Snap Track

Right mouse click on the “Stencil Name” will allow for the saving of the Stencil to the hard drive for future use. Use the “Save As” function and change the name to HO Code 100. Now using drag and drop the track shapes can be placed onto the layout. Use the “Assign to Layer” command to make sure all of the track placed on the canvas are in a “Track” group. This makes it easier for later processing of the layout. This procedure can be used to generate all of the different pieces of Snap Track and the curvatures of the track.



When adding the track shapes to the shape/stencil it is recommended to group the different percentages of the curve together. All ½’s together, then all ¼’s, but it is possible to group these in any manner any order by dragging the shape icon in the shape menu to a different location.

It is recommended to build these curvatures for radii that increment in 1 in. values. This results in being able to represent curvatures using flex track of various radii. This is useful since the minimum radius for this layout is 17 in. and Snap Track does not exist for this radius of track.

Note: The concentric circles for a specific radius are 1 in. greater and 1 in. smaller than the desired radius of the circle. This takes into account ½ of an inch on each side of the radius of the circle. Subtracting the concentric circles (selecting the largest circle first) will result in a circle of 1 in. width for the track.

Non-Picture Track Shapes

For the true die hard planners, it is possible to create a shape using the drawing tools to replicate the track in the picture. This is done by drawing rectangles for each tie and the end pieces of the piece of snap track to generate a non-picture representation of the track. For all scales this method can be used to represent longer pieces of straight track representing pieces of flex track. For HO use this to define at lengths of 18 in., 27 in. and 36 in. straight segments.

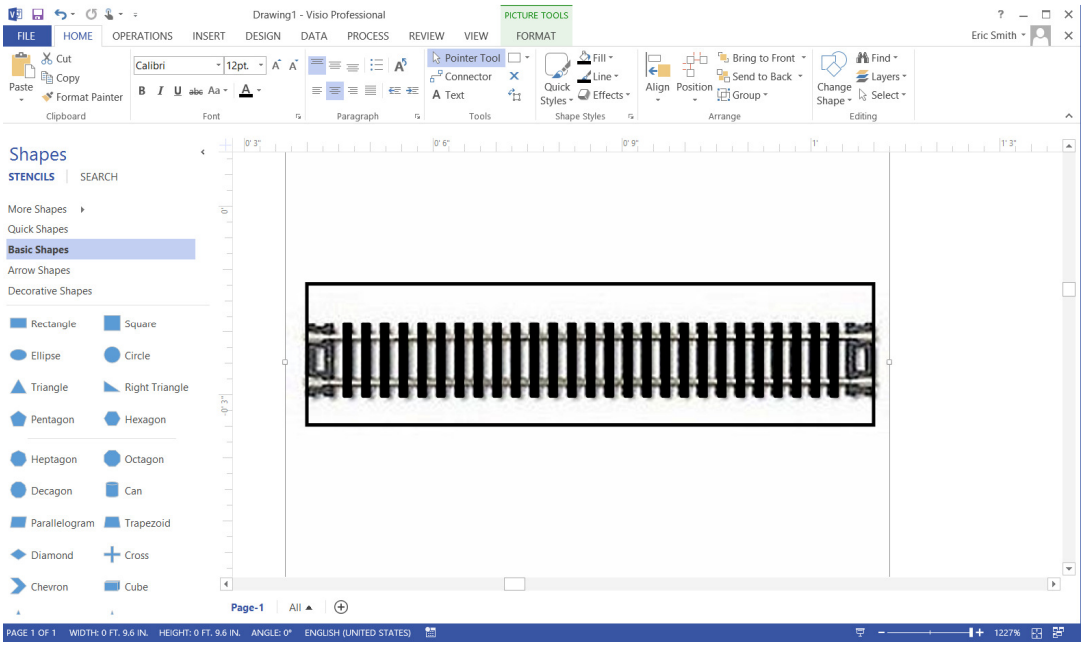
As an example of this technique, import the 9 in. Straight picture from the internet into the canvas and rotate it 90^{o} so that the track runs from left to right. Draw a rectangle exactly 9 in. in length on top of the picture and set the fill of the rectangle to "No Fill". Select the track package picture and scale it with the corner white selection rectangles until the length of the track portion of the picture matches the length of the rectangle. It may be necessary to zoom into the canvas in order to see this correctly.

There are two ways to easily zoom into or out of the canvas. The first of these is to use the zoom in/out mechanism on the bottom right of the bottom of the canvas. Moving the zoom component or pressing the plus symbol (+) or the minus symbol (-) will zoom in or out.

The second zoom method, if the mouse has a track wheel, is to use the control-Mouse wheel mechanism. Holding down the control and rotating the mouse wheel forwards will increase the zoom factor. Holding down the control key and rotating the mouse wheel backwards will decrease the zoom factor.

Draw a ¼ pt. line width rectangle over one of the ties of the straight piece of track. It is possible to draw all of these rectangles representing the ties by hand, but Visio® has provided a copy feature that works much faster for this task. Select the newly generated tie rectangle, hold down the "Control" key until a small plus "+" symbol appears on the cursor. Holding the Shift key down left mouse click on the tie and drag it away from the existing tie. This generates a copy of the object in the canvas. Use this method to generate 5 ties that are placed over 5 ties on one end of the track picture. Deselect the last tie and select all 5 of the ties that

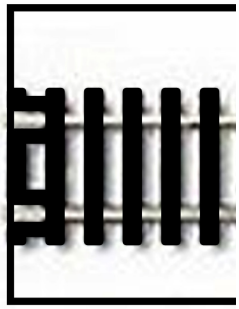
have been created. Using the same technique, with the Control and drag, 5 more ties can be generated. Repeat this until the appropriate number of ties have been created to cover the ties on the picture.



Select all of the ties and align them to the top using the “Align” menu from the “Arrange” tool option on the Home tab. To make the ties equally spaced, select one end tie first then select all of the ties and use the “Position” menu from the “Arrange” tab to “Distribute Horizontally”. Lastly, fill the color of the ties with either black or a dark brown.

Using small rectangles with 1 pt. lines it is possible to generate the tie “caps” on each end of the piece of track. For the Snap Track, use 5 small rectangles and 2 lines to create the end cap.

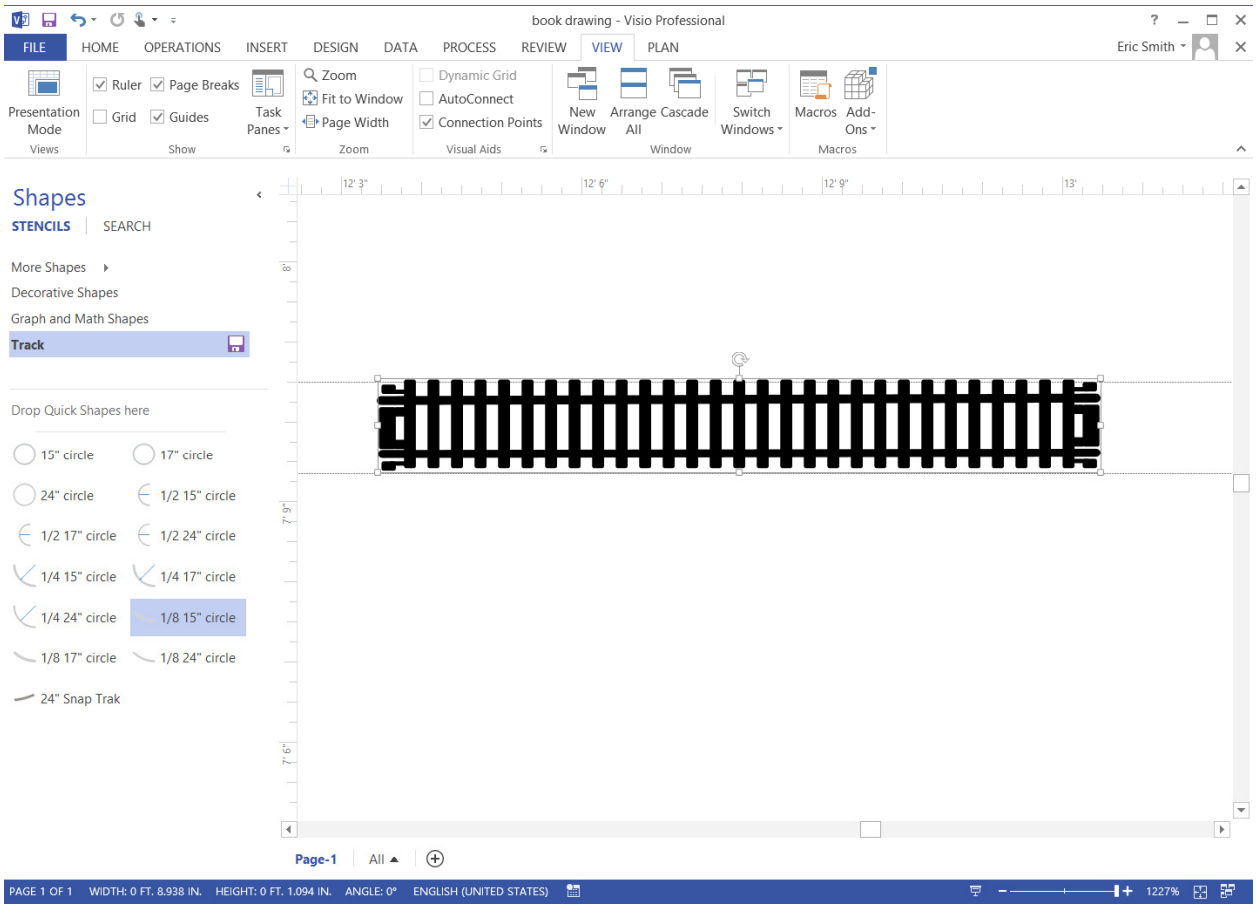
Group all 7 of these smaller rectangles together and fill them with the same track color. Using the Shift-Drag-Copy method, copy this shape. Use the “Position”-“Rotate Shapes”-“Flip Horizontal” to create the other end of the track end cap. Use the mouse or Arrow keys, position the end cap to the other end of the piece of the track.



Lastly, draw 2 lines representing the track straight down the newly created drawing where the track should appear in the underlying picture. The width of the lines representing the rail may have to be changed to accurately represent the

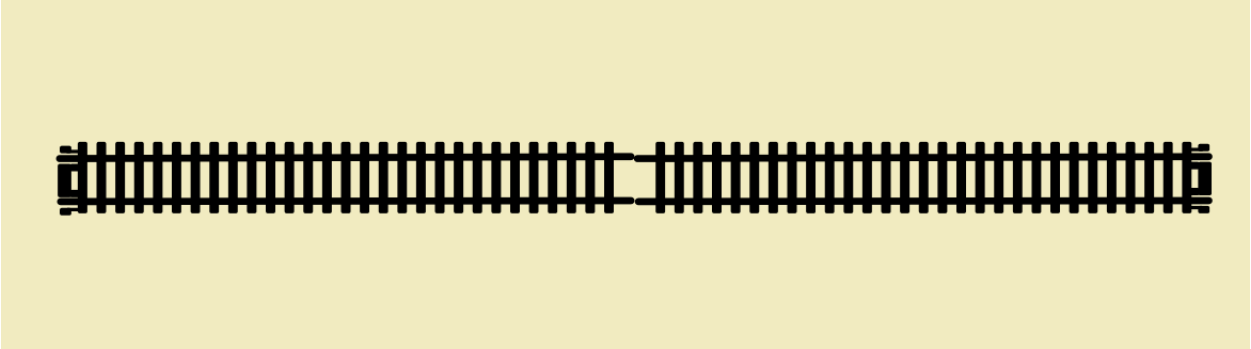
width of the rail on the actual track. It is not necessary to change the color of the line from the default black, but user preference may want to color these lines silver to represent the rail color. Delete the underlying picture and the 9 in. rectangle that were put into the drawing as guides. Select all of the pieces comprising the track, group them together and drag them into the track stencil. Viola, a 9 in. straight of Code 100 Snap Track® that can be used to drag and drop into the drawing canvas.

Note: If your layout uses different manufacturers track or switches, Stencils can be created for each of the manufacturer's track products or they can all be placed into one single stencil.

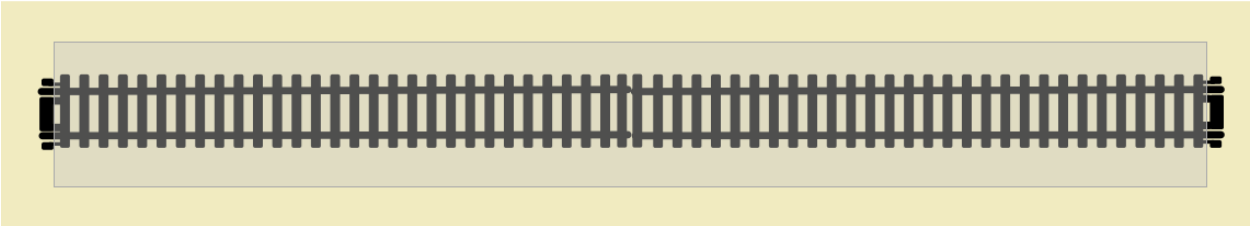


As mentioned earlier, this method is useful to make longer straight pieces of track representing set lengths of straight track. The intent is that these would be pieces of flex track that are on the layout and are either full size or cut down to a specific size.

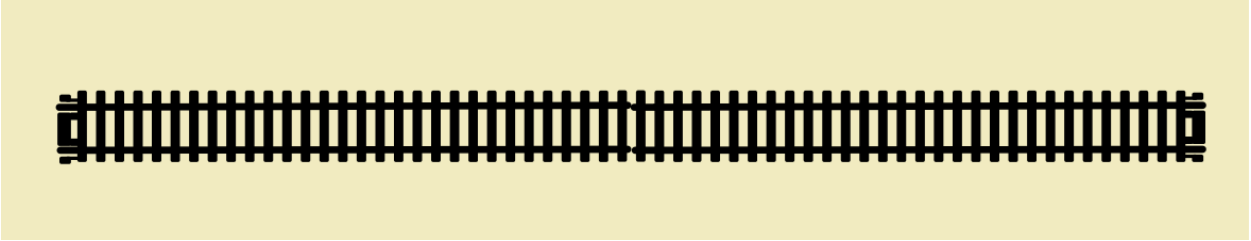
The easiest way to construct a piece of straight that is longer is to use the 9 in. straight that has already been constructed. Drag two copies of the 9 in. straight onto the canvas and place them end-to end. Select one at a time the objects and ungroup them using either shift-control-u or the ungroup command from the “Arrange” toolbox on the Home tab. This action will cause a dialog box to be displayed stating it will break the link to the master. The master is the shape definition put into the stencil. Press “OK” to accept this dialog/action. Select the end caps for each of the straight pieces of track that are in the middle and press the delete key. This will remove these two objects from the screen.



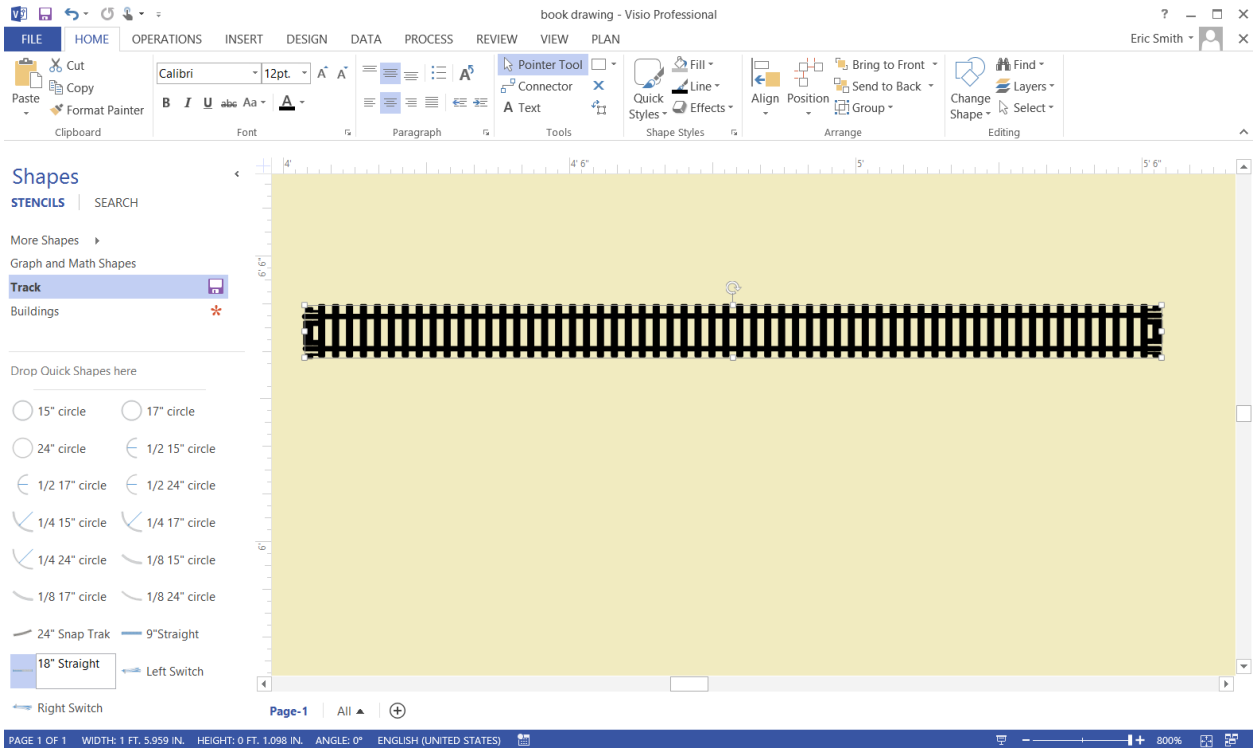
Select one of the tie pieces and using the control drag copy method copy two more ties to approximately the center between the 2 pieces of track. Select all of the ties for both of the track objects without the end caps. To do this, select the “Pointer” tool from the “Tools” toolbox and drag a selection box over the ties. Try to not include the outer ends of the rails next to the end caps or the end caps themselves.



Using the Home tab “Arrange”-“Position” select “Distribute Horizontally”. This will equally space the ties between the rails.



Carefully select both of the rails from one of the pieces of track and delete them using the delete key on the keyboard. This will result in the rails stopping halfway down the track. To correct this, select one of the rails and hold down the shift key. Using the left mouse button “stretch” the rail over the ties to the other end of the track piece. Holding the Shift key down while stretching the line representing the rail will result in the line being set at exactly a straight horizontal orientation. Repeat the process of stretching the line for the other rail. Select the entire 18 in. rail object and group it together using either a control-g or using the Home tab’s “Arrange”-“Group” command. Drag this into the Track Shape Stencil and rename it to “18” Straight”.

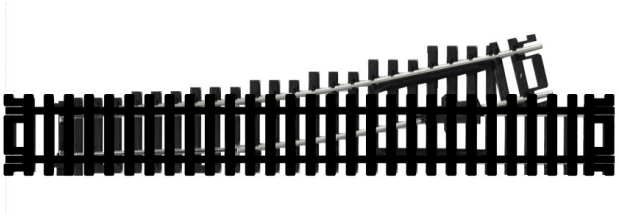


This technique can be repeated using the 9 in. and 18 in. pieces to create 27 in. and 36 in. pieces of track for the stencil.

Generating a Switch Shape

With the general track components defined in the Stencil the next step is to generate switch shapes. From either a scan or a internet image, an HO Code 100 #4 switch machine picture can be used to generate a very accurate depiction of a switch machine. It doesn't matter whether the switch machine picture is left or right for the beginning steps of the shape definition.

Import the picture into the canvas using the "Insert"-"Picture" procedure. It is preferred that the switch machines to be oriented horizontally left and right, but the procedure will work for a vertical orientation as well. The horizontal track component of the switch is the same as a 9 in. straight piece of track for the #4 turnout and the radius is that of an 18 in. curve. It is possible to use the switch machine picture after being cleaned up from photo editing software for a switch representation or it is possible to generate the shape using the techniques listed in the Non-Picture Track Shapes section.



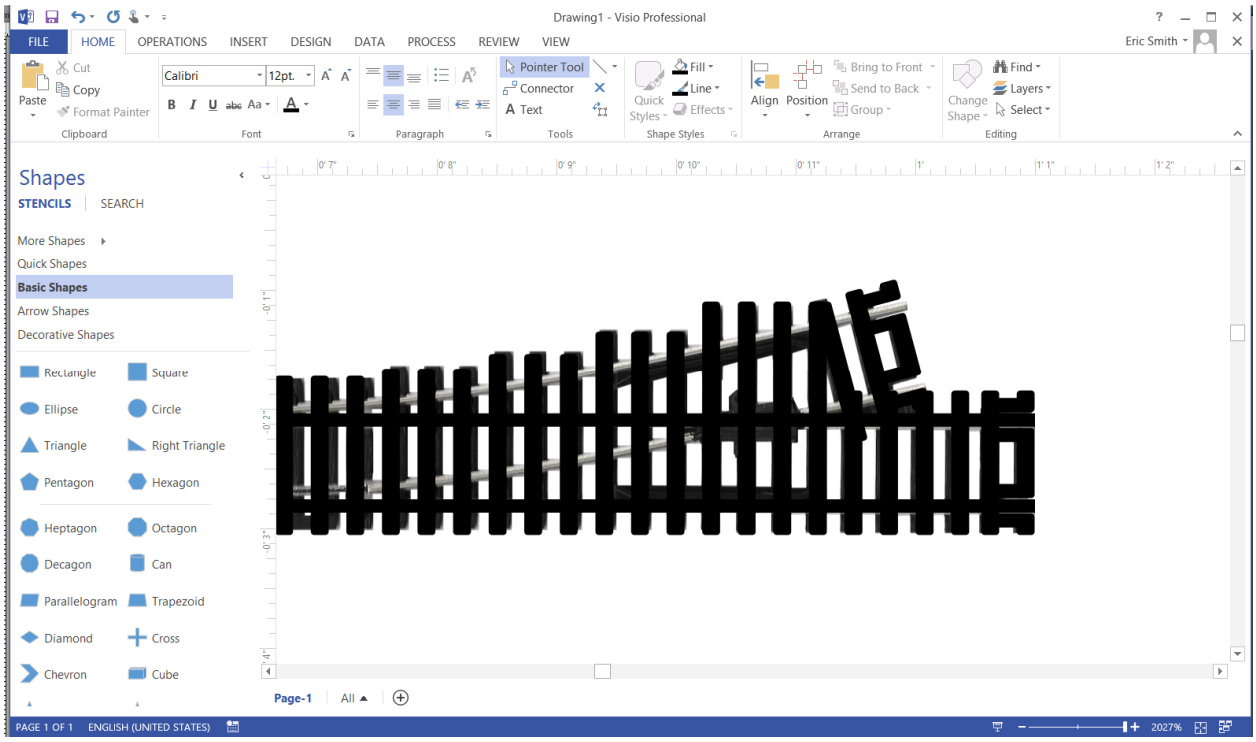
To generate the non-picture representation of the switch drag a 9 in. straight object onto the canvas and use it as the sizing mechanism for the background photograph. Align and size the switch picture such that the straight portion of the switch picture matches up to the end points of the straight piece of track.

Align the 9 in. straight on top of the switch, then select the straight track and "ungroup" it. This will cause the dialog box to appear stating it will break the link to the master. This step allows it to be broken back into the individual components that were used to generate the shape originally.

Using the top center selection box on each tie, stretch the ties until they match up to the curvature of the outside of the curved part of the shape. This is about 17 of the ties from the 9 in. piece of track. Using the Control-Drag-Copy mechanism select one of the smaller ties and copy it near the top of the curved switch part. Rotate this tie 20^{o} counter-clockwise. Drag it until it meets up with the last long

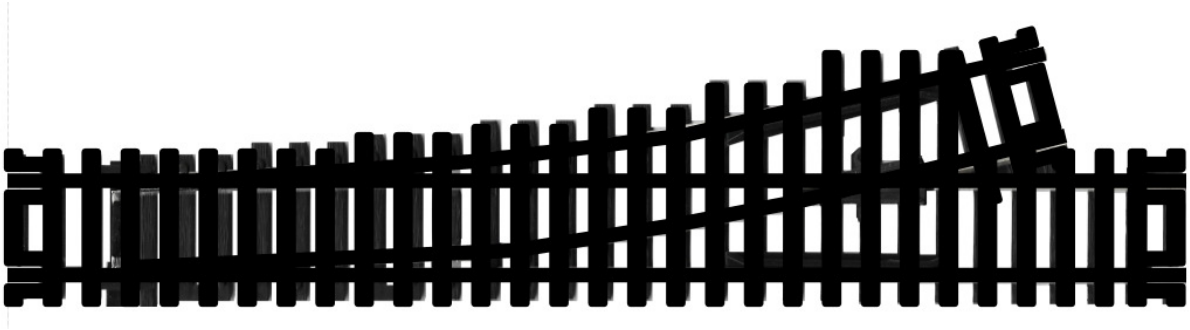
tie and shorten it appropriate to match the underlying representation. Copy this tie and place it as the last tie for the end cap of the switch.

Copy the end cap piece from the straight track. Rotate it 20^{o} counter-clockwise and place it in the appropriate position of the curved part of the switch.



Draw in the rails for the curvature portion of the switch by using the line tool to draw the curved portion of the rails. This can be done by using the “Arc” tool, but it is not necessary for this to be precise, so the line tool is adequate for the drawing of the curve. Start the first part of the line at the 2nd tie from the non-curved switch end of the straight. Draw a line from that point for 8 ties ending just outside of the rail from the straight track. Clicking again on the end point of the just drawn line will allow for an extension of the line shape. This is another line that shares a vertex with the first line. Draw this line for 4 ties up the curvature of the rail of the underlying picture. Repeat this procedure 2 more times until the end of the rail reaches the end of the end cap for the track.

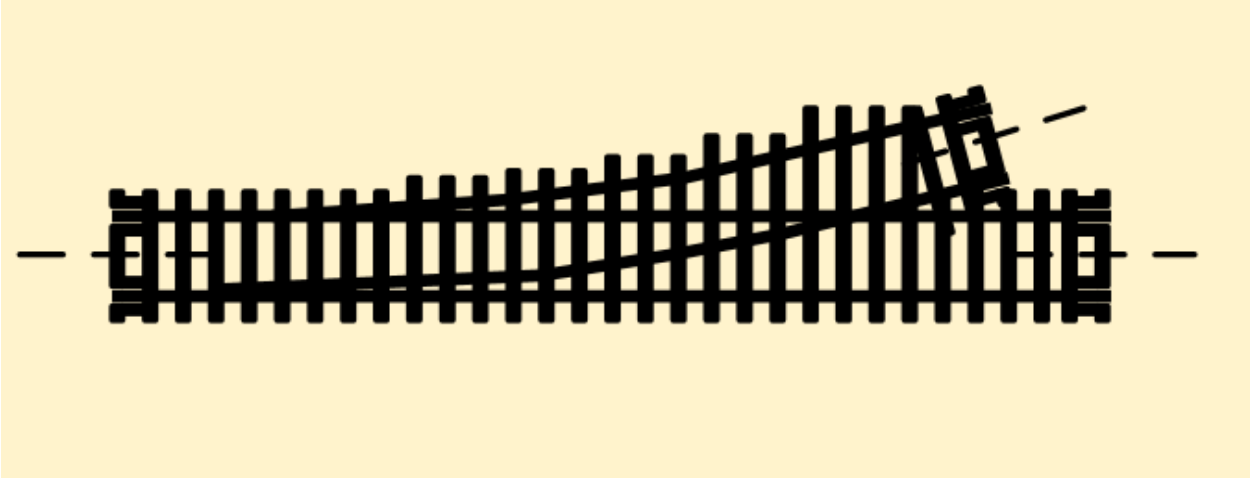
Use the same procedure to generate the curved track for the inside rail.



To indicate the position of the switch throw bar, draw a black rectangle from the inside of the rail to the end of the throw bar. Do not draw the switch machine in the shape because these may be hidden under the track, use an alternative switch motor, or use a manual ground throw.

The last step in defining this shape is to indicate the centerline of the curvature of the switch. This makes it easier to line up other track pieces to the switch when defining the layout. Using the line tool, draw a line from the center of the track 2 ties in from the curve end cap, draw the extending out a little ways from the end cap away from the switch. Set the line width of this line to 1 pt. and using the "Line" tool's option of Dashes, select the 3rd dashed option. Additionally, it is useful to repeat this alignment line creation for both ends of the straight portion of the track.

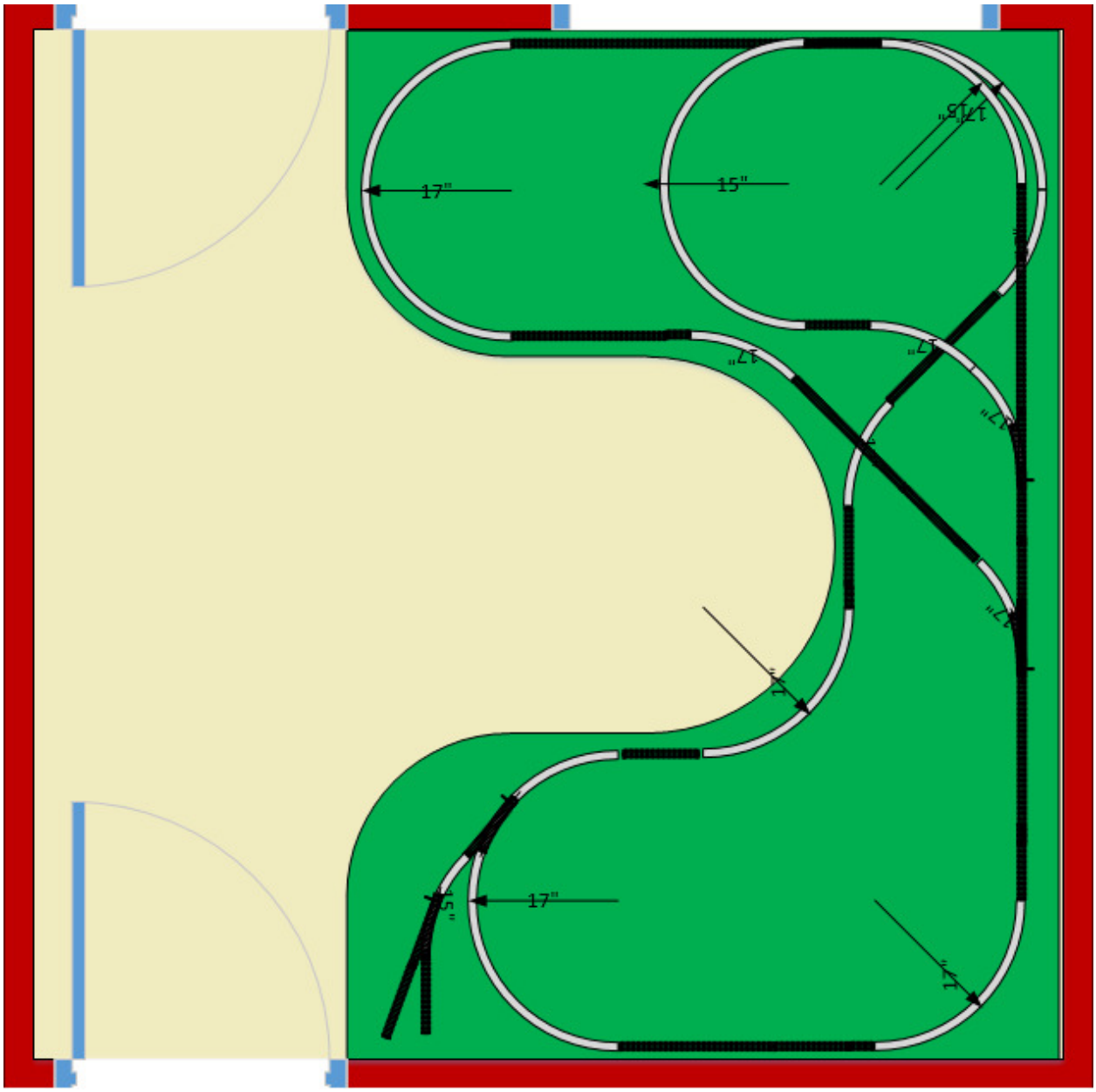
Delete the underlying picture and group the components of the newly drawn switch. Drag this shape into the Stencil and label it appropriately as to the direction of the switch, such as Left #4 Switch or Right #4 Switch. Next drag the switch back into the canvas and using the "Arrange"-"Rotate Shapes", flip the shape vertically. This has now created a switch that has the turn out opposite direction. Drag this shape into the Stencil and name it the appropriate switch direction.



Save the stencil so that it is available for continuing use.

Note: The switch shape drawing method can be used for other track shapes such as curved switches or different degree crossings.

Add the track plan as shown:

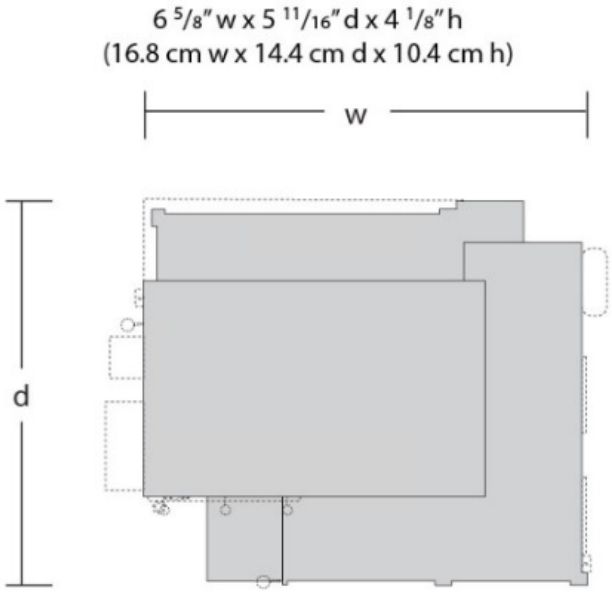

17"
15"
17"
17"
17"
17"
17"
17"
17"

Industries and Buildings

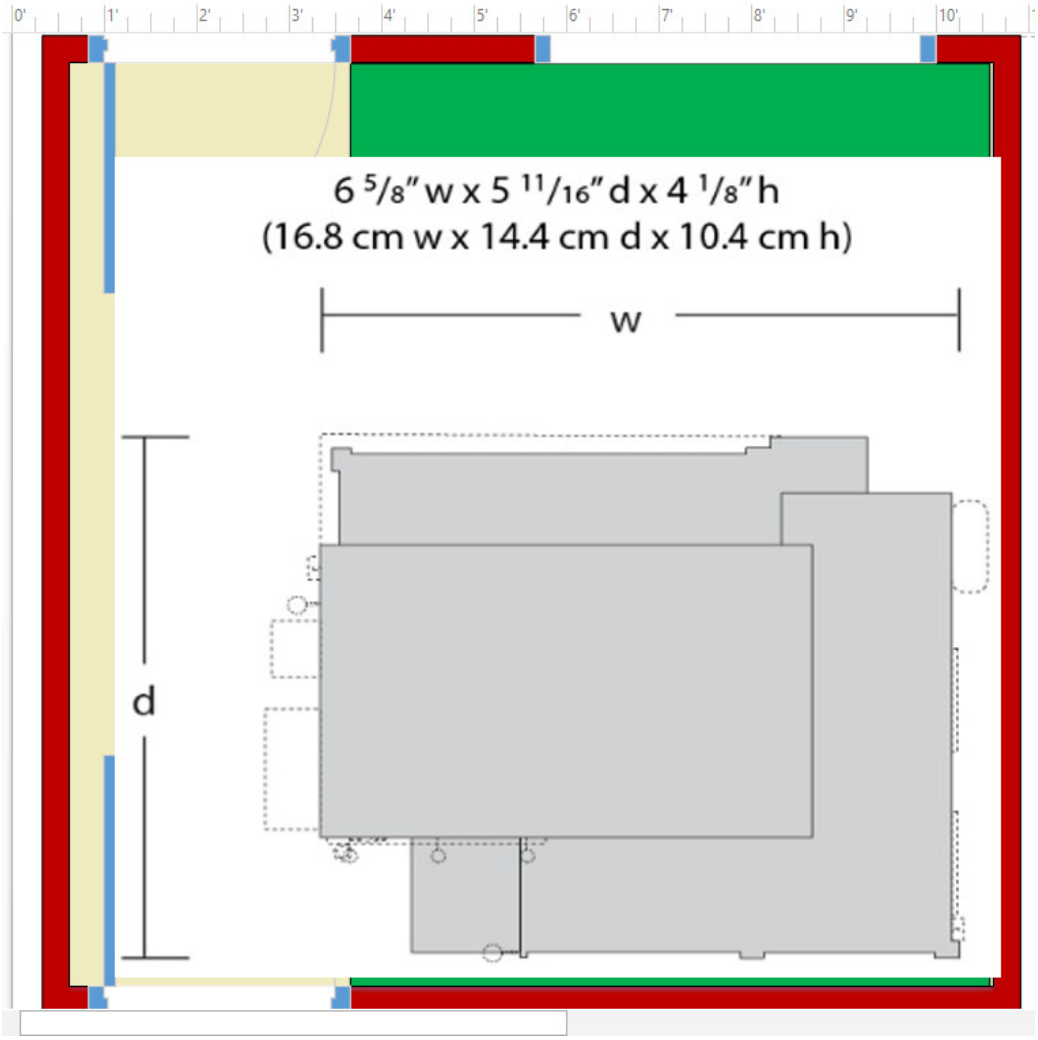
The procedure used for creation of the track stencil can be used to define industries and buildings shapes that can be used on the layout. This aides in the track planning by allowing for placement relative to the track. Many of the plastic kit manufactures such as Woodland Scenics® and Walthers® provide measurements of building kits that can be used to draw "Top down" building representations. Each of these building representations can be added to a buildings stencil and used exactly like the track shapes stencil for drag and drop of industries or buildings onto the layout.

Note: If there are building kits that are already constructed, then drawing a top down view is fairly easy to generate using measurements from the actual building.

To learn how to do this start with the Woodland Scenics® kit for the Sicken Tire Company[1] in HO scale. On the Woodland Scenics® website is a picture of the dimensions of the kit when built. This image is perfect for developing a top down view of the kit for a stencil representing the industry. Either capture or download the actual image from the website and save it to the local hard drive. Using the procedures for importing track pictures, import the picture into the canvas. Do not worry that it is too large as this will be taken care of through the manipulation of the size, by shrinking the picture.



[1] HO Sicken Tire image from http://woodlandscenics.woodlandscenics.com is reused with permission of Woodland Scenics®.



With the dimensions of the kit known, it is possible to shrink the image proportionally to the correct size by using the small white selection boxes on the corners of the picture. However, to get it to the correct size it is recommended to draw a rectangle that exactly matches one of the dimension on top of the picture. Use the width dimension on the picture for this effort.

Note: When working down at this level it may be necessary to zoom in on the image so that the dimensions are easy to see and replicate.

Using the conversion of 6 5/8 in. to 6.625 in decimal, build a rectangle that is equivalent to this size in width and 5 11/16 (5.6875) in depth. When the rectangle is drawn, a very thick border will appear around the rectangle. Select the “Line” dropdown from the “Shape Styles” and using the “Weight” menu option select “¼

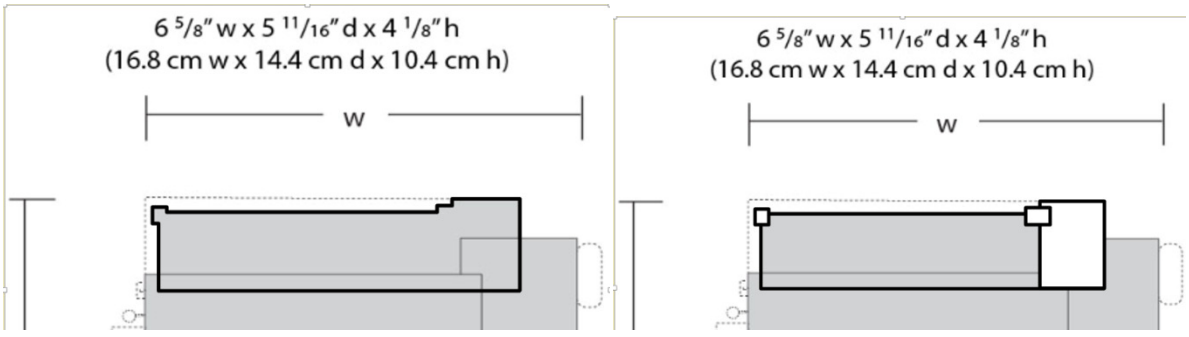
pt.” This is the thickness of the line that is drawn around the shape. It will be necessary to do this for all of the rectangles used to draw the shape.

With the rectangle on top of the picture, resize the picture so that the width is exactly the same size as the rectangle. If the depth of the rectangle was set, then the size of the picture will fit into same size of the rectangle. It is okay to delete the rectangle at this point as the exact shape of the building will be constructed in the following steps.

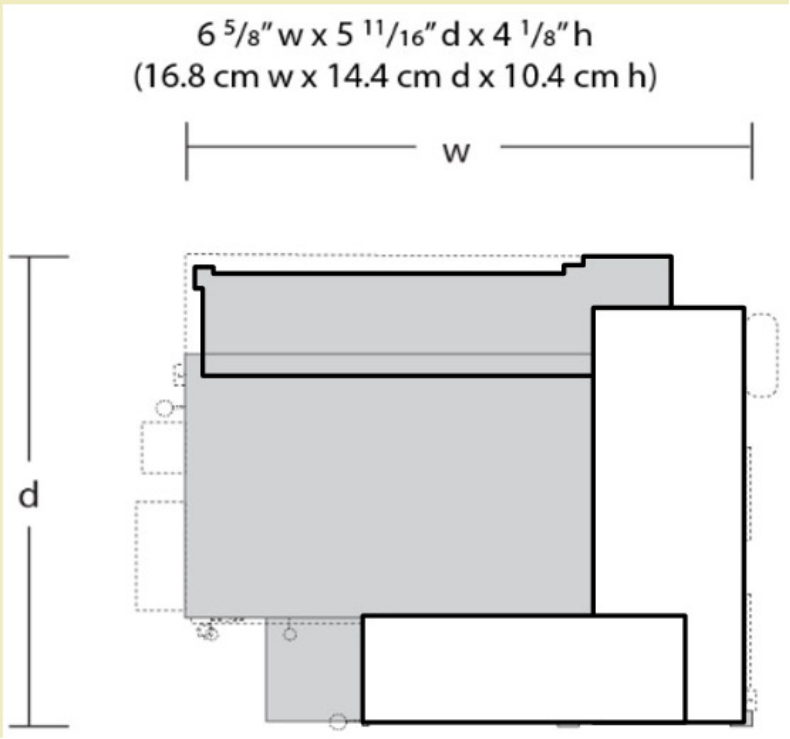
Draw a rectangle depicting what looks like the “lowest” level of the building. This is the “top” of the image from Woodland Scenics®. Do not worry about getting the small protrusions included at this step. Only draw the main rectangle.

Note: if the starting point of the drawing will not exactly match where on the screen you wish to draw, then it is probably because the snap to grid option is selected. To turn off the snap to grid, select the “View” tab’s “Visual aids” extended dialog box. This is opened by selecting the bracket/right arrow at the bottom of the “Visual Aids” toolbar. In the “Snap & Glue” Dialog deselect the “Snap” option and select “OK”.

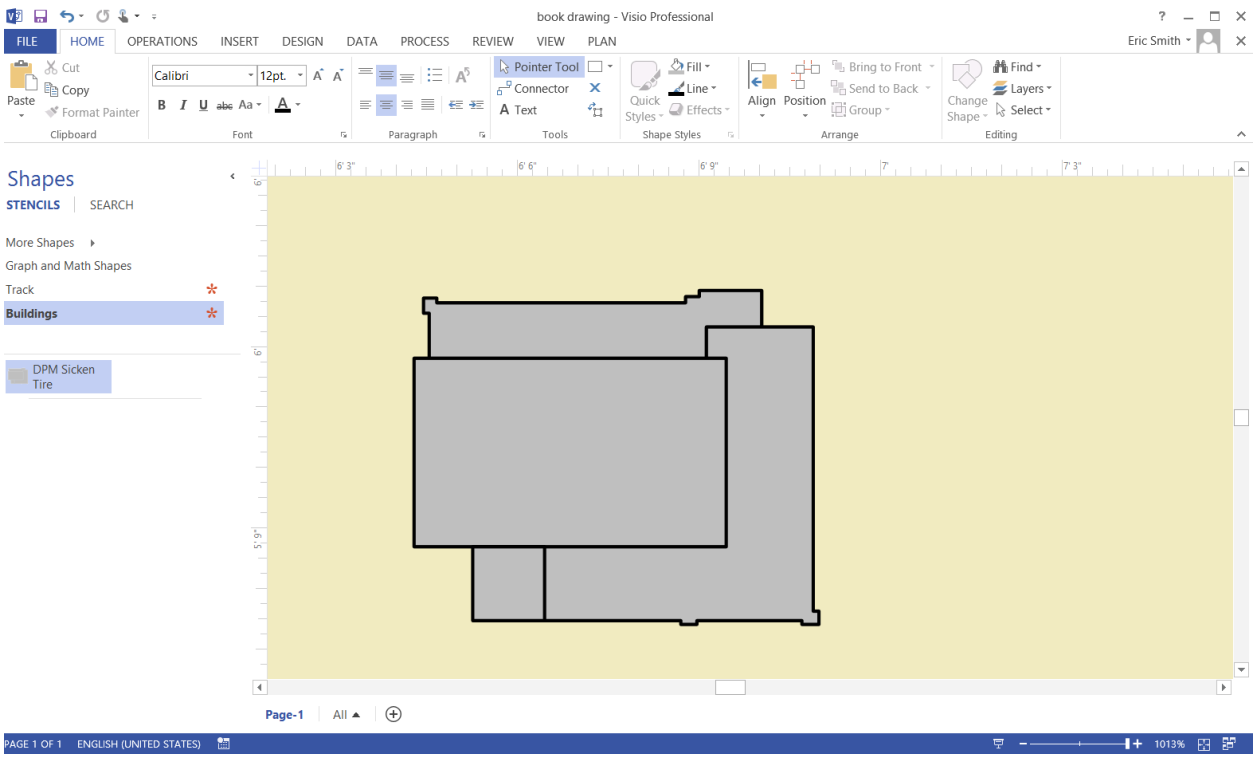
It is now possible to draw the additional “small” rectangles/protrusions from the shape on the top wall. Draw 3 small rectangles with a line width of ¼ pt. matching the outside outline of the underlying picture. To get the shape correct, use the “Union” operation to merge the 4 rectangles together. This will form the top side of the image.



To draw the right side, draw 2 rectangles representing the depth and width of the right side of the picture and the longer bottom side picture. To get the correct shape union these two shapes together.



Draw the remaining bottom rectangle. Because the left or main building overlaps on top of the right side constructed object, it will be necessary to make that object transparent. To do this select the constructed object and from the “Home” menu tab’s “Shape Styles” select the pull down menu for the “Fill” option. Select the menu item at the very bottom of this menu “Fill Options”. This will bring up the Format Shape toolbar on the right side of the screen. Open the “Fill” options by selecting the white triangle next to the Fill text. The last option in this list is “Transparency”. Select a Transparency of about 50%. This will let the original picture behind the drawing be seen as well as the other rectangles that have been drawn “behind” this object. Draw the remaining center rectangle to the correct size. To complete the shape reselect the “transparent” object and reset its transparency back to “0%”.



It is very advantageous at this point to “group the object” into a single entity before placing it into a Stencil. From the Home tab, select the “Pointer tool”. Drag a square around the objects to put into the single shape. And either use a Control-G or from the Home tab select the Group function from the Arrange toolbox and group the objects together.

This can be done to represent all of the buildings, kits and industries. It isn’t necessary to replicate minute details of the kit on these representations, just make sure the general shape is constructed so that it accurately represents the object from a top down 2 dimensional view.

Create a new Stencil/Shape library using the same technique used for the track and title this one “Buildings”. Using the same process of drag and drop the buildings into the Shape/Stencil. To place onto the layout, the shape can be selected and using the click and drag method be placed onto the canvas. Make sure these objects are in different layer than the track layer titled “Buildings”.

It is useful when placing an industry onto the layout to give that industry a name. This makes the layout customized to the developer of the layout. “Uncle Bill’s Tires” is a lot more personalized than “Sicken Tire”. When placing the shape into the stencil it should be named or labeled in the Shape Stencil, but to the kit name

from the manufacturer. This way it is easy to identify what kits need to be constructed when the layout plan is complete.

When the object is placed from the shape stencil onto the canvas title it to reflect the personalized name of the object. To label the object select the text toolbox option “A Text” from the “Tools” menu on the Home tab. When the mouse is moved into the drawing canvas the cursor will change to a text entry cursor. This is a small “plus” sign with a box to the lower right. Click and drag a text box that is the size of the building. Do not worry that the font is monstrous in size as the “Font” options on the Home tab allow for a smaller font to be selected. For this building it is suggested that using a 6 pt. font size will not overflow the sides of the building.

The text box containing a name is just another object that has been added to the drawing. This text box around the actual building can be manipulated like any other object in that it can be sized, rotated, color added to it, and even the font color. Most of these capabilities are through the “Font” toolbox on the Home Menu.

Note: Each object that is placed onto the screen can have text put “into” that object’s definition. All circles, squares, rectangles, buildings, etc. Text is inserted into the object by selecting the object and then typing the selected text. Visio® will automatically enter the text centered in the object inside a text entry box. Clicking outside of the object will close the box and add the text to the object.

Terrain, Tunnels and Rivers

At this point it is just dragging, rotating and aligning up track and curve pieces to create the layout. Most layout plans have varying terrain to add interest to the track plan. This can be represented in the 2D representation in Visio®. To represent different levels of a layout, it is easier if the other levels are represented by a color that is different than then layout base color. It is useful to pick primary and secondary computer colors:

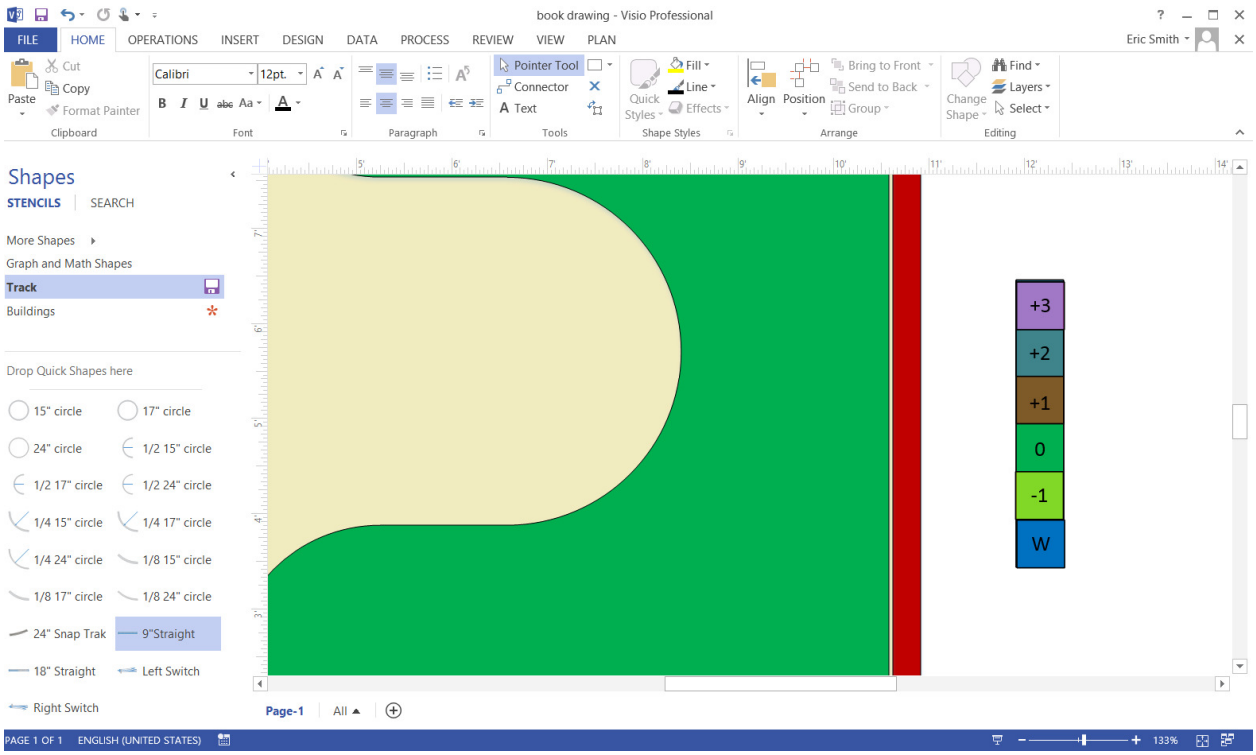
Computer Primary Color		**Computer Secondary Color**	
Red	Up 1 level	**Cyan**	Up 2 Levels
Green	Layout Base	**Magenta**	Up 3 Levels
Blue	Water	**Yellow**	Down 1 level

For ease of use later, create a legend using these colors so that each color can be seen in its appropriate hue. This is a result of having the transparency on every level (except the Layout Base and Water) set to about 50% so that the underlying track (tunnels) can be seen easily.

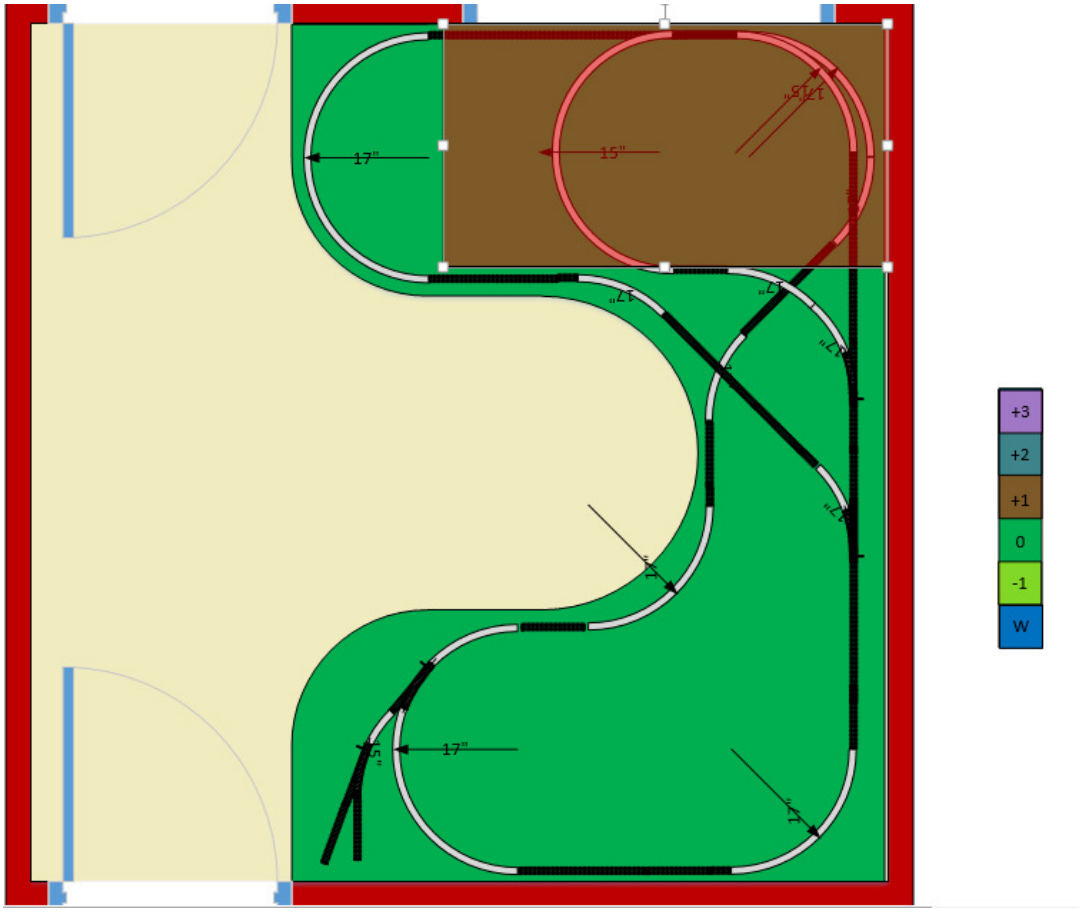
To create the legend, draw a tall rectangle on the canvas outside of the room of the layout. Make this rectangle about ½ of an inch wide and 3 inches tall. Color this rectangle with the same color as the base layout (Green). Draw a ½ in. x ½ in. rectangle and place it over the very bottom of the green rectangle. Copy this rectangle and place one exactly right above the bottom rectangle. Using the shape fill color the bottom rectangle blue and the second rectangle yellow. These represent the water and the level 1 layer down.

Copy the yellow rectangle and using either the mouse or arrow keys, place the pasted rectangle up a full skipped ½ in. of the green rectangle. This lets the ground be a level 0. Drag the top of this rectangle until it matches the top of the green rectangle. It should be 1 ½ in. tall. Using the Fill a shape, change the color of this to a bright red. To tone it down go into the “Fill Options” and change the Transparency of this rectangle to 50%. It will now change the color of the rectangle to a brown as it is blended into the green beneath it. Repeat these steps creating rectangles for the up 2 and up 3 levels

It is possible to number these levels, but additional blank lines must be placed into the text of the box to get it to align properly with the box above it.

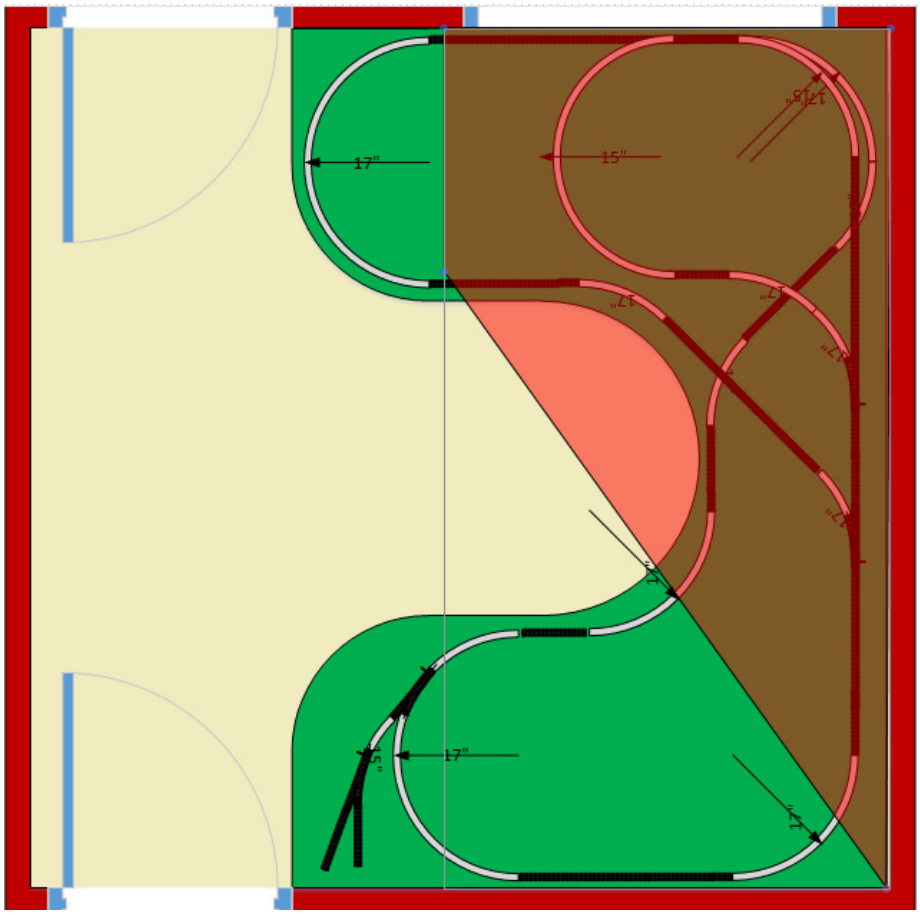


Add a rectangle to the drawing canvas to represent terrain. It doesn't matter where this rectangle is located or its size. Move the rectangle to where its upper right corner matches the top right corner of the base layout. Select the rectangle representing up 1 level from the legend. It is the red filled rectangle with 50% transparency making it brown. Using the "Format Painter" option from the clip board copy the style of the brown rectangle onto the newly created rectangle. The white rectangle will turn brown and any track underneath will show through.



With the newly colored rectangle selected (the white sizing rectangles are displayed), select from the “Tools” menu the Line tool. The white boxes disappear and 4 blue dots appear on the 4 corners of the rectangle. Each of the blue dots represent a drawing point of the rectangle. Select the one on the lower right and drag it all the way to the bottom (the opposite side of the layout) straight down. If the point has successfully been selected, the cursor will change to a 4 arrow cursor representing that the point can be moved.

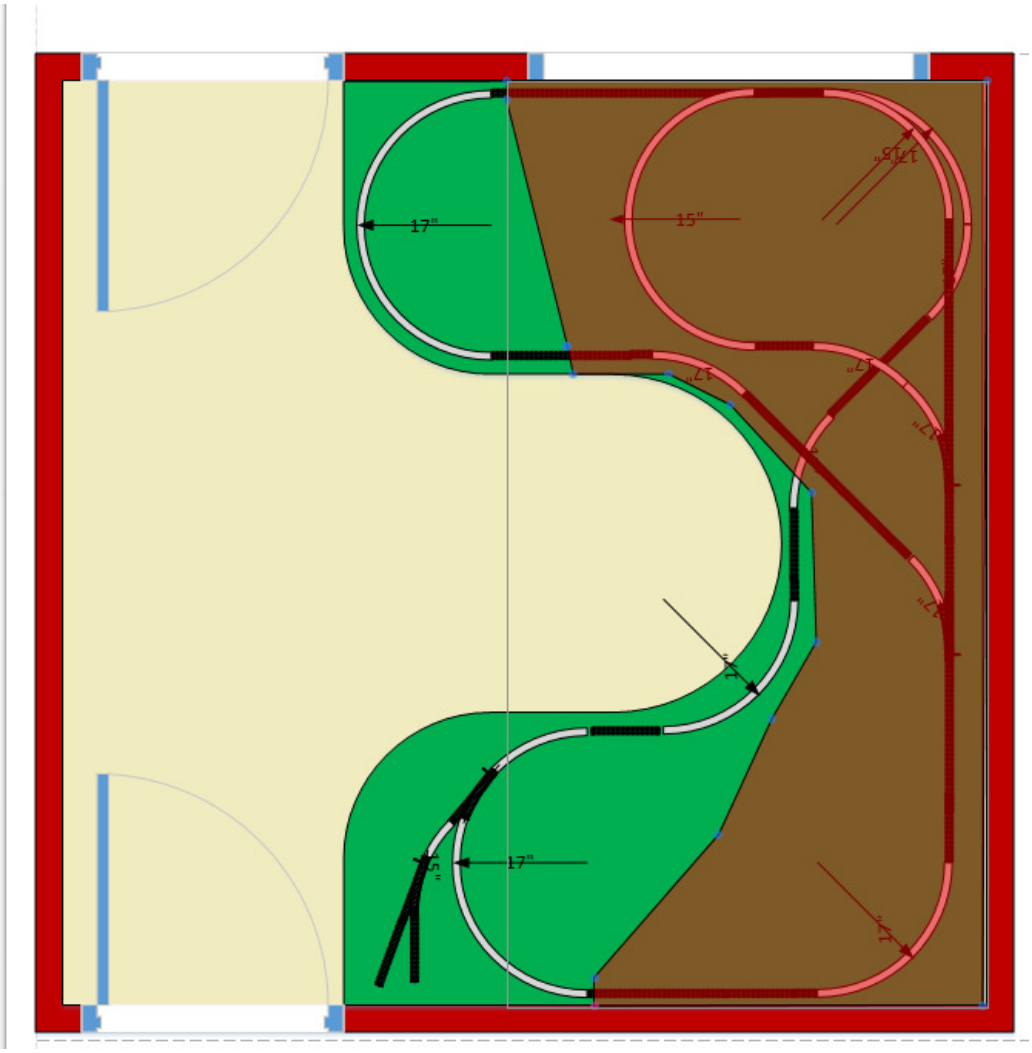
Move the top left rectangle point to the left until it is to the other side of the window at the beginning of the straight track portion. Move the lower left corner of the rectangle to a point just above the track on the bottom of the top side of the layout.



The rectangle now crosses many parts of the layout that want to be seen and even into portions of the room that are outside of the base layout. This can be fixed by the addition of new control points to the shape. Each of these new control points can be manipulated/moved in exactly the same way as previously described. Hold down the control key (CTRL) and put the cursor on a portion of the outline of the newly deformed rectangle and press the left mouse button. This will cause the creation of a new control point on the shape. The object is a pentagon and no longer a rectangle. Drag the new point such that it would represent a tunnel entrance for the top straight on the layout.

Add another control point just below the one on the bottom of the top of the layout. This will be used to represent the “upward” directional portion of the terrain.

Add control points and manipulate the shape until it looks like the one shown below.



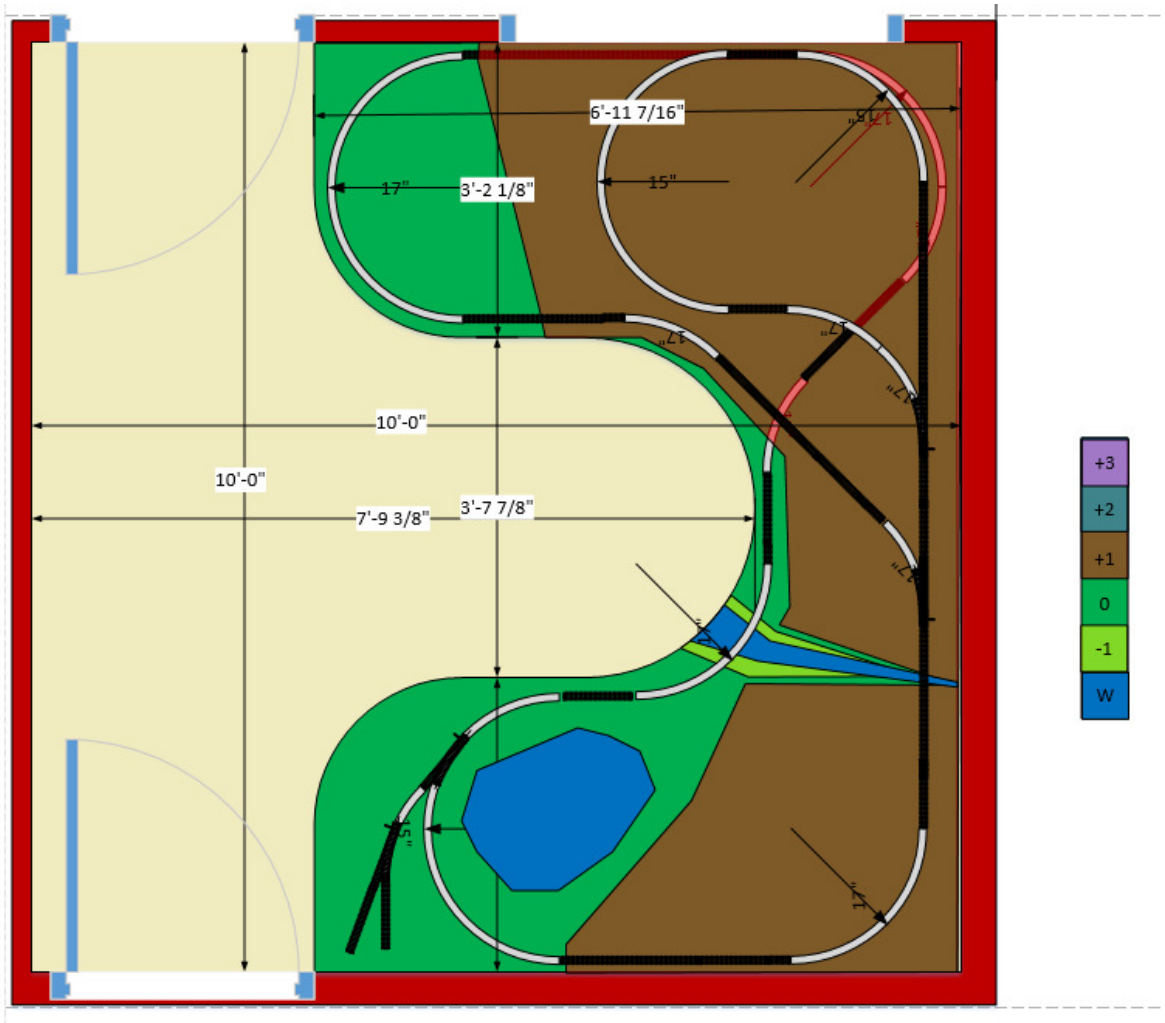
In order to get the track in the correct placement on the terrain it is necessary to move either the terrain or the track in the ordering it was drawn into the layout. This can be accomplished in one of two ways: Send the terrain to the Back, and then move it forward one level at a time. Or, select each piece of track that is to be on top and use “Bring to Front” to reposition it on top of the terrain. Using either or a combination of these methods will generate the correct placement of some of the track under the terrain, indicating a tunnel. Select the terrain and on the “Home” tab use “Arrange”-“Send to Back”. This will place the terrain under everything on the drawing, even the room. As such it will disappear from being visible on the canvas. Without de-selecting the terrain, use the “Arrange”-“Bring Forward” to bring the terrain forward of one entity at a time. This will need to be repeated until the track in the tunnel is masked “red”, and the track on top is clear.

The deformation of a rectangle, by adding new control points, can be used to create water pathways, rivers, mountains, and all representations of terrain. It is not limited to only 5 levels as in this tutorial.

Note: using the "Arrange" mechanisms on the Home tab allow for editing and manipulation of many items on the canvas. The ordering of what shows on top can be manipulated for all objects on the screen.

Creeks, ponds, rivers and waterways are generated in the same manner as the first level of the terrain. Draw a rectangle and place it on the layout. Using the "Clipboard"-"Format Painter" copy the water fill color from the legend. Use the "Tools"-"Line Tool" to move and add control points to the water.

To represent terrain that is below the base layout area use the same technique and copy the fill characteristics to the -1 legend value.



Control Panel Diagram

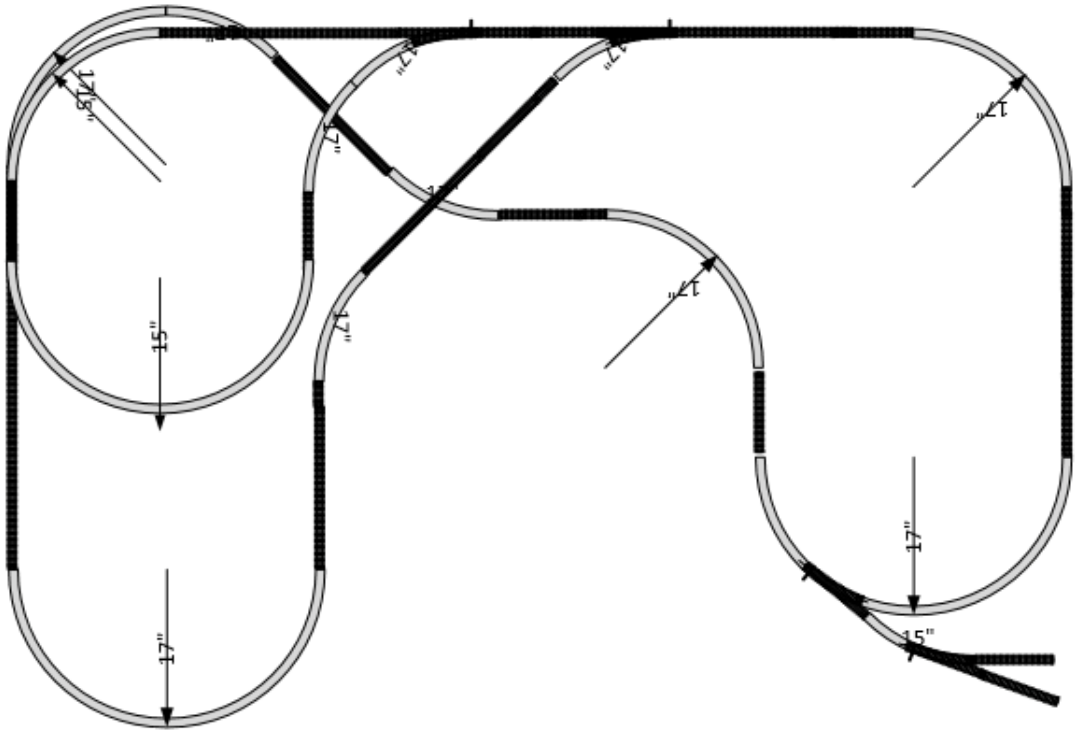
With the track plan now complete, it is possible to use Visio® to aide in other layout planning activities. The first is to design a control panel diagram from the existing track plan. This control panel diagram will exist in a new page inside of the same file as the layout on a new page titled “Control Panel”. This diagram can be used for a layout switching control panel or simply as a schematic to verify that the desired train directional switching is correct.

At the bottom of the canvas on the left just before the shape/stencil toolbox is a listing of all of the pages in the current file. Currently only “Page-1” exists. To the right of “Page-1” is a selection mechanism for selecting a specific page, and a plus “+” symbol inscribed in a circle. This is the “Add Page” to the working file. A right mouse click on the tab of the page will bring up a list of options to perform on the page. Select Rename and change the name of the page to “Control Panel”. The same technique can be used to rename “Page-1” to “Layout”.

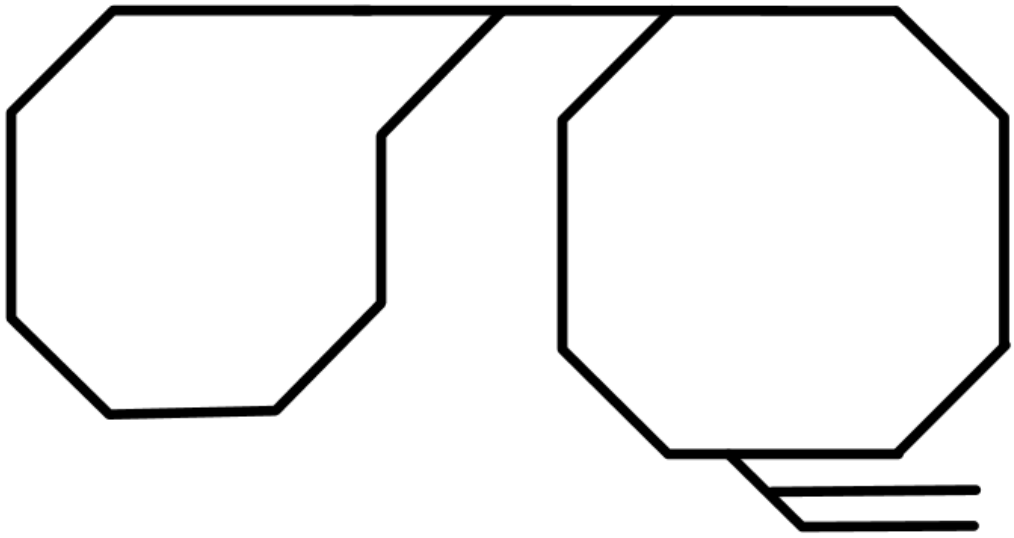
A left mouse click onto the page name tab at the bottom is used to switch between the pages of the Visio® file. Switch back to the “Layout” page and using the “Layers”-“Layers Properties” remove the check mark for the visible of all of the layers and select “OK”. What will be left is only the track and the terrain. The goal is to have only the track remain visible. Select the terrain and the legend and add them to a new Layer called “Terrain” and set that layer’s visible to off. At this point all that remains on the canvas is the track.

Using the select “All” method of “Control-a” will select all of the track on the canvas. Add these to another new layer titled “Track”. Leave this layer visible. Select all of the track and from the “Home”-“Clipboard” toolbox select “Copy”. This will make a copy of all of the track into a temporary holding area of the computer’s memory. Select the “Control Panel” page from the bottom page tabs and paste the track onto the “Control Panel” page.

For this tutorial, a control panel would probably sit between the two major parts of the layout, so the layout as drawn rotated 90^{o}. Using the “Control-a” method select all of the track and using the group rotation component at the top of the group rotate the entire layout representation 90^{o} counter-clockwise.



In the tutorial diagram, there are 6 switch machines, two sidings and one loop that will need isolation and be implemented as a reversing loop. The schematic of the drawing layout can be reduced to showing the major areas as follows:



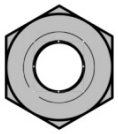
As can be seen in this diagram the basic part of the loop that went into the tunnel is simplified to just showing the circle the track actually traverses. This simplification is used to indicate the primary path for the track.

The next step is to convert the track plan into a control panel layout. The first step in this process is to “Lock” the layer of the track so that it does not interfere with any of the drawing of the control panel. Using the “Editing”-“Layers”-“Layer Properties” select “Color” for the Track layer. This must be done before locking the layer as one it is locked, this option is not available. Select a yellowish color from the color pull down list. The logic behind this maneuver is to allow for the overlaid control panel schematic to be easily distinguished from any new drawing on the canvas. Lastly, lock the track layer and press “OK”.

The control panel layout described here will denote toggle switches and lamps to indicate the switch direction. To indicate both the toggle and the lamps can be done using the shapes already defined in Visio®. On the “Shapes” toolbox select “Search” and enter the text “Nut”. This will bring up a list of Nut shapes that have already been defined by Microsoft. If the “Hex nut top” shape does not appear, select the “More results..” Drag the “Hex nut top” to the canvas. This will cause the Shape Data dialog box to appear asking for the Thread Diameter of the nut. For simplicity, just use the 1 ½ value.

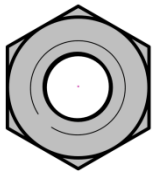
Add a fill color of light gray or sliver to the nut and increase the line size from ¼ pt. to 1 pt. and color it black. This makes is look a little more color appropriate to a hex nut from the hardware store.

Inserting a circle shape that fills the center of the nut represents the lamp. Do not worry about applying a fill to this circle as it that will be done in the following steps. Draw another circle, with a ¼ pt. line, that fits exactly the outside dimensions surrounding the hex nut and change the fill to “No Fill”. This provides the separation of the rotation of the hex nut when adding it to a control panel. Select both the nut shape and the circles and group them together.



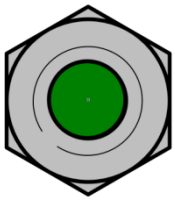
Note: This is an excellent time to learn about connection points. Connection points allow for exact placement of lines between objects that are on the screen. They can used to generate routing lines between objects, much like the traces on a

printed circuit board. For the purpose of the control panel they will be used to indicate connectors on the toggles or lamps for track paths between the switches.

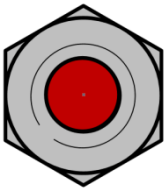


With the nut/circle selected in the canvas, select from the Home tab the “X” in the “Tools” toolbox. This is the insert or select a connection point icon. Selecting this will bring up a gray square around the center of the nut. Hold down the control key on the keyboard and using the mouse’s left mouse button click in the center of the square around the center of the nut. A red dot will appear indicating the position of the connection point. It is possible to add more connection points, but for this tutorial and laying out a control panel this is the correct placement. The use of the connection point will be shown later.

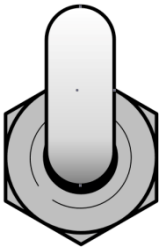
Make a copy of the nut using the “Clipboard”-“Copy” command as the shape will be used for multiple shape creations in the following steps.



To represent a green lamp, select the center circle and color it to a dark green. This will be the “right of way” colorization for the lamps.



For a red lamp, paste the nut shape from the one copied before the previous step. Fill this one to a dark red.

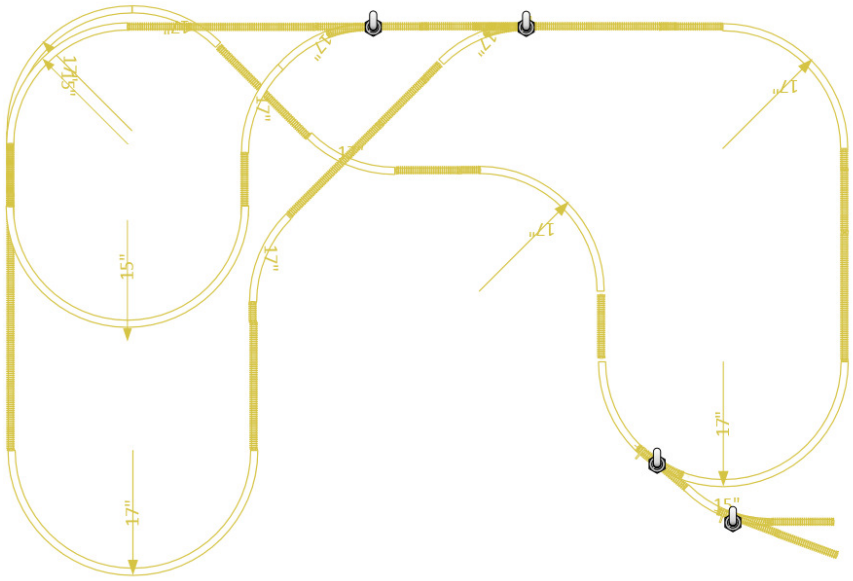


For a toggle button, past the nut shape again onto the drawing canvas. Select the center circle and color it to a black color. From the “Shapes”-“Search” search for a “round rectangle”. This will bring to the Shapes toolbar various versions of the round rectangle object. Select the one from the Drawing Tool Shapes titled “Rounded rectangle” and drag it to the canvas. Change the size of this object to be 0.25 in. in width and about 0.4 in. in height. Reposition the “pill shaped” round rectangle to where the bottom is resting inside the bottom of the black circle.

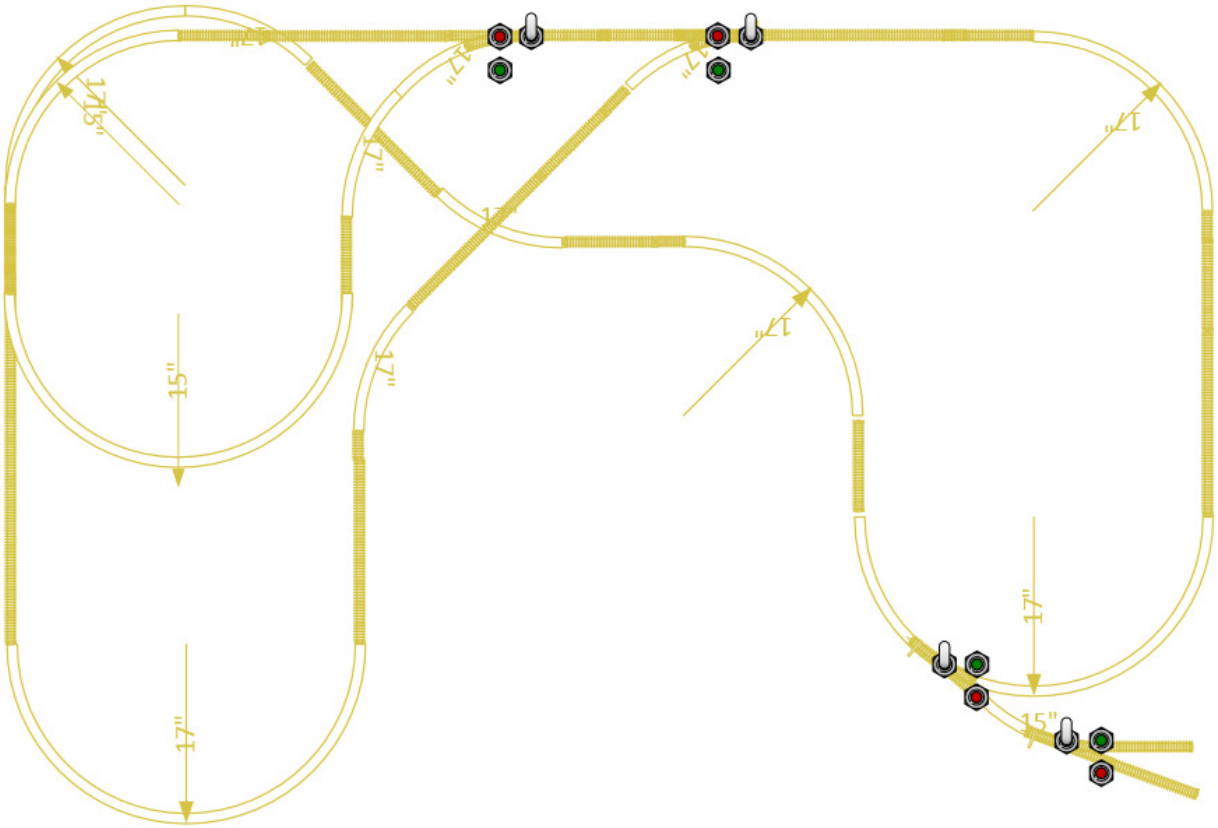
To make the toggle lever appear like a vertical lever, open the “Format Shape” toolbox from the more options portion of the “Shape Styles” on the Home tab. In the Format Shape select a FILL of “Gradient fill”. This will color the pill a funny color, but this is easily remedied. Under the “Gradient Stops is a horizontal box with 2 end chevrons and a center chevron. Select the chevron on the right end of the box and then change the “Color” directly underneath to a medium gray. Select the toggle lever and the underlying nut and group them together.

Create a new Shape Stencil titled “Lamps” and put the lamps and the toggle into the shape library.

On the canvas, drag one of the toggle buttons to each of the switch locations on the track drawing.

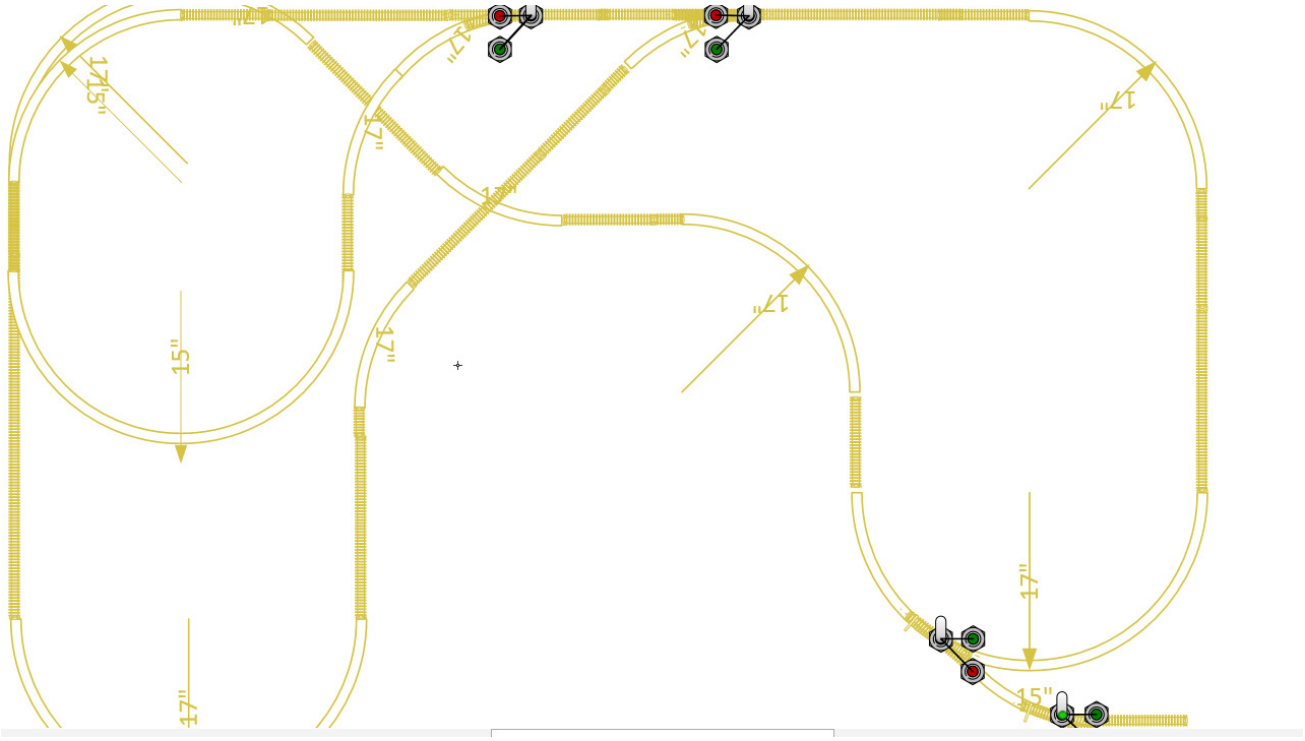


For each branch of the track past a toggle, place a lamp. This can be a personal preference as to either red or green.



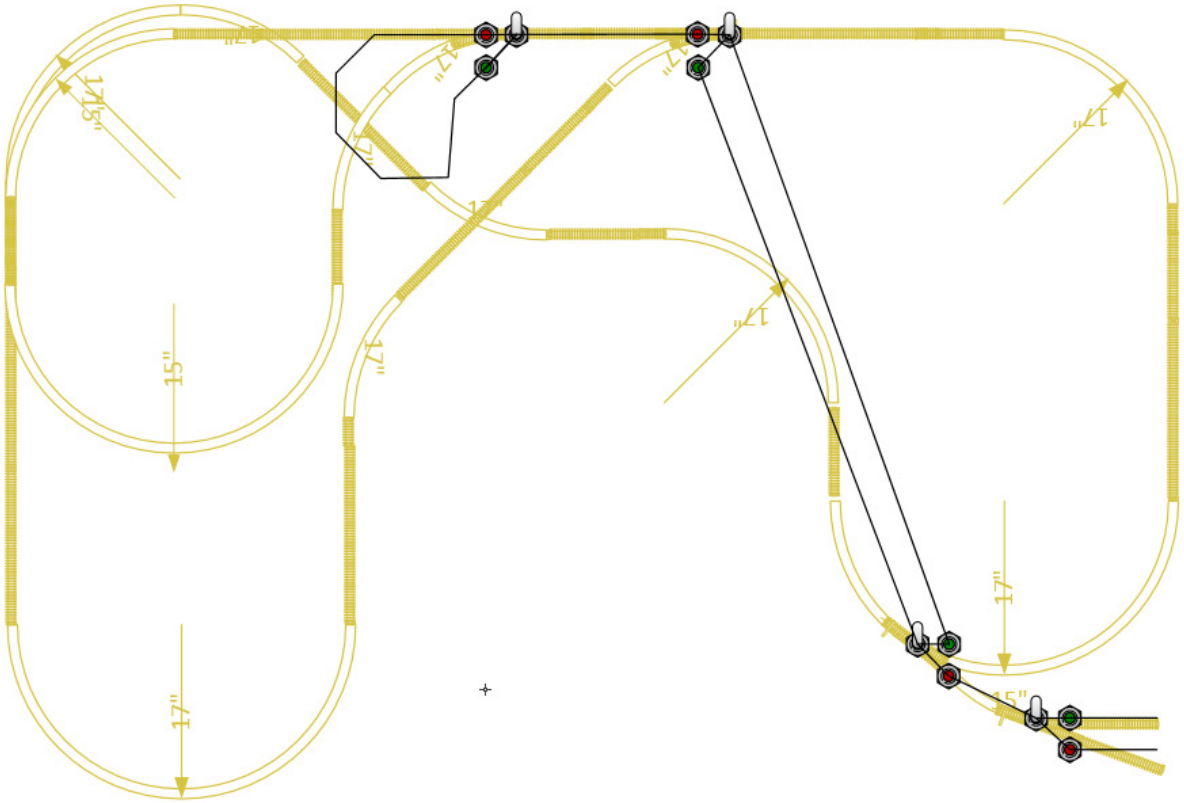
Before starting the next step of drawing the lines between the lamps and toggles, verify that the snap features are all turned on. On the View tabs under the visual aids additional capabilities in the "Snap & Glue" dialog make sure all of the snap options are selected. This allows a line to be drawn from one object to another such that when the object is moved, the line will move with the object.

Using the Line tool from the “Home” tab’s “Tools” toolbox draw a line from the center of each toggle to center of each lamp the switch represents. A green box will highlight at the center of the toggle and the lamp to indicate the correct positioning. First do this for all of the Green lamps, then do it for all of the Red lamps. This is to make sure that the line being drawn is not considered a continuation of the line, but rather a line object in its own right.



The next step is to make the track connections between sections indicated by the lamps. Don't worry that the organization of the "schematic" is incorrect as this will be corrected shortly. Draw a line for each siding that travels from the center of the lamp to the end of the siding. If space is not appropriately available, extend the line of the siding beyond the end of the track.

Try selecting and moving a toggle or a lamp around on the canvas. The lines between the objects will stay in position as the object is moved to a different place. Selecting one of the connector lines and using the "add a connection point with the Control-Left mouse click" onto the line will allow for the line to be expanded to indicate a loop or other "change".

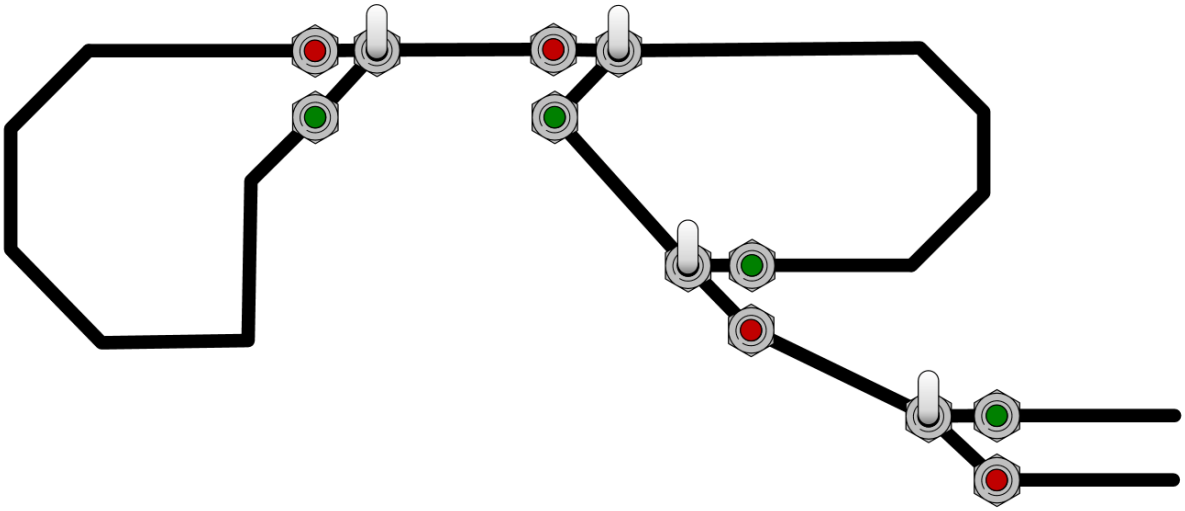


Since a toggle and the two lamps are considered a single object, it is recommend that each switch's toggle and two lamps be "grouped" together. This way, movement can occur to organize the control panel layout without having to move each switch's components independently.

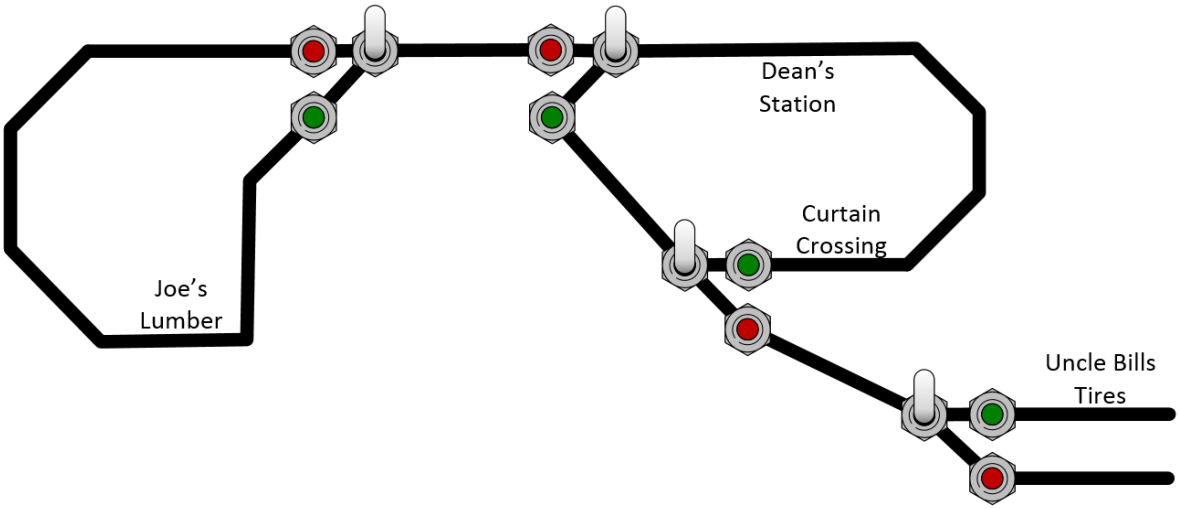
At this point it is time finish out the "look and feel" of the control panel. There are two problems currently with the way it is drawn, the first is that the lines are a very narrow line and not the wide size consider appropriate for a control panel. The second is that the lines appear on top of the toggles and switches. Both of these problems are easily corrected with techniques that have already been presented, they are just time consuming.

For the line width, select each line and with the "Shape Styles"-"Line"-"Line Weight" to a 6 pt. line. Before moving to the next line, use the "Arrange"-"Send to Back" to move it behind the toggles and or lamps. Do not worry that it goes behind the actual track representation of the layout. This can be fixed by making the track layer not visible through the Home tab's "Editing"-"Layers"-"Layer Properties" Mechanism.

The organization of the control panel can now be rearranged to provide a linear representation of a control schematic.



The last piece of the control panel is to provide labels to areas of interest of where particular industries are located. Using the text tool it is possible to place labels onto Control Panel where appropriate.

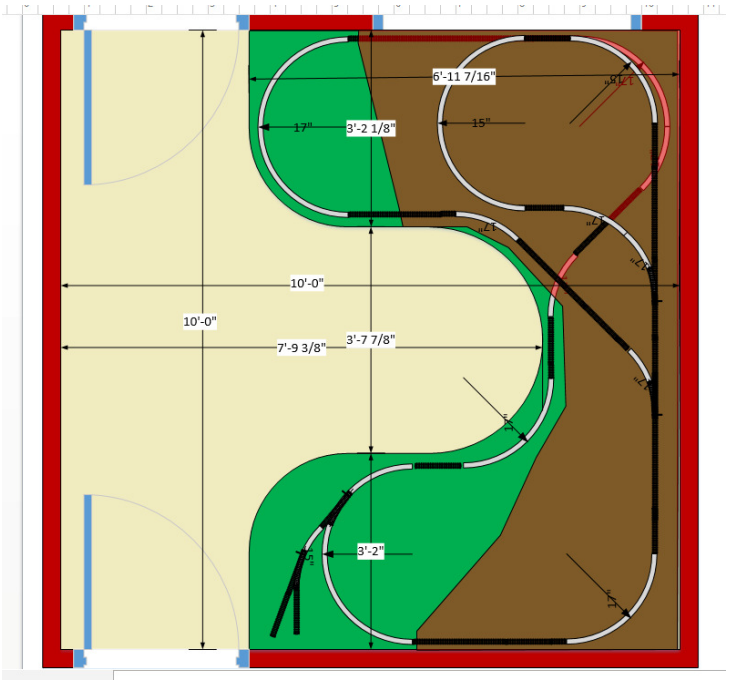


Measurements

Up to this point the size and measurement indicators have been set by using the size of the object on the bottom of the canvas. Visio® provides mechanisms to allow for accurate dimensional specifications to be shown on the screen. In the Shapes-Search perform a search on the word “dimension”. This will bring up a list of the dimensioning shapes that are available in Visio®. The primary dimension tools to use are from the “Rack-mounted Equipment” shape stencil. These are “Dimensioning-horizontal” and “Dimensioning-vertical”.

Return to the Layout page and drag an instance of the “Dimensioning-horizontal” shape onto the screen. The initial size of the object is 16 in. or 1 ft. 4 in. The units that this shape represents can be changed by a right mouse click on the object and selecting “Precision & Units”. From this dialog box the precision (how accurate) can be changed and the units to other US or Metric values.

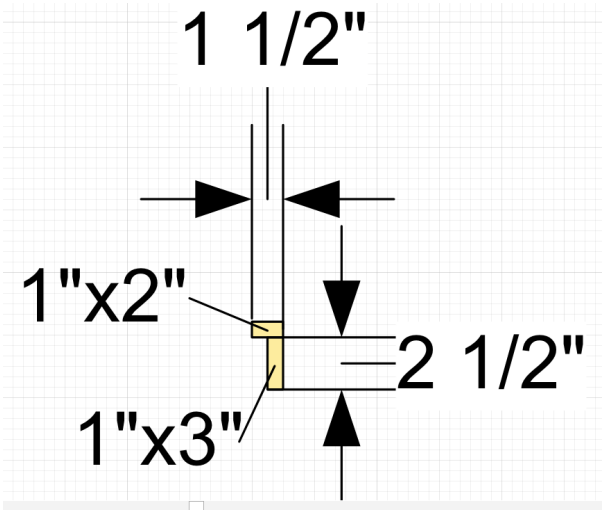
Drag the measurement object to just above the room on the top left corner. Select the “gray” selection box on the lower right of the object and drag it until it reaches the other side of the room. The dimension should now be exactly 10 ft. 7 in. A similar procedure can be done with the Dimensioning-vertical for the vertical measurement of the room.



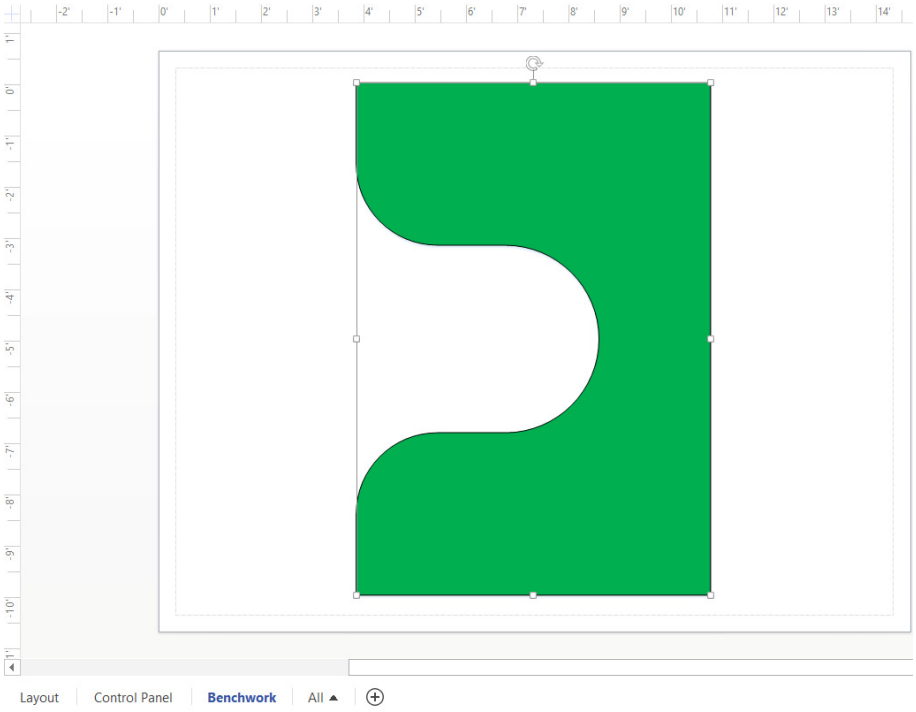
It is useful to experiment with measurement tools from the shape search for other dimensions on the layout. As with all of the other objects in the canvas, it is useful to place all measurement objects into a new layer titled “Measurement”. This way the measurement lines can be turned on or off easily with the visible checkbox of the Layer’s Properties.

Benchwork

Planning benchwork is paramount to the development of a good layout. With Visio® being a 2D CAD package, it is possible to plan the benchwork for the underlying foundation for the layout. For the tutorial layout assume the option is to use an L-Girder benchwork. The L-Girder has been widely accepted as the way to build a sturdy platform for building a Model railroad. This uses beams constructed into an L shape that allows Joists to be placed easily for either a cookie cutter base or splines for track. For the tutorial layout the L-Girder will be constructed of 1 in. x 4 in. vertical components and 1 in. x 2 in. lumber for the horizontal component. Risers will be constructed of 2 in. x 2 in. legs and 1 in. x 2 in. cross braced supports.

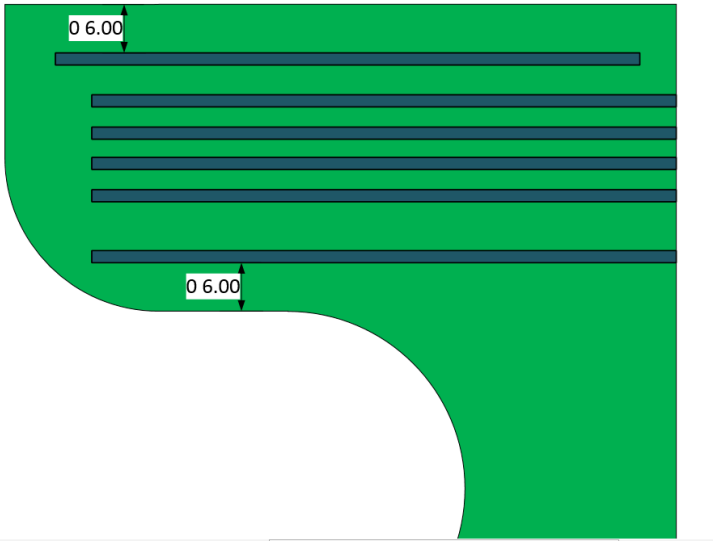


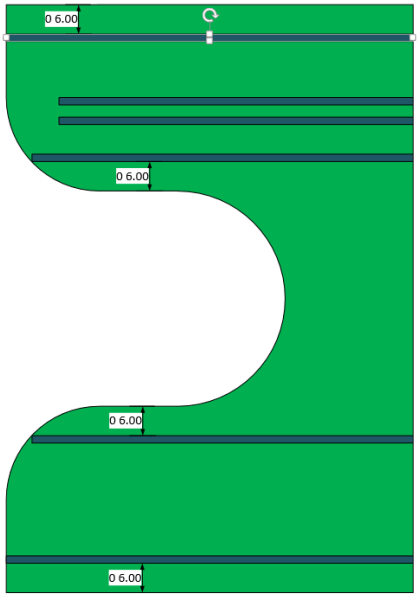
To define this placement and design of both the risers and the L-Girders is a fairly easy task in Visio®. Add a new page to the drawing and rename it to “Benchwork”. From the Layout page select only the “Base Layout” image and copy it onto the new Benchwork page.



From this view it is apparent that there is a need for joists to handle the curvatures of the base layout. But the first thing to do is to define where the L-Girders will be placed to support the joists. Draw a 1 ½ in. high rectangle that is about 6 ft. in length. 1 ½ in. represents the top width of the 1 in. x 2 in. board that serves as the top of the L-Girder. Select a color from the “Style Shapes”-“Fill” and color the L-Girders all to a common colorization. Copy and paste this rectangle 5 times so that there are 6 copies of the rectangle on the canvas.

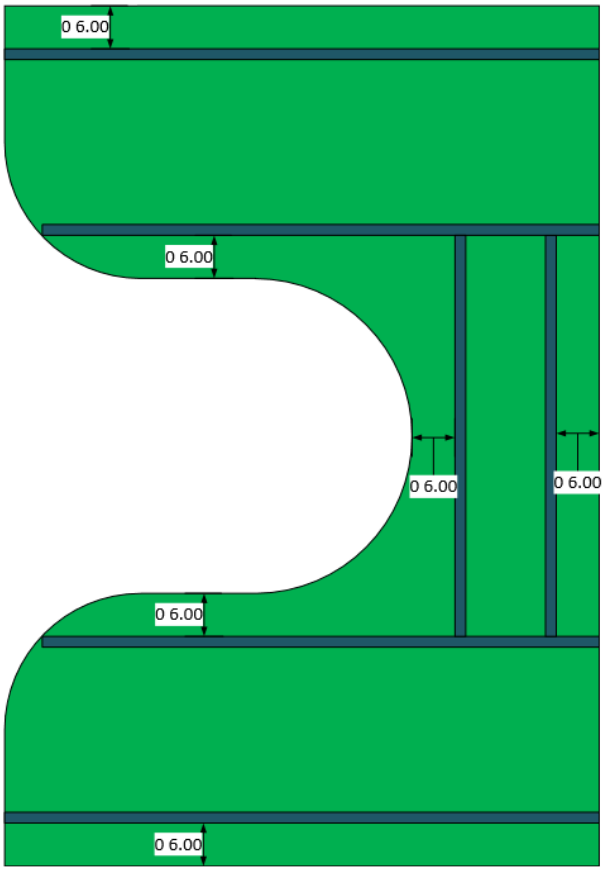
Using the vertical shape tool, drag a copy of the vertical dimension object to the canvas and align it with the top of the layout. Make the height of the dimension to 6 in. move one of the rectangles until it is exactly 6 in. from the top of the layout. Copy the dimension object and place it on the inside flat portion of the top “pill”. Move one of the rectangles until it aligns horizontally with this measurement.

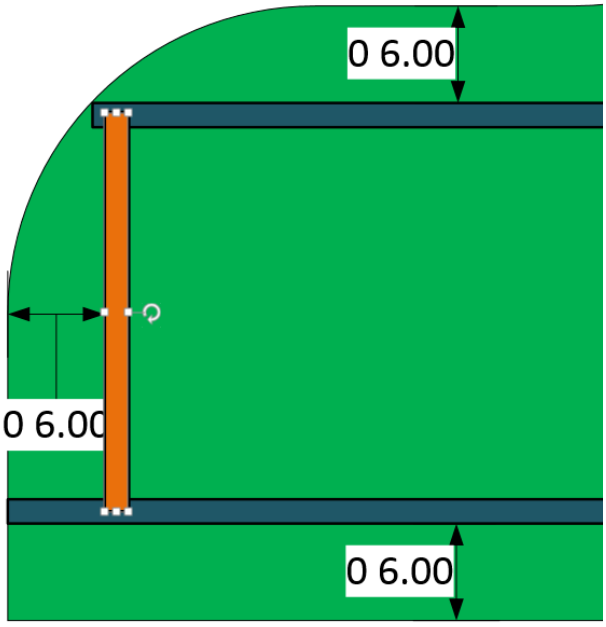




Select the “carefully” placed 4 rectangles and align them to the right using the Home tab “Arrange” alignment mechanism. Move these 4 rectangles until they are flush with the right side of the base layout. Next stretch each rectangle until it either meets or just barely touches the left side of the base layout.

Using the horizontal dimension tool create two dimension objects that are 6 in. in width and place them at the vertical center of the layout. This is where the layout is thinnest in the horizontal dimension. Rotate each of the remaining L-Girder pieces 90° so that they appear as vertical L-Girders. Move one girder to where it is 6 in. from the inside of the curve and the other to where it is 6 in. inside the back (Right) side of the base layout. Resize each of these until each abuts against the horizontal L-Girders on top and bottom.

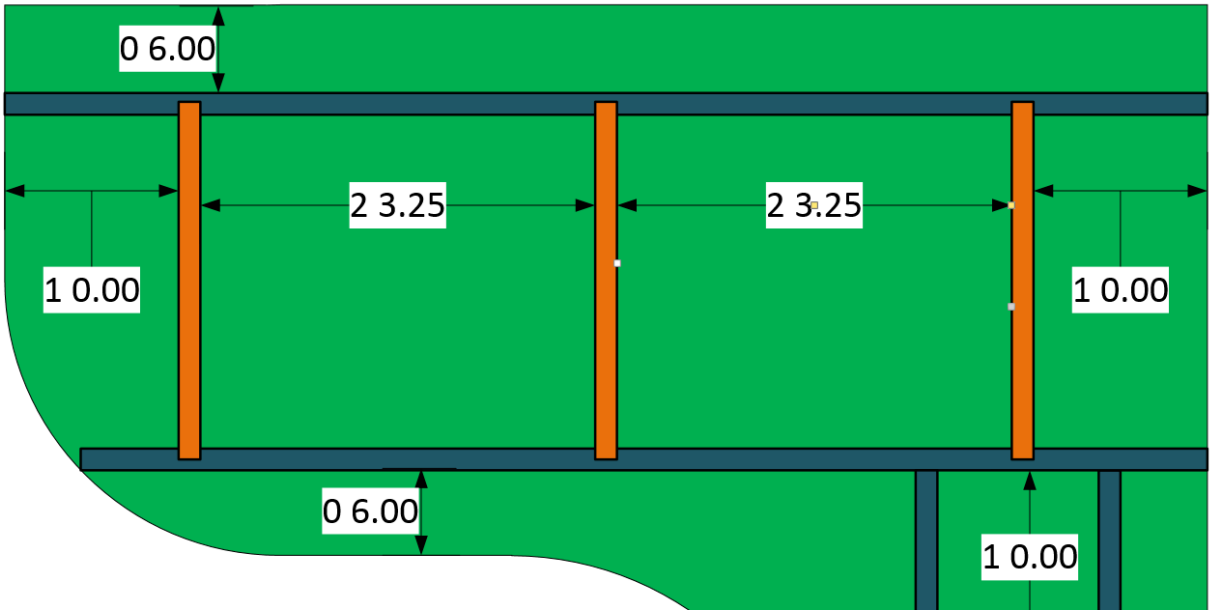




The next step is to decide where to place the risers for to support the L-Girders. For this layout, assume that the maximum spacing for an L-Girder riser will be no more than 30 in. and placement of the outside edge risers will be 16 in. from the edge of the base layout. Place a horizontal dimension measurement object that is 6 in. from each edge of one of the pill halves. Place a second 6 in. horizontal measurement object from the right edge of the base layout. Using the rectangle tool draw a vertical rectangle that is 1 ½ in. wide that spans across the two horizontal L-Girders at the 6 in. distance from the end. Using the “Fill” mechanism, make this shape a different

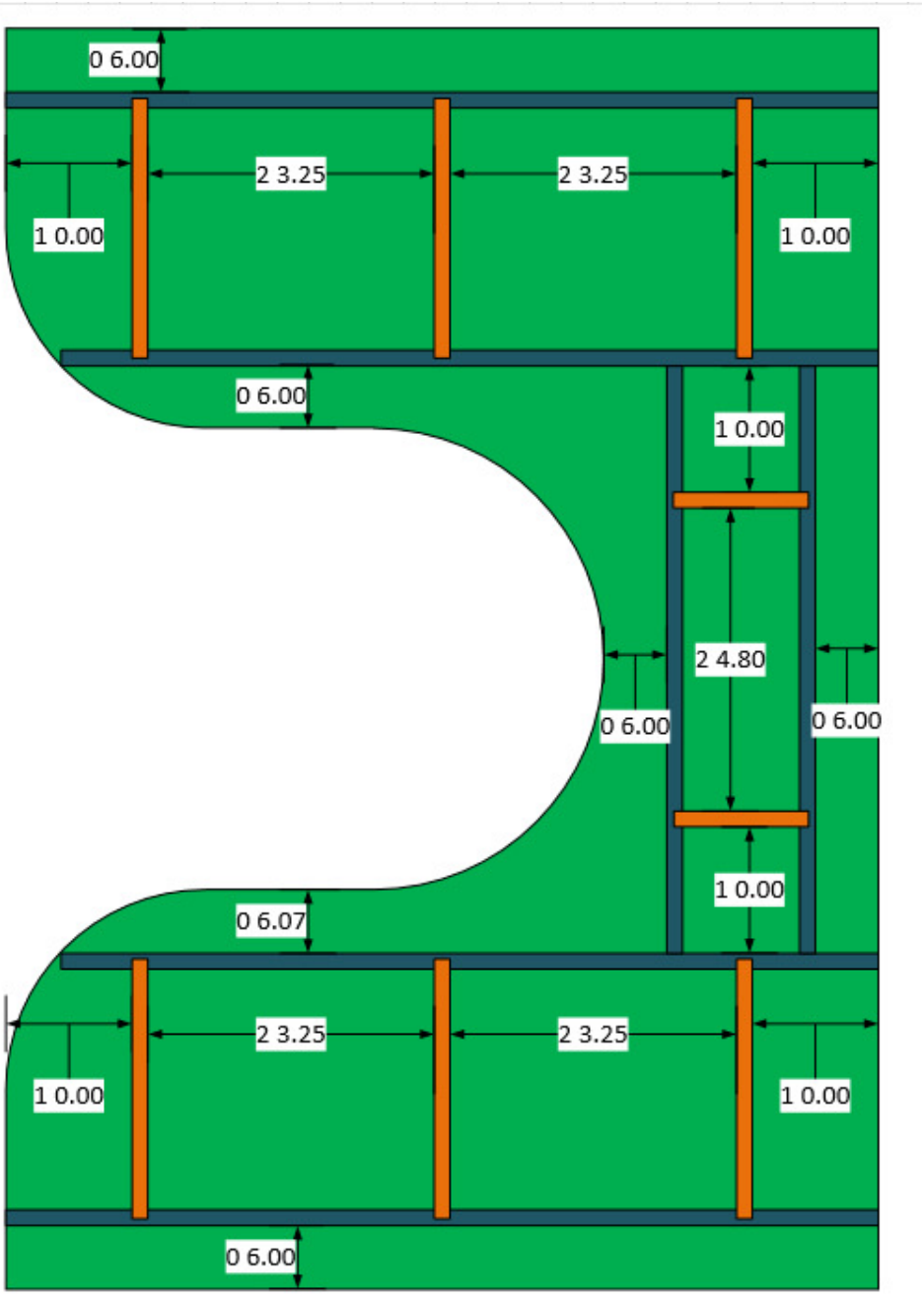
color than the L-Girders. Resize the riser rectangle until it leaves the 3/4 in. of the width of the L-Girder on both the bottom and the top L-Girders.

Copy the riser object and place it to where it abuts against the right side 6 in. measurement object at the same distance between the L-Girders. Using the control-drag copy mechanism, make a copy of the riser and place it in between the two other risers. Deselect all of the riser and then select them one at a time starting from the left most riser. Using the “Arrange”-“Align” tool align the three risers to the top. Without deselecting the risers, select the “Position”-“Distribute Horizontally” mechanism to move the center riser to where it is exactly halfway between the other risers. Generate a copy of the horizontal dimension object for the distance between each of risers. Copy the risers and the measurements and place them on the other “pill” shape to where they match the alignment of the other “pill” shape.



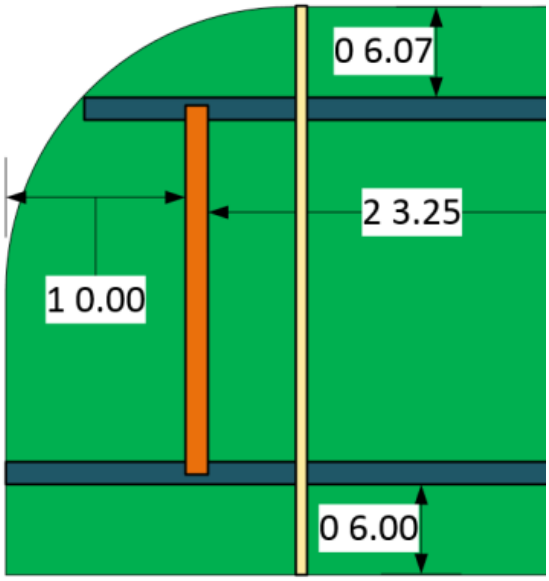
The next step is to generate the risers to support the vertical L-Girders previously put in between the horizontal L-Girders. To do this copy one of the risers already on the screen and rotate it 90^{o}. Place a 12 in. vertical dimension object in between the two vertical L-Girders where one end meets against the horizontal L-Girder. Move the riser until it sits between the two vertical L-Girders at the 12 in. offset distance. Repeat this step to generate the other riser on the opposite end.

Lastly, generate a vertical dimension object that indicates the distance between the two new risers. If everything went correctly, all risers are on the layout and the dimensions between any of the risers is less than 30 in.

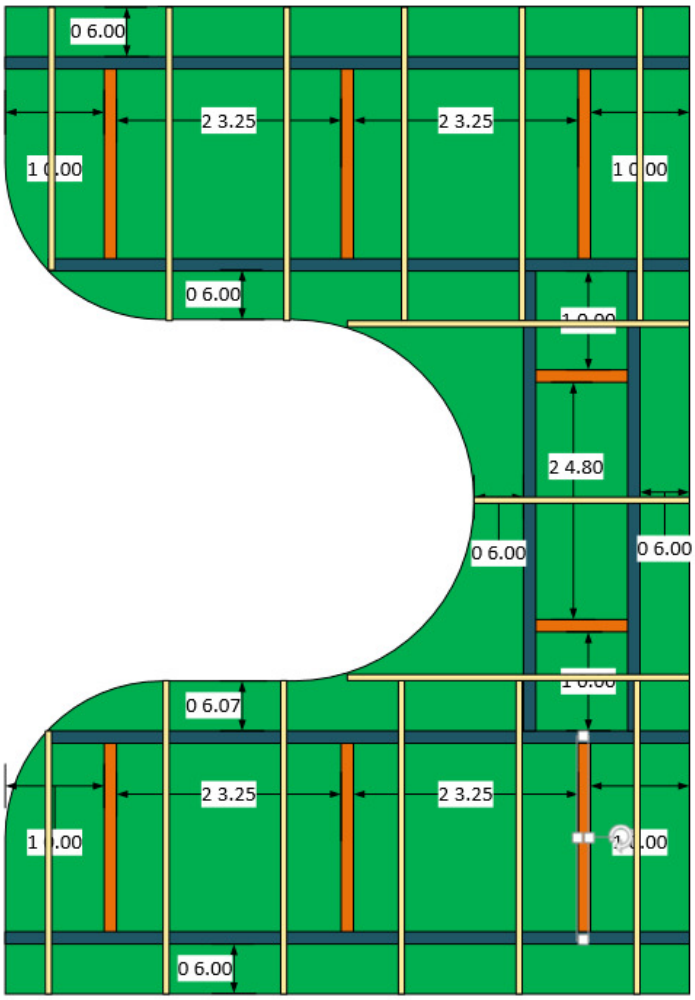


The risers actually will exist under the L-Girders, so select all of the L-Girders and using the “Arrange” toolbox, bring them to the top.

Place the joists across the L-Girders by drawing joist rectangles on the L-Girders. This is probably an exact science, but it seems to be more of a designer's preference that dictates where the joists are located. Using the rectangle tool, draw a rectangle that is ¾ in. in width and stretches from the top wall until it meets the bottom of the flat portion of the center of the pill. Using the "Fill" change the color of the joist to a different color of that used for the L-Girders and the Risers.



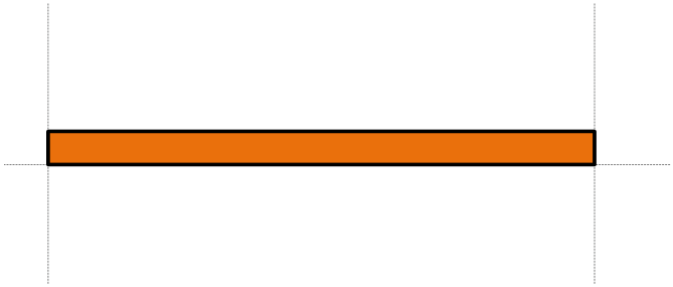
It is now just a matter of placement of the joists so that they are equally spaced at intervals that will support the actual layout. Assume that there a 6 joists for each of the "pill" sections of the layout and 3 for the portion in between. Using the copy and paste mechanisms along with the align toolbox, these can be placed to an approximate location. Use the "Distribute horizontally or vertically" where appropriate and place them at equidistant locations from each other. Lastly, size each joist so that it meets two edges of the base layout.



Once the placement and the sizing of the risers has been determined, the 2D drawing tool can be used to design the actual risers. Select all of the risers from the drawing and copy them using either Control-c or the “Clipboard”-“Copy command, but do not paste them anywhere. Add a new page titled “Risers” to the drawing and paste the risers to the canvas using either Control-v or the “Clipboard”-“Paste” command. Only 1 horizontal and one vertical riser rectangle is needed as the others are simply duplicates and can be deleted. Rotate the vertical riser rectangle into a horizontal position, 90º.

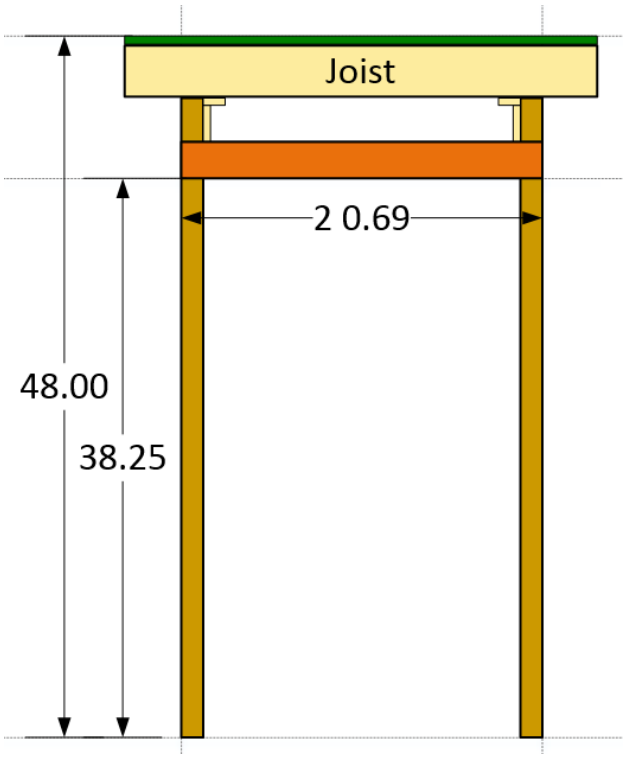
The purpose the riser rectangles, at this point, is to provide an exact size for the width of each of the risers. The next step is to define the height above the ground the base layout will reside. Just for ease of design, use 48 in. as this measurement. Subtract off the thickness of the base layout, for this use ½ in. for ½ in. plywood, leaving 47 ½ in. for the riser, L-Girder and Joists. Using a 1 in. x 3 in. riser takes this down to 45 in. (3 ft. 8 in.).

This is an excellent place to learn about guidelines. These are non-drawing lines that are horizontal or vertical that allow for objects to "snap" to them. The way to put a guide line on the canvas is to left mouse click inside of the ruler, either on the left or the top of the canvas. Holding down the left mouse button, drag the guideline into the drawing until it meets to the left side of one of the risers. Repeat this process for the other side of the riser. Drag one from the top ruler until it reaches the bottom of the riser.

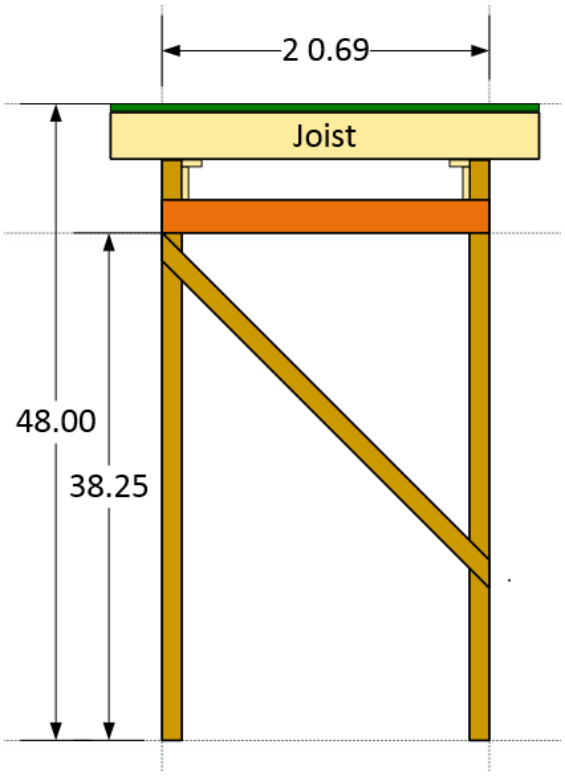


Drag a Dimensioning – vertical object to the screen and move it around until the top of the measurement object meets with the guideline. A small green square will appear indicating it is okay to snap to the guideline. On the opposite end of the measurement object stretch it until it is 38 1/4 in. in height. Drag a guideline from the top ruler until it meets up with the bottom of the measurement object.

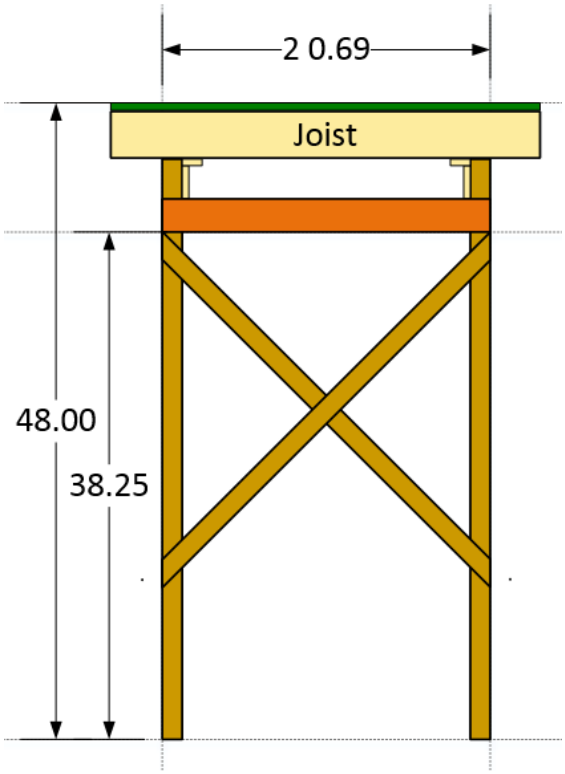
Draw a rectangle that is 1 ½ in. in width, but fills the space between the guidelines in height. The green snap boxes will indicate when the rectangle meets the guideline. Repeat this step for the opposite side of the riser.



The riser legs must be cross braced to provide stability. This is shown in a 2D diagram by the addition of 1 in. x 2 in. cross braces placed at 45^{o} to the legs. To draw this in Visio®, copy and paste one of the leg pieces and using the rotate mechanism on the top of the rectangle rotate it 45^{o} counter clockwise. Move the cross brace until the top most corner meets up to the upper left corner of the left most leg. This will place the brace in a “proper position” for providing the cross brace capability. On the bottom of the cross brace change the length of the brace until the bottom most portion of the bottom of the brace meets up to the right side of the right brace. Both the top and the bottom of the brace should extend beyond the edge of the legs of the brace.

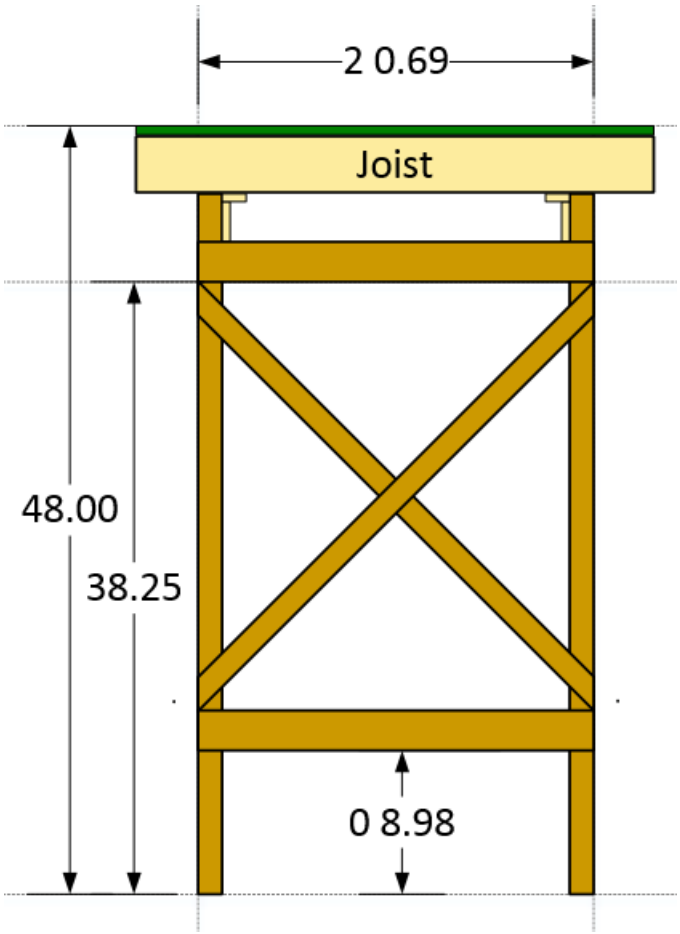


The leg “brace” should still be in the clipboard from when it was copied previously. Paste another copy of the leg and move it to where it is on the outer side of the left most leg of the riser. Select the cross brace and then the newly pasted “outside” leg and using the “Operations”-“Subtract” option, remove part of the cross brace. Repeat this process for the opposite side of the brace.

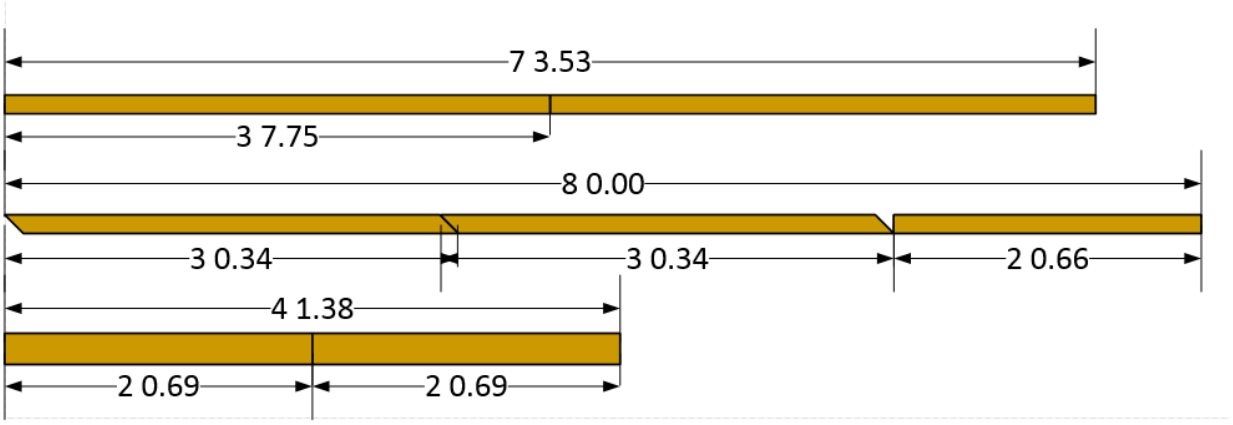


Copy and paste the cross brace. Using the “Arrange”-“Position”-“Rotate Shapes” flip the pasted brace horizontally. This will make a mirror image of the original cross brace. Move this brace until it meets to the right side top of the right most leg.

To complete the riser a horizontal component should be added to guarantee that the riser will not move. Use the top piece of the riser (this is the one copied from the other page) for the horizontal rectangle/stabilizer. If more stability is required a second horizontal stabilizer can be added at the bottom of the cross braces.



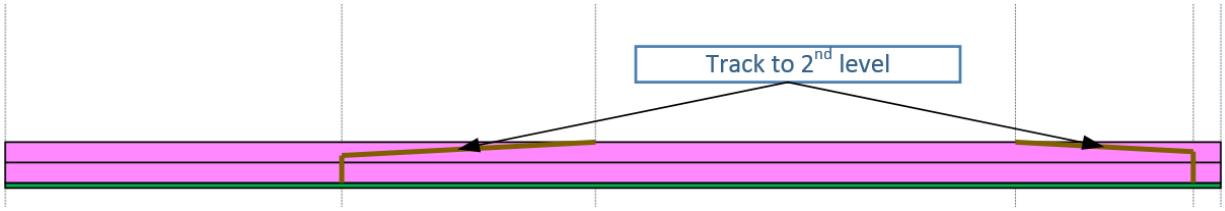
The last step with the risers, is to determine how much lumber will be required to build a riser. This can be estimated by taking a copy of the riser, placing the 2 in. x 2 in. pieces end to end, and by placing the 1 in. x 2 in. pieces end to end. (Note: one cross brace will need to be “flipped vertically” to make the ends line up. Horizontal dimension measurements can accurately show the length of each piece and the total length of the lumber necessary for a riser.


7 3.53
3 7.75
8 0.00
3 0.34
3 0.34
2 0.66
4 1.38
2 0.69
2 0.69


DAL-TILE
ACME

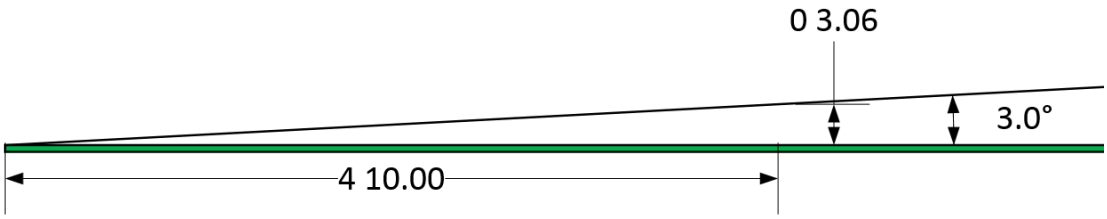
Elevation Representation

Visio® is a 2D representative drawing package and not a 3D representation of the layout. However, the mechanisms that have previously been described can be used to draw a front or side view of the layout. Add another page to the drawing and rename this one to “Elevation”. Draw a horizontal 1 in. thick rectangle on the canvas that is 10 ft. wide. Color this rectangle the same color as the layout base as this is a representation of that piece of the layout drawing. The Home tab’s “Format Painter” is a great tool to help with this step. On the Layout page, select the base layout. Next select the “Format Painter” and switch over to the Elevation page. Select the horizontal rectangle that was just created. If everything went correctly, the base elevation representation is the same color as the base layout on the Layout page.

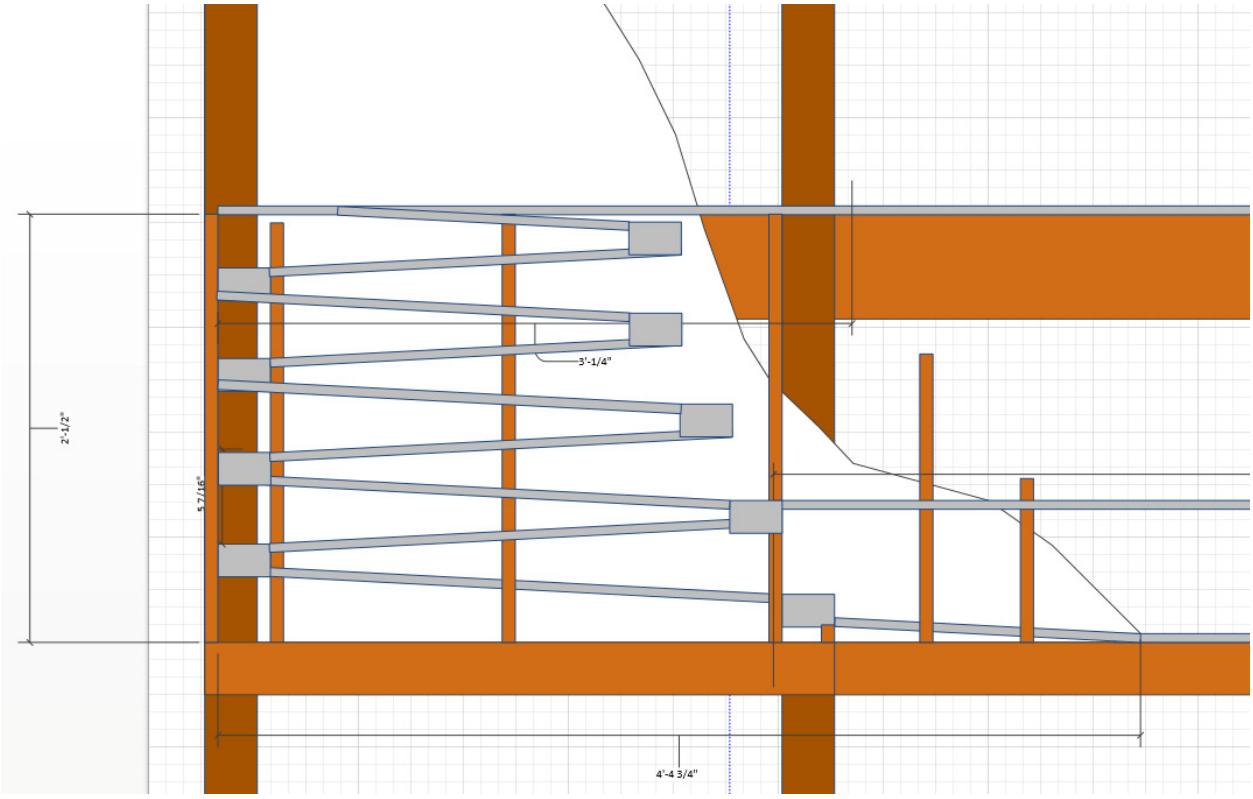


Adding additional rectangles are used to represent ½ or ¾ in. plywood and can be rotated to an appropriate climb for the track, such as 1º, 2º or 3º. This mechanism allows for transition between various layers and the profile of the terrain.

In this phase of the drawing it is very useful to have rise/run charts for the various grade angles. The following charts are helpful for determining the distance up a curve or straight grade allows by the curvature radius. Appendix A contains Grade charts that show a run up to 3 in. in climb. The curve charts are start at the N-Scale 9.75 in. then increment 1 in. up to a 30 in. radius. HO would start at 15 in. radius on these charts.



The technique of showing the elevation can be used to represent a helix for elevation transitions as shown below:



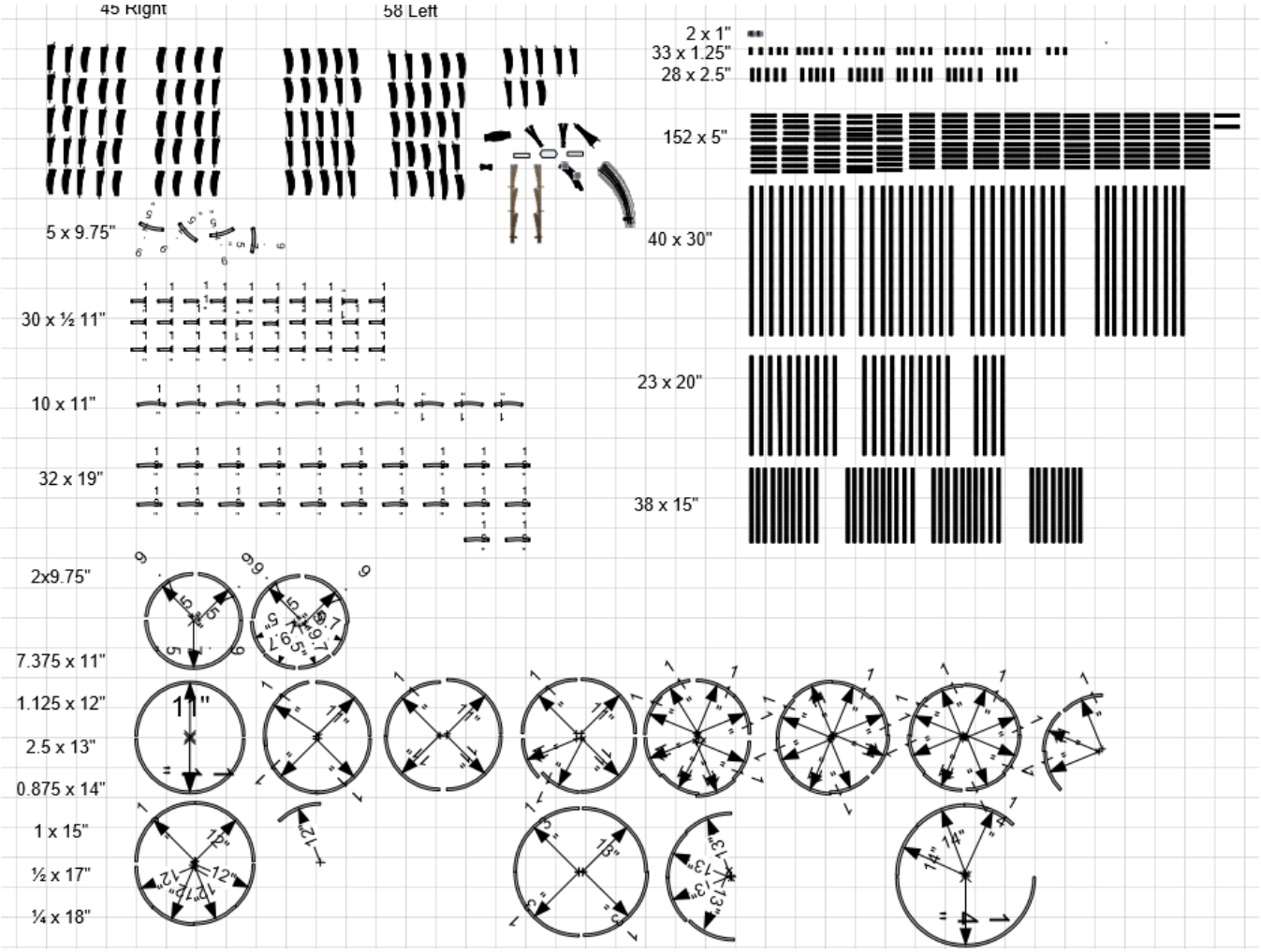
Inventory

Because of the ease of the drag and drop of shapes in Visio®, the design becomes more complex with additional track, curves and buildings added to the layout. For a complex design it is easy to lose track of the number of times a building has been used or to keep track on the number of left or right switches. This method can be used to assist in that computation.

From the Layout page change the visible value for all layers except the track to not be visible. Select all of the track on the screen using either the control-a command or by dragging a selection box around the layout. Copy the entire track into the copy clipboard using either a control-c command or by the use of the Home tab's "Clipboard"-"Copy" command. Create a new page and rename this new page to "Inventory". Select this page to be the current drawing canvas and paste the track layout onto this page.

The next step is to divide the canvas into 4 conceptual quadrants. This is so that it is possible to separate all of the pieces of track with a "click-and-drag" process. Using this method will result in a separation where by the pieces of track can be separated further to quantify the track pieces.

All Switches	All Straight
Curves	Snap Track/ Other



A benefit of this organization is that with a count of the individual components, even the amount of cork required for the track can be calculated by summing up the amount of track in the inventory. Curve radius length (circumference) is calculated by using the formula:

$$c = 2\pi \mathrm{r}.$$

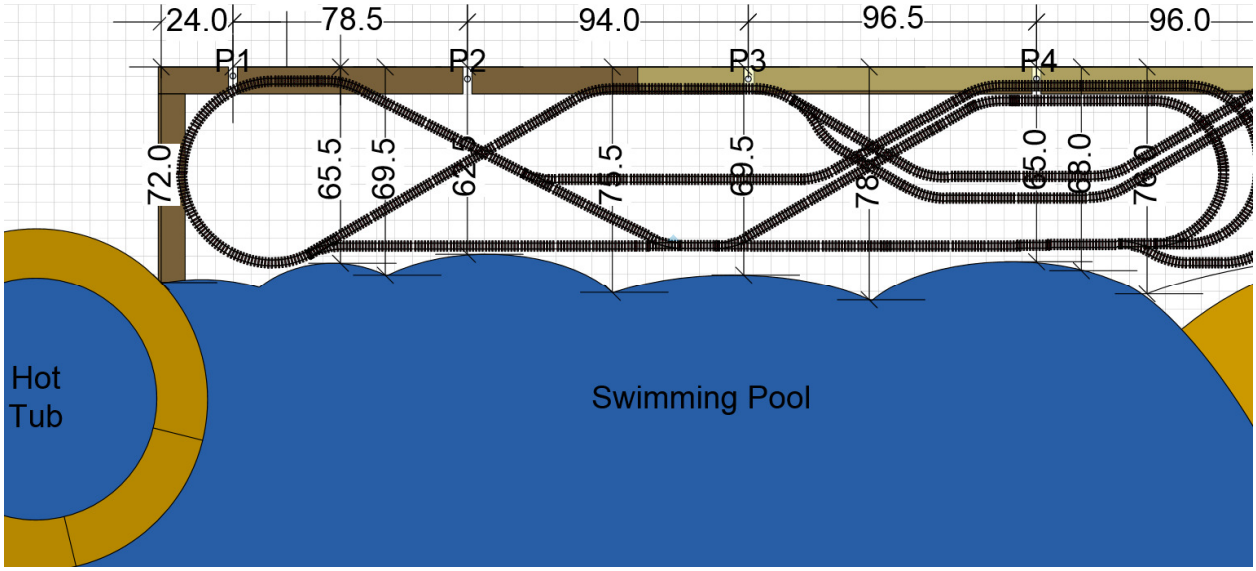
For the ½ radius divide that by 2, for the ¼ divide by 4, etc.

To count various buildings perform a similar technique of copying the building layer from the layout page to a new page titled “Buildings”. Past the buildings and sort them by type, or shape. This will allow for a concise count of specific building kits that are being used on the layout.

Epilogue

This tutorial has presented some of the basic commands and techniques that can be used from Visio® in order to design a track plan. Although the tutorial doesn't cover every mechanism in the Visio® application, it does provide enough of a starting point as to be able to build your own track plan for your layout.

The Stencils/Shape libraries that are created in this tutorial can be used for your custom layout and should not need to be generated again (unless you are in another scale). Be sure to save often and to experiment with the various components of the tool either by searching for keyword in the Shapes or by the Help mechanism on the top right in the shape of a Question Mark "?". Using this drawing package in my opinion is a very comprehensive method for designing a 2D representation for your model railroad layout. Even one for outside using the LGB shape stencil.



Appendix A. Grade Charts

3 degree Grade					
Run	**Rise**	**Run**	**Rise**	**Run**	**Rise**
1	0.0524	**29**	1.5198	**48**	2.5156
5	0.2620	**30**	1.5722	**50**	2.6204
10	0.5241	**32**	1.6770	**52**	2.7252
12	0.6289	**34**	1.7819	**54**	2.8300
14	0.7337	**36**	1.8867	**56**	2.9348
16	0.8385	**38**	1.9915	**58**	3.0397
18	0.9433	**40**	2.0963		
20	1.0482	**42**	2.2011		
24	1.2578	**44**	2.3059		
26	1.3626	**46**	2.4108		

3 Degree Grade Curves								
Radius	**length**	**Rise**	**1/2**	**Rise**	**1/4**	**Rise**	**1/8**	**Rise**
9.75	61.2611	3.2106	30.6305	1.6053	15.3153	0.8026	7.6576	0.4013
10	62.8319	3.2929	31.4159	1.6464	15.7080	0.8232	7.8540	0.4116
11	69.1150	3.6222	34.5575	1.8111	17.2788	0.9055	8.6394	0.4528
12	75.3982	3.9515	37.6991	1.9757	18.8496	0.9879	9.4248	0.4939
13	81.6814	4.2807	40.8407	2.1404	20.4204	1.0702	10.2102	0.5351
14	87.9646	4.6100	43.9823	2.3050	21.9911	1.1525	10.9956	0.5763
15	94.2478	4.9393	47.1239	2.4697	23.5619	1.2348	11.7810	0.6174
16	100.5310	5.2686	50.2655	2.6343	25.1327	1.3172	12.5664	0.6586
17	106.8142	5.5979	53.4071	2.7989	26.7035	1.3995	13.3518	0.6997
18	113.0973	5.9272	56.5487	2.9636	28.2743	1.4818	14.1372	0.7409
19	119.3805	6.2565	59.6903	3.1282	29.8451	1.5641	14.9226	0.7821
20	125.6637	6.5858	62.8319	3.2929	31.4159	1.6464	15.7080	0.8232
21	131.9469	6.9150	65.9734	3.4575	32.9867	1.7288	16.4934	0.8644
22	138.2301	7.2443	69.1150	3.6222	34.5575	1.8111	17.2788	0.9055
23	144.5133	7.5736	72.2566	3.7868	36.1283	1.8934	18.0642	0.9467
24	150.7964	7.9029	75.3982	3.9515	37.6991	1.9757	18.8496	0.9879
25	157.0796	8.2322	78.5398	4.1161	39.2699	2.0580	19.6350	1.0290
26	163.3628	8.5615	81.6814	4.2807	40.8407	2.1404	20.4204	1.0702
27	169.6460	8.8908	84.8230	4.4454	42.4115	2.2227	21.2058	1.1113
28	175.9292	9.2201	87.9646	4.6100	43.9823	2.3050	21.9911	1.1525
29	182.2124	9.5493	91.1062	4.7747	45.5531	2.3873	22.7765	1.1937
30	188.4956	9.8786	94.2478	4.9393	47.1239	2.4697	23.5619	1.2348

2 Degree Grade							
Run	**Rise**	**Run**	**Rise**	**Run**	**Rise**	**Run**	**Rise**
1	0.0349	**29**	1.0127	**48**	1.6762	**68**	2.3746
5	0.1746	**30**	1.0476	**50**	1.7460	**70**	2.4445
10	0.3492	**32**	1.1175	**52**	1.8159	**72**	2.5143
12	0.4190	**34**	1.1873	**54**	1.8857	**74**	2.5841
14	0.4889	**36**	1.2572	**56**	1.9556	**76**	2.6540
16	0.5587	**38**	1.3270	**58**	2.0254	**78**	2.7238
18	0.6286	**40**	1.3968	**60**	2.0953	**80**	2.7937
20	0.6984	**42**	1.4667	**62**	2.1651	**82**	2.8635
24	0.8381	**44**	1.5365	**64**	2.2349	**84**	2.9333
26	0.9079	**46**	1.6064	**66**	2.3048	**86**	3.0032

2 Degree Grade Curves								
Radius	**length**	**Rise**	**1/2**	**Rise**	**1/4**	**Rise**	**1/8**	**Rise**
9.75	61.2611	2.1393	30.6305	1.0696	15.3153	0.5348	7.6576	0.2674
10	62.8319	2.1941	31.4159	1.0971	15.7080	0.5485	7.8540	0.2743
11	69.1150	2.4136	34.5575	1.2068	17.2788	0.6034	8.6394	0.3017
12	75.3982	2.6330	37.6991	1.3165	18.8496	0.6582	9.4248	0.3291
13	81.6814	2.8524	40.8407	1.4262	20.4204	0.7131	10.2102	0.3565
14	87.9646	3.0718	43.9823	1.5359	21.9911	0.7679	10.9956	0.3840
15	94.2478	3.2912	47.1239	1.6456	23.5619	0.8228	11.7810	0.4114
16	100.5310	3.5106	50.2655	1.7553	25.1327	0.8777	12.5664	0.4388
17	106.8142	3.7300	53.4071	1.8650	26.7035	0.9325	13.3518	0.4663
18	113.0973	3.9494	56.5487	1.9747	28.2743	0.9874	14.1372	0.4937
19	119.3805	4.1689	59.6903	2.0844	29.8451	1.0422	14.9226	0.5211
20	125.6637	4.3883	62.8319	2.1941	31.4159	1.0971	15.7080	0.5485
21	131.9469	4.6077	65.9734	2.3038	32.9867	1.1519	16.4934	0.5760
22	138.2301	4.8271	69.1150	2.4136	34.5575	1.2068	17.2788	0.6034
23	144.5133	5.0465	72.2566	2.5233	36.1283	1.2616	18.0642	0.6308
24	150.7964	5.2659	75.3982	2.6330	37.6991	1.3165	18.8496	0.6582
25	157.0796	5.4853	78.5398	2.7427	39.2699	1.3713	19.6350	0.6857
26	163.3628	5.7048	81.6814	2.8524	40.8407	1.4262	20.4204	0.7131
27	169.6460	5.9242	84.8230	2.9621	42.4115	1.4810	21.2058	0.7405
28	175.9292	6.1436	87.9646	3.0718	43.9823	1.5359	21.9911	0.7679
29	182.2124	6.3630	91.1062	3.1815	45.5531	1.5907	22.7765	0.7954
30	188.4956	6.5824	94.2478	3.2912	47.1239	1.6456	23.5619	0.8228

1 Degree Grade							
Run	**Rise**	**Run**	**Rise**	**Run**	**Rise**	**Run**	**Rise**
1	0.01746	**50**	0.87275	**92**	1.60587	**134**	2.33898
5	0.08728	**52**	0.90766	**94**	1.64078	**136**	2.37389
10	0.17455	**54**	0.94257	**96**	1.67569	**138**	2.40880
12	0.20946	**56**	0.97748	**98**	1.71060	**140**	2.44371
14	0.24437	**58**	1.01239	**100**	1.74551	**142**	2.47862
16	0.27928	**60**	1.04730	**102**	1.78042	**144**	2.51353
18	0.31419	**62**	1.08221	**104**	1.81533	**146**	2.54844
20	0.34910	**64**	1.11712	**106**	1.85024	**148**	2.58335
24	0.41892	**66**	1.15203	**108**	1.88515	**150**	2.61826
26	0.45383	**68**	1.18694	**110**	1.92006	**152**	2.65317
29	0.50620	**70**	1.22185	**112**	1.95497	**154**	2.68808
30	0.52365	**72**	1.25676	**114**	1.98988	**156**	2.72299
32	0.55856	**74**	1.29167	**116**	2.02479	**158**	2.75790
34	0.59347	**76**	1.32658	**118**	2.05970	**160**	2.79281
36	0.62838	**78**	1.36150	**120**	2.09461	**162**	2.82772
38	0.66329	**80**	1.39641	**122**	2.12952	**164**	2.86263
40	0.69820	**82**	1.43132	**124**	2.16443	**166**	2.89754
42	0.73311	**84**	1.46623	**126**	2.19934	**168**	2.93245
44	0.76802	**86**	1.50114	**128**	2.23425	**170**	2.96736
46	0.80293	**88**	1.53605	**130**	2.26916	**172**	3.00227
48	0.83784	**90**	1.57096	**132**	2.30407		

1 Degree Grade Curves								
Radius	**length**	**Rise**	**1/2**	**Rise**	**1/4**	**Rise**	**1/8**	**Rise**
9.75	61.2611	1.0693	30.6305	0.5347	15.3153	0.2673	7.6576	0.1337
10	62.8319	1.0967	31.4159	0.5484	15.7080	0.2742	7.8540	0.1371
11	69.1150	1.2064	34.5575	0.6032	17.2788	0.3016	8.6394	0.1508
12	75.3982	1.3161	37.6991	0.6580	18.8496	0.3290	9.4248	0.1645
13	81.6814	1.4258	40.8407	0.7129	20.4204	0.3564	10.2102	0.1782
14	87.9646	1.5354	43.9823	0.7677	21.9911	0.3839	10.9956	0.1919
15	94.2478	1.6451	47.1239	0.8226	23.5619	0.4113	11.7810	0.2056
16	100.5310	1.7548	50.2655	0.8774	25.1327	0.4387	12.5664	0.2193
17	106.8142	1.8644	53.4071	0.9322	26.7035	0.4661	13.3518	0.2331
18	113.0973	1.9741	56.5487	0.9871	28.2743	0.4935	14.1372	0.2468
19	119.3805	2.0838	59.6903	1.0419	29.8451	0.5209	14.9226	0.2605
20	125.6637	2.1935	62.8319	1.0967	31.4159	0.5484	15.7080	0.2742
21	131.9469	2.3031	65.9734	1.1516	32.9867	0.5758	16.4934	0.2879
22	138.2301	2.4128	69.1150	1.2064	34.5575	0.6032	17.2788	0.3016

1 Degree Grade Curves								
Radius	**length**	**Rise**	**1/2**	**Rise**	**1/4**	**Rise**	**1/8**	**Rise**
23	144.5133	2.5225	72.2566	1.2612	36.1283	0.6306	18.0642	0.3153
24	150.7964	2.6322	75.3982	1.3161	37.6991	0.6580	18.8496	0.3290
25	157.0796	2.7418	78.5398	1.3709	39.2699	0.6855	19.6350	0.3427
26	163.3628	2.8515	81.6814	1.4258	40.8407	0.7129	20.4204	0.3564
27	169.6460	2.9612	84.8230	1.4806	42.4115	0.7403	21.2058	0.3701
28	175.9292	3.0709	87.9646	1.5354	43.9823	0.7677	21.9911	0.3839
29	182.2124	3.1805	91.1062	1.5903	45.5531	0.7951	22.7765	0.3976
30	188.4956	3.2902	94.2478	1.6451	47.1239	0.8226	23.5619	0.4113

About the author

Eric smith is a Software Engineer with over 30 years of programming applications for the Medical, Telecommunications and Defense industries. He is an active model railroader and has been building layouts for over 40 years. He is currently a Project Engineering Manager developing avionics software.

Dedication

To my wife Cynthia and my children Erin, Gena, Ian and Kayla who have supported my insane love of model railroading. Without their love and support this would not have been possible.

Acknowledgements

I would to thank the following for their assistance in the development of this book:

Dr. Andrew Hull for pushing me to write the book. My daughter Kayla Smith for not so gentle guidance, but always in the right direction.