TurboCAD Pro V21.1 – 5 Cylinder Radial Engine

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Special Note

All of the work presented within this tutorial is based on TurboCAD Pro V21.1 (64-Bit). Although users of previous versions are welcome to try the tutorial it cannot be stated what results will be achieved. Many changes, some subtle and others not so subtle, are made with each program revision. Although many steps and directions would be generic some may not be. The same can be said for tools between versions. Older versions may not have the same tools as Pro V21.1 and if the same tools are available the tools themselves may have been revised and hence, work in a different manner than they previously did.
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Introduction

The Radial Engine tutorial was originally written for TurboCAD Pro V15, but it has been fully updated for TurboCAD Pro v21.

I have wanted to create a tutorial for a radial engine for eons but always felt a bit intimidated by the idea. However, like any good modeler, I decided to face the challenge and see what I could come up with. To my surprise and pleasure, the task was not terribly difficult in the end. It just required some forethought, a bit of time spent researching and the drive to make it happen, which I already have in spades, as the saying goes. Although I based the radial engine on some internet photos I found while researching, much of the model was made up as I experimented with the design.

I hope that you will enjoy following the tutorial and will feel the magic of TurboCAD that I feel every time I create something with the program.

Best regards,
Don

Within the tutorial the reader will be lead through each keystroke to produce every component of the radial engine that is illustrated on the cover of the tutorial. The reader will learn how to create all the components using 2D profiles and modified 3D shapes. The reader will learn how to insert standard lighting, how utilize render scene luminance and utilize a render scene environment. Additionally, the reader will learn how to render their drawing and save it in a high resolution image format.

This tutorial is in no way intended to teach engine design or construction, but rather it is intended to teach the use of some of the tools that TurboCAD has to offer and to introduce the new user to a drawing methodology. The author feels confident that the techniques outlined within the tutorial can help lay the foundation for future successful TurboCAD drawing and illustration for even the newest user.

As with any technically advanced software, the user is generally faced with a steep learning curve. It is the hope of the author that the money and time spent working through a Textual Creation tutorial will help ease the learning and allow the reader to come away feeling confident that they made a wise decision.

This tutorial will assume that the reader has the Platinum edition of TurboCAD Pro V21.1. One platinum specific mechanical tool is used at one point during the tutorial but a non-platinum workaround is also illustrated at the time. 64-Bit TurboCAD is recommended for the tutorial.

There are many ways to approach a project and it is likely that each person using the program would proceed in very different ways, so be open to alternative methods as experience builds.

This tutorial assumes that the beginner has studied the desktop to some degree and can locate most of the tools. Since there are endless desktop configurations that can be set up in TurboCAD the author has opted to illustrate the required tools with the TurboCAD Classic user interface with its Office 2003 theme and the default toolbars in their undocked format.
Please remember that any supplied images and files are for use within the tutorial only and may not be shared or sold to others.

Place all tutorial images in a permanent location on the hard drive.

For those working through the tutorial in pre-V18 versions please note that most of the functions described in the tutorial, as being on the Modify menu, were on the Format menu in previous versions of the program.

Also note that render times are much better in V18 through V21 than one will see if using previous versions of TurboCAD. TurboCAD now uses Multi-Threading for renders and can make use of multiple processors.

Lastly, the Copy in Place tool was reintroduced into TurboCAD V18 as a permanent tool. Users who don't have this tool will need to use the Make Copy method. That is to select the object to copy in place, select the Make Copy tool to turn it on, tab into the first field on the Inspector Bar – but don't change anything – simply press Enter. Select the Make Copy tool again to turn it off.
2D Profiles – Front View

To ensure that the final 3D components will fit and function as desired, a good portion of time will be spent creating 2D profiles. These profiles will eventually be revolved or extruded into 3D shapes and then manipulated as needs dictate.

The use of colored 2D lines, as seen in this tutorial, is a method the author has devised to help isolate individual components. Green is generally used to illustrate components that are to be traced and then deleted. They are called trace aids in the tutorial. Red and blue lines are generally used in an alternating fashion to help distinguish between objects that are situated next to each other. Occasionally other colors get used when it is known that certain object(s) will be specifically selected further along in the drawing process. In this case, selection is easily made with the Select by Color function of the program. Additionally, different colors may be used as needs dictate to distinguish between different groups of 2D objects. Trace aids are almost always deleted but 2D profiles are generally kept in case future issues arise. Keeping the 2D profiles helps to lessen the amount of work needed to recreate 3D objects if/when issues are encountered.

Please note that the use of color as described above is not the same as one might find used in architectural drawings where colors identify specific types of objects such as electrical, plumbing and gas.

The image below shows the first profiles that are going to be worked towards in this section.
Select the Circle Tan to entities tool from the Circle/Ellipse toolbar.

Left mouse click the two green circles, as indicated in the picture below, to select the first two entities.
Move the cursor in a left upwardly direction for a short distance and then Tab into the Inspector Bar and enter 3 in the Radius field. Press Enter.

<table>
<thead>
<tr>
<th>Radius</th>
<th>Diameter</th>
<th>Circumf.</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>6 in</td>
<td>18.849559215 in</td>
</tr>
</tbody>
</table>

Left mouse click the two green circles, as indicated in the picture below, to select the first two entities.

Move the cursor in a right upwardly direction for a short distance and then Tab into the Inspector Bar and enter 3 in the Radius field. Press Enter.

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</tbody>
</table>

Select the Tangent from Arc or Curve tool from the Line toolbar.

Select Green from the color dropdown menu on the Property toolbar.

Left mouse click at the circle, as indicated in the picture below, to place the first point of the line. In progress below.
Repeat the process at cylinders 2, 3 and 4. Press Esc to deselect the selection.

Select and delete the four 6.5" gray lines.

To define the out and inner diameters of the crankcase, select the Triple Point Circle tool from the Circle/Ellipse toolbar.
Select Blue from the color dropdown menu on the Property toolbar.

Using three V SEKE snaps, at the locations indicated below, place the first circle.

Press the Space Bar to exit the tool.

Select the Offset tool from the Offset or New Modify toolbar.

Tab into the Inspector Bar and enter .75 in the Distance field. Press Enter.

Select the large blue circle as the contour to offset and then left mouse click within the contour to define which side to offset to. In progress below.
2D Profiles to 3D Objects – Session 1

The 2D profiles will be used shortly to create 3D objects.

To better manage the drawing as it progresses, layers will be created and objects assigned as needed.

Open the Design Director palette.

Select New Layer at the top off the Design Director palette to create a new layer.

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Select New Layer at the top off the Design Director palette to create a new layer.

Type 2D Front View in the Layer name field and click OK or press Enter.

In the same manner create a second layer called 2D Side View.

Press Ctrl + A to select all the objects in the drawing.

Assign the selection to the 2D Front View layer by left mouse clicking the clear box to the right of the 2D Front View layer name on the Design Director palette. A green arrow will appear indicating that the procedure was done.
Alternately objects can be assigned to their layers via the Properties toolbar at the top of the TurboCAD desktop.

Press Esc to deselect the selection.

Select the Revolve tool from the 3D Object toolbar. No options selected.

Select the top piston ring as the object to revolve. Using two V SEKE snaps on the right side of the piston profile, define the revolution axis. In progress below.

Select the middle piston ring as the object to revolve. Using two V SEKE snaps on the right side of the piston profile, define the revolution axis. In progress below.
Left mouse click the Select By icon at the top of the palette.

Switch to Front view.

Select Plane by Active View from the Workplane toolbar.

Press and hold the Shift key down. Left mouse click the spring cavity object and the valve cavity object to add them to the current selection. Release the Shift key.
Select the Mirror Copy tool from the Copy toolbar.

C SEKE snap the top circle of the main cylinder to define the first point of the mirroring line. Press and hold the Shift key down. Move the cursor upward a short distance and then left mouse click to define the second point of the mirroring line. Release the Shift key. In progress below.

Switch to Isometric SE view.

Press and hold the Ctrl key down. Left mouse click the layer 0 name on the Design Director to deselect it. Release the Ctrl key.

Now turn off the four valve layers by left mouse clicking one of the eyes icons of the four. They are turned off, en masse.
With the cylinder collection still selected, select the Radial Copy tool from the Copy toolbar.

Place the cursor by the inner edge of the crankcase and then C SEKE snap to define the radial axis. In progress below.

Tab into the Inspector Bar and enter 5 in the Sets field. Press Enter.

Select the 3D Subtract tool from the Boolean & Facet toolbar.

Select the crankcase as the object to subtract from. Press and hold the Shift key down. Select the five sets of cylinders as the object to subtract. Release the Shift key.

Select Finish.
Press the Space Bar to exit the tool.

Turn off the Crankcase layer.

Press Ctrl + K to open the Select by Colors dialogue. Select Red and Blue and then click OK.

Assign the selection to the 2D Front View layer.

Turn on the cylinder layer.

Select the 3D Add tool from the Boolean & Facet toolbar.

Using two left mouse clicks, add the two components together. Select cylinder first so the assigned Cylinder layer name remains. In progress below.
2D Profiles – Side View

It is now time to create the other profiles that are viewed from the side. This will include the remainder of the crankshaft, the bearings, the cam disk, the rocker arms (and related objects) and the front cover. The back of the engine will not be created within this tutorial in order to stay at a reasonable length.

The image below illustrates what will be worked toward before the trace aids are deleted.

Turn off all the layer, except layer 0 and then turn on the 2D Front View layer, the Cylinder layer, the Cylinder Head layer, the four Valve layers, the Crankcase layer and the Crankshaft layer.

Press and hold the Shift key down. Select the two large blue crankcase profile circles. Release the Shift key. Assign them to layer 0 for now. In progress below.
Turn off the 2D Front View layer.

Switch to Left view momentarily to change the workplane.

Select Plane by Active View from the Workplane toolbar.

Switch to Isometric SE view.

Select the Line tool from the Line toolbar. Three lines will be created while in Isometric SE view.

Select Green from the color dropdown menu on the Property toolbar.

Place the cursor by the edge of one of the large blue circles and then C SEKE snap to place the first point of the line. Tab into the Inspector Bar and enter 19 in the Length field and 0 in the Angle field. Press Enter. In progress below.

Place the cursor by the top edge of the outer blue circles and then Q SEKE snap to place the first point of the line. Tab into the Inspector Bar and enter 8 in the Length field and 0 in the Angle field. Press Enter.

Place the cursor by the top edge of the inner blue circles and then Q SEKE snap to place the first point of the line. Tab into the Inspector Bar and enter 8 in the Length field and 0 in the Angle field. Press Enter.
Turn off the two 2D layers.

Press Ctrl + K to open the Select by Colors dialogue. Select Green and click OK.

Press Delete to remove the placement aids.

Switch to Isometric SE view.

Press and hold the Shift key down. Select the two blue circles. Release the Shift key. Tab into the Inspector Bar and enter -8.5 in the Y Position field. Press Enter to move them to the front of the front cover, not including the bearing collar.

<table>
<thead>
<tr>
<th>Pos X</th>
<th>Pos Y</th>
<th>Pos Z</th>
</tr>
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<tbody>
<tr>
<td>-4.5928109187 in</td>
<td>-8.5</td>
<td>6.3214619127 in</td>
</tr>
</tbody>
</table>

Turn on the Crankcase layer.

Select the Simple Extrude tool from the 3D Object toolbar.

Turn on the Use Compound Profile option and turn off the Two sided extrude option.
Press and hold the Shift key down. Left mouse click the two blue circles as the region to extrude. Release the Shift key.

Switch to World Plan view.

Move the cursor up to one of the vertexes at the back side of the crankcase and V SEKE snap to define the extent of the extrusion.

Switch to Isometric SE view.
Press Esc to deselect the selection after it renders.

Select the Wireframe tool icon to end the render.

Turn off the four 3D layers and turn on the Cylinder, Cylinder Head, Crankcase, Front Cover and Bearing Cover layers.

Press Ctrl + A to select all the visible objects.

Open the Properties dialogue for the selection.

Under the Material tab ensure LightWorks is selected under Renders. Select Glass from the Category dropdown menu and select the first material from the Material dropdown menu. Select Edit.
Turn off all layer, except layer 0, and then turn on the layers, as indicated in the picture below.

Select one of the rockers.

Right mouse click and select Edit Tool.

Select the black line rocker.

Open the Materials palette. Locate the Metals category. Double click on the Engine Chrome thumbnail to apply the material to the selection.

Right mouse click and select Finish block/group editing.