

DuctworkPro

for AutoCAD

User Guide

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Copyright 2004, Randall C. Wilkinson

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Freeware Version Users:

This document describes the Professional Version of Ductwork. The Freeware Version lacks some of the professional features described here, such as.

- Toolbar menus for maximum speed
- Automatic duct sizing
- Material list data for spreadsheets
- Less commonly used elbows
- Turning vanes for mitered elbows
- More transition fittings and branch tap fittings
- Rotated elbows for sloping ducts
- 3D ducts and fittings
- Documentation for custom menu programming

INTRODUCTION

DUCTWORK is a system of LISP programs, blocks, and menus for AutoCAD that allow you to quickly design and draw HVAC ducts. DUCTWORK was designed to allow you to work fast and in an interactive manner. As you add fittings to your drawing, straight sections of duct are automatically connected to the previous fitting. There are many design "Rules of thumb" built in to the program. This frees you up from having to worry about how to draw ductwork and fittings and allows you concentrate on exploring different design alternatives. It works on any AutoCAD hardware platform from Release 2000 on. It will also work on Architectural Desktop 3.3 or later.

The features of the system are accessible through four different modes, the pull-down menus, and icon menus, toolbar menus and by typing commands at the keyboard.

All ductwork drawn with this system is drawn using centerlines, although the centerlines may not be displayed. All ductwork, fittings, and text will be placed on the proper layer and drawn in the proper color and line type as they are selected. Most symbols depicting elbows, taps, inlets and outlets have been created as blocks to be inserted into your drawings. The entities that the blocks are comprised of were created on layer 0 and the block itself will be inserted on the correct layer.

INSTALLATION

1. Copy the files to your hard drive

Copy all the files to "c:\ductwork". Usually that is done when you extract the files from the ZIP file. You could put it in another directory, but then you MUST do step 2 below.

2. Set the HVACPATH lisp variable for automatic execution

This step is not required if the files were installed in the "C:\ductwork" directory as recommended. If you have installed the files in "c:\ductwork" as recommended, skip to step 3.

Edit your existing...or add a file called "acad.lsp" in your "Support" directory. Using a text file editor, to the end of the file, add:

```
(setq hvacpath "c:\\ductwork\\")
```

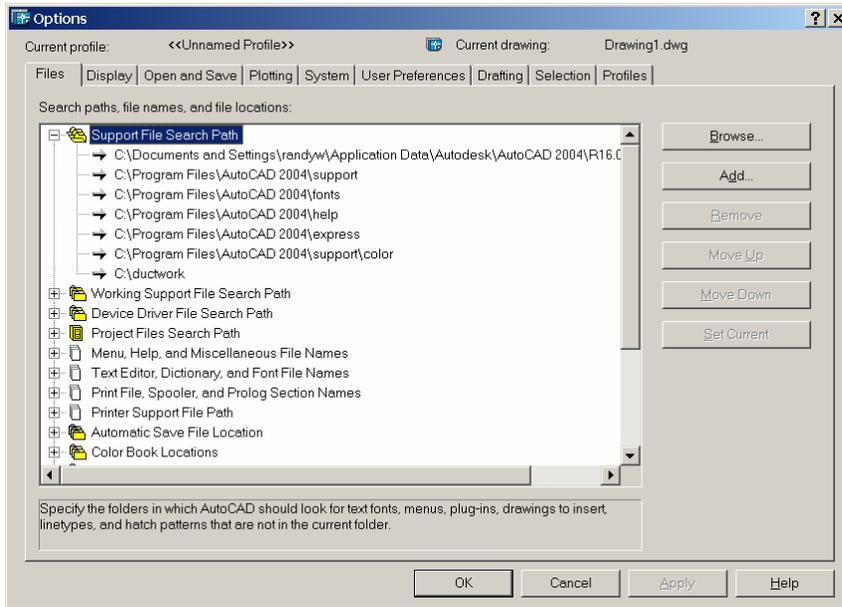
Note that those are double backslashes, twice inside the quotes. The double backslashes at the end are essential.

The above line will then be executed every time a AutoCAD starts. You should have at least one blank line in the file after the line above.

3. Add the new directory to the list of support directories

Add "c:\ductwork" to the list of support directories. In Release 2000, to do that, go to the tools menu, choose options, select the files tab, click on "support files search path", click the add button, enter the new search path..."c:/ductwork" (without the quotes). Release 2000 and 2002 are similar.

It should look like this after you have done it:

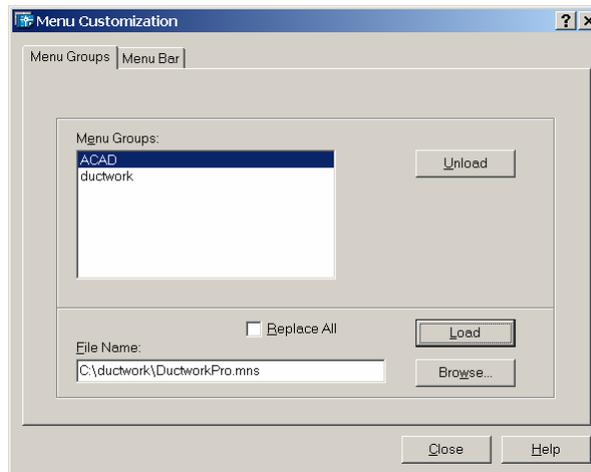


Click OK to close the options dialog. Re-start AutoCAD (the change does not take effect until AutoCAD is re-started).

4. Add the Ductwork menu to the standard AutoCAD menu

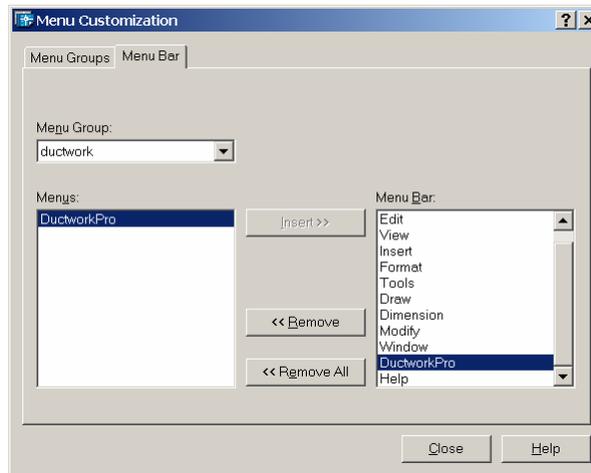
Use the menuload command to merge the ductwork menu into the AutoCAD menu. Don't use the menu command to load the menu. You need to use the menuload command so the ductwork menu is merged with the standard AutoCAD menu.

Type "menuload" at the command prompt. Click the browse button and navigate to the "C:\ductwork" directory. Select the "DUCTWORKPRO.MNS" file. Then click the Load button. Now it looks like this:



Click on the Menu Bar tab at the top of the dialog box. Under Menu Group, select "Ductwork". Select a place on the right side (under Menu Bar) where you would like the Ductwork menu to be inserted. Then click the Insert button.

Now it looks like this:



Click the Close button. You should now see the Ductwork or DuctworkPro pull-down menu at the top of the AutoCAD screen.

You're Done! If all went well, you should be able to use the system. Click the Ductwork Pull-down menu and choose Initialize.

Troubleshooting

If you get an error message when you try to initialize, that is usually caused by not having the HVACPATH variable set correctly. Go back to Step 2 above.

If you cannot see the Icons in the Icon menus, then you have not added the "C:\ductwork" directory to the list of support directories. Go back to Step 3 Above.

If you only see the ductwork pull-down menu, and none of the standard AutoCAD pull-down menu items, then you did not use the "menuload" command to load the partial menu file. Go back to step 4 above.

Drawing Ductwork

The program and menu work together to draw two-line ductwork. You specify the size and starting point for a duct, then the direction. A duct cursor marks the spot on the screen. Then you choose a fitting from the menus. The program allows you to drag the fitting into place with the dragging motion locked orthogonally to be aligned with the duct cursor. It then draws the duct from the previous duct cursor location to the inlet of the new fitting.

Before drawing ductwork, the following steps are necessary:

- Select operating modes. This is accomplished through the Ductwork Control dialog box which can be accessed by choosing 'Options' from the screen or pull-down menu or by typing 'DDW' at the command prompt. This step can be skipped if the default modes are acceptable. These options will be explained in detail later.
- Specify duct size and place the duct cursor in the location the duct should start. The Duct Cursor is a marker in the drawing area of the AutoCAD drawing which indicates the start point, width and current direction of the next section of duct to be drawn. The Duct Cursor can be placed in the drawing by selecting NEW CURSOR from the screen or pull-down menu, or by typing the command 'NDC' (for New Duct Cursor) at the command prompt. The duct cursor is a temporary object on the screen and will disappear if you redraw or zoom. To re-display the current duct cursor, type 'SDC' (for Show Duct Cursor) at the command prompt.

To draw the first and subsequent ducts from the previous fitting, repeat these steps as required:

- Choose a duct fitting from the toolbar, tablet, icon or pull-down menus (alternative methods of selecting fittings described below).
- Drag the fitting into place. The cross-hairs will be rotated to align with the proposed new duct, and ortho mode will be enabled to help align the new fitting with the previous fitting. The connecting duct will be drawn and the duct cursor will be advanced to the outlet of the new fitting.

To draw ductwork elsewhere in your drawing, repeat the above steps.

DUCTWORK OPTIONS DIALOG BOX

The DUCTWORK Control dialog box contains drawing and design aids which allow you to set the parameters for drawing ductwork. This dialog box can be invoked at any time by typing 'DDW' at the command prompt.

The screenshot shows the 'DUCTWORK for AutoCAD - Control' dialog box. It is organized into three main sections:

- Layer Name Usage:** A list of layer names with corresponding text input fields and a dropdown menu. The layers listed are: Ductwork (M-HVAC), Equipment (M-HVAC-EQPM), Grilles_Diffusers (M-HVAC-CDFF), Notes_Symbols (M-HVAC-TEXT), Instr_Controls (M-HVAC-INST), Rectangular Centerlines (M-HVAC-DUCT-SCL), Round Centerlines (M-HVAC-DUCT-RCL), and Non-Plotting (M-HVAC-NPLT).
- Auto Sizing Limits:** Two input fields: 'Max_Press. Drop per 100 ft. (In. W.G)' set to 0.100, and 'Max_Velocity (fpm)' set to 1000.
- Duct Draw Options:** A collection of checkboxes and color pickers. Checkboxes include 'Auto Sizing', 'No Labels', 'Centerlines', 'Fittings Only', 'Explode Fittings', 'Spreadsheet Record', and 'Turning Vanes' (which is checked). Color pickers are present for 'Seam Color' (set to Red) and 'Flex Color' (set to Blue).

An 'OK' button is located at the bottom center of the dialog box.

When you change any of the option in this dialog box, the current status of all options are stored in the drawing file, and will remain even if the drawing is ENDED then later edited.

The dialog box is divided into the following three areas:

Layer Name Usage - Options controlling the names of layers to be used

Auto Sizing Limits - Pressure drop and velocity limits for automatic ducts sizing

Duct Draw Options - Options to control the way duct and fittings are inserted into your drawing

LAYER NAME USAGE

This area allows you to specify the names of the layers to be used for each of the general categories supported by DUCTWORK. By default, DUCTWORK uses layer names as recommended by the American Institute of Architects' Layer Name Guidelines. If you want to change the layers to be used for all future drawings, you must edit the default text for the attributes stored in the DUCTWORK drawing.

The Ductwork layer name has a special pull-down menu for a suffix that can be easily selected. Use this if your preference is to draw various duct system on different layers. If you choose "(none)" then no suffix will be added.

AUTO DUCT SIZING

This area allows you to specify the default sizing limits if you are using the automatic duct sizing option. If the auto duct sizing option is on, these will be offered as default for each duct to be sized. At the time that each duct is sized you will have an opportunity to over-ride these defaults.

DUCT MODES

AUTO SIZING

This option provides automatic sizing of ducts, based on the drawing defaults of maximum velocity and maximum pressure drop, and the required airflow. When Auto Sizing is chosen the program will prompt for duct CFM air flow quantities and velocity/pressure drop restrictions. It will then calculate the minimum duct dimensions that do not exceed the specified limits.

When this option is not checked the program will prompt for duct dimensions. . Un-Checking this option makes the user responsible for choosing duct sizes.

NO LABELS

This option allows the user to add duct labels (sizes) as desired at a later time. If this option is not checked, the program provides automatic duct size labeling on the text layer and in the correct orientation.

CENTERLINES

Checking this option will cause the program to draw centerlines for each section of straight duct that connects each fitting. Fittings will not have centerlines. The centerlines drawn will extend beyond the ends of the straight section drawn such that in most cases, the intersection of centerlines for the inlet and the outlet of the fitting would be visible. Centerlines are placed on the layer specified in the corresponding setting in the Layer Name Usage area.

FITTINGS ONLY

This option suppresses the connecting ductwork between fittings. This allows you to insert a duct fitting anywhere in your drawing without having to set the duct cursor or specify a duct size.

If this box is checked, the program will prompt for size, rotation and placement of all fittings. When specifying the rotation, the block is temporarily placed at the center of the screen, allowing you to "drag specify" the rotation desired.

When Fittings Only is not checked, the program will place fittings according to the current duct cursor (start point, size and direction) and force new fittings to be aligned with the previous fittings.

EXPLODE FITTINGS

Selecting this option will explode all the fitting and symbol blocks and place all entities in the block on the layer on which the block was to be inserted. For maximum efficiency and smallest drawing file size, keep all blocks as blocks. For maximum flexibility, you may want to turn this option on.

When Explode Fittings is chosen, all fittings inserted will be exploded after inserting. The program uses a special explode function that moves all the exploded entities to the layer that the block was inserted onto. You can manually explode a block using the same special explode function choosing EXP1 from the tools menu.

If this option is not checked, the program maintains fittings and symbols as blocks in the drawing.

SPREADSHEET RECORD

This option automatically generates a materials list for all fittings and ducts drawn. When this box is checked, all ductwork and fittings added to a drawing will be recorded in a data file. This data file can be used to determine the materials required to install the ductwork or to determine the pressure drop through the duct system.

Data is written to a comma delimited ASCII file having the same filename as the drawing file with a .PRN filename extension. This is a one way connection to the data in the data file. If you delete the ducts or fittings in the drawing, the items written in the data file are not automatically deleted, you must do it manually.

TURNING VANES

When this option is set, turning vanes are drawn for 90 degree mitered elbows in rectangular ducts. Other mitered elbows will not have turning vanes drawn, even if this option is selected.

This option is on by default.

SEAM COLOR

This is the color of minor lines and seams that are used when the program must create fittings on-the-fly. When this dialog is closed, the seam color is saved in a special file that is used by the SEAMCOLOR.SCR script file. This script file can change the seam color that is used in each of the fittings blocks.

To change seam line colors throughout the system:

1. Change the seam color item in the Ductwork Options dialog box. You can use a color name or number.
2. Exit the current drawing and start a new drawing.
3. Type "script" and browse to the "c:\ductwork" directory (or wherever you installed the DuctworkPro files). Select the file called "seamcolor.scr" and click OK.
4. Each drawing that uses the seam color will be opened and modified to use your new seam color.

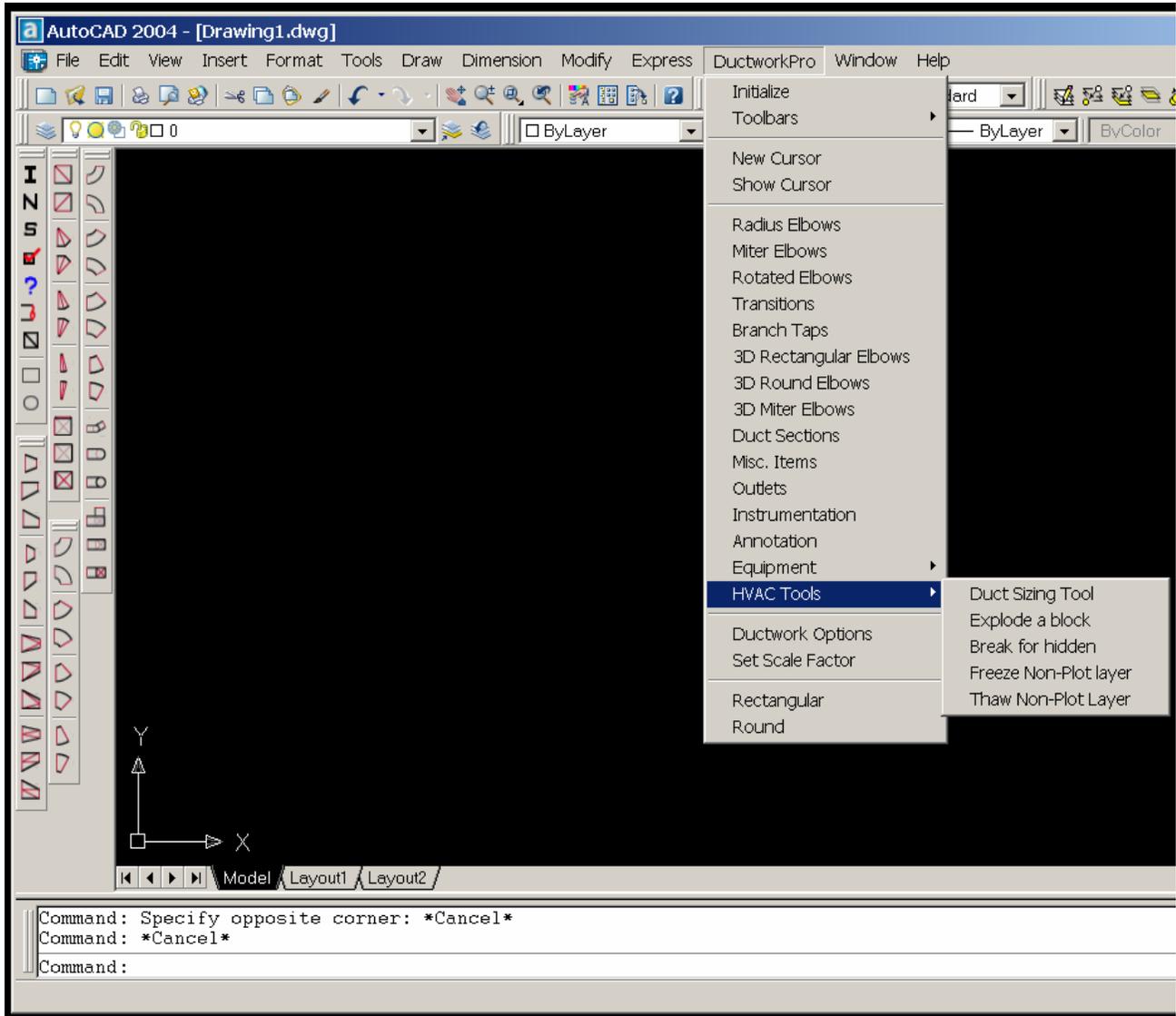
FLEX COLOR

This is the color that is used for flex ducts. It should correspond to a heavy line weight.

MENUS

The Pull-Down menus are the only full and complete set of Ductwork menu choices available. Other menus (icon, toolbar, and tablet) have been abbreviated, but may be faster and/or easier to use.

MAIN PULL-DOWN MENU

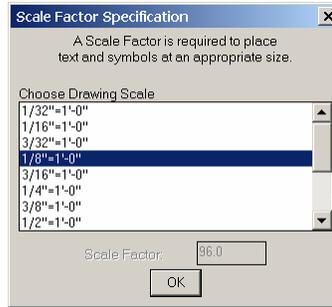


The main Pull-Down menu presents choices that allow you to select the general category of the HVAC item or task required.

Initialize

This menu item will initialize the system and load the required program files. If this is a new drawing of a drawing that has never been edited using the Ductwork system, you will be prompted for the scale factor for this drawing.

The scale factor is used to determine the correct size for text and symbols.



Toolbars

This menu item will shows or hides the toolbar menus.

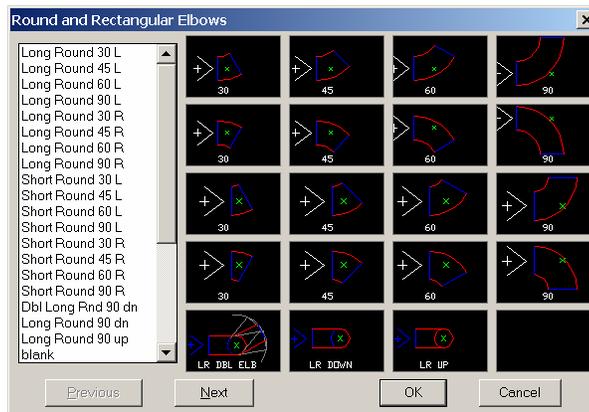
New Cursor

Use this menu item to start drawing a new duct section or branch. Equivalent to typing NDC at the command prompt.

Show Cursor

When the duct cursor disappears, because you did a redraw or zoom, use this to make the duct cursor visible again. Equivalent to typing SDC at the command prompt.

Radius Elbows



This menu item will display the complete radius elbow icon menu. This menu contains all radius elbows.

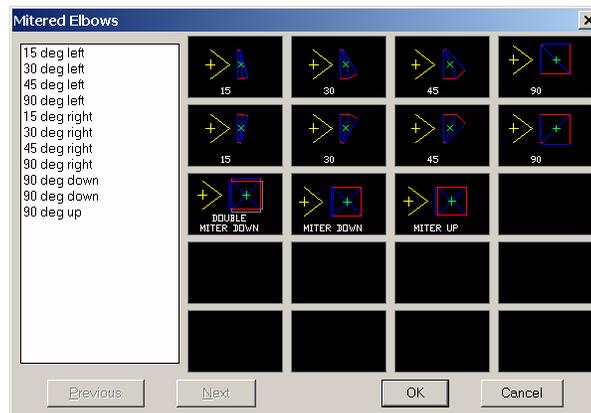
Radius elbows turning left and right are all inserted as blocks in the normal way. Radius elbows for round ducts turning up or down are inserted as blocks, but up and down elbows for rectangular ducts are generated on-the-fly using polylines. The arrow indicates the inlet of the fitting and the fitting is show in the 0 degree rotation position.

There are two menu choices that will create a double elbow arrangement for a vertical offset, one for round ducts and one for rectangular. These menu items work similar to the normal elbows, except that they will prompt for a new direction after inserting the first elbow turning down. For round ducts, the new direction can be any angle. For rectangular ducts the new direction must be straight ahead or 90 degrees left or right.

For the elbows turning up, the program does not automatically add cross hatching.

Long radius elbows are defined as those that have an inside radius equal to the duct width. Short radius elbows are those that have an inside radius equal to ½ the duct width.

Mitered Elbows



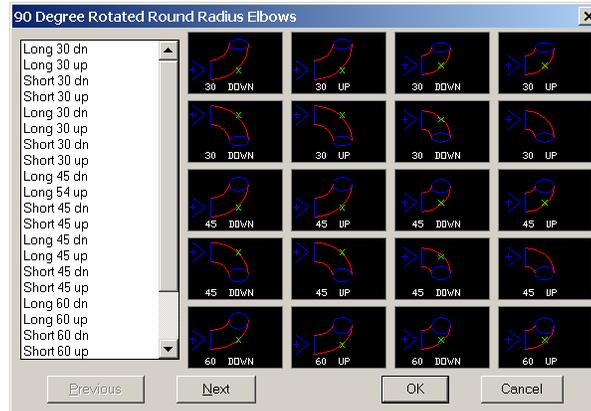
This menu item will display the complete mitered elbow icon menu. This menu contains all mitered elbows.

Mitered elbows turning left and right are all inserted as blocks in the normal way. Mitered elbows turning up or down are generated on-the-fly using polylines. The arrow indicates the inlet of the fitting and the fitting is show in the 0 degree rotation position.

There is a menu choice that will create a double elbow arrangement for a vertical offset. This menu items work similar to the normal elbows, except that they will prompt for a new direction after inserting the first elbow turning down. The new direction must be straight ahead or 90 degrees left or right.

For the elbows turning up, the program does not automatically add cross hatching.

Rotated Elbows



This menu item will display the complete rotated radius elbow icon menu. This menu contains radius elbows that are rotated in such a way as to create a sloped duct.

The radius, rotated elbows icon menu provides a means to add elbows that connect horizontal or vertical round ducts to ducts that are sloped. Elbows are available that slope 30, 45 or 60 degrees from horizontal in both short and long radius versions.

The inlet to these elbows is always through the end that is either horizontal or vertical. So, to make a section of duct that has a sloped offset, you may need to insert the first rotated elbow, then re-set the duct cursor, then insert the next elbow coming from the other direction.

Transitions

This menu item displays a menu that allows you to choose from various duct transitions. Transitions are available in the following configurations:

- Concentric
- Eccentric Left
- Eccentric Right
- 15 Degree sides
- 30 Degree sides
- Rectangular-to-Round
- Round-to-Rectangular

When you choose a transition, the program prompts for a new duct size, it will then draw a transition from the current duct size to the newly entered duct size, and allow you to drag it into place. If AUTO SIZE mode is on you will be prompted for a new duct CFM instead.

Note that the change in duct height for a rectangular duct may govern the length of the transition. Also, rectangular-to-round or round-to-rectangular transitions have a minimum length equal to the current duct width or diameter.

Branch Taps

This menu offers choices for duct fittings that connect to existing ducts.

These fittings are NOT inserted at the current duct cursor, but the duct cursor will be set to the outlet of the fitting after it is inserted. Additionally, the branch tap is momentarily placed at the center of the screen to allow you to indicate the orientation angle, BEFORE the tap fitting is placed.

ROUND and BOOT fittings will break open the line designating the side of the duct. The other taps do not break the duct.

When you are prompted for the rotation angle of the tap, keep in mind that the orientation shown in the menu is the 0 degree rotation angle.

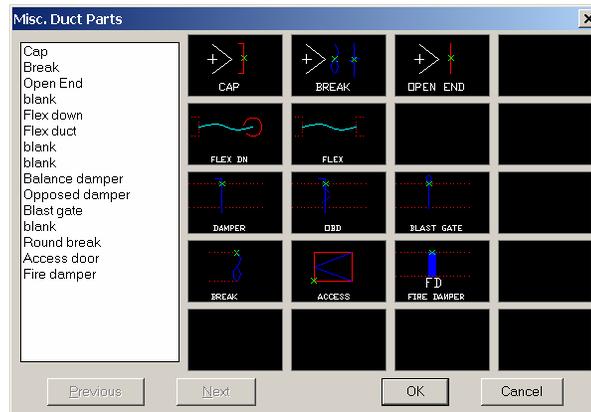
3D Elbows and Fittings

These menu items display icon menus that allow you to choose various 3D elbows and fittings. 3D elbows and fittings are experimental and not implemented in a way that is equal to the 2D functionally. There are round and rectangular fittings and ducts that turn horizontally. Elbows turning up and down are not tested and working properly. Also, there are no 3D transitions or other fittings.

Duct Sections

The DUCT SECTIONS icon menu provides menu choices to draw ducts in section, or rising up in plan view. The outline of the duct will be drawn, and a hatch pattern will be used to draw the cross hatching. The hatch pattern scale factor is determined by the drawing scale factor such that when plotted, the spacing between lines in the cross hatching will always be the same distance apart.

Misc Items



This menu presents some misc. duct items for your ductwork needs. Each is described below:

CAP

This inserts a duct cap block and allows you to drag it into place. A duct is then drawn connecting the cap from the previous fitting.

FLEX DN

This menu item will allow the user to place a flexible round duct connection in the drawing. The duct cursor location does not effect this function.

When you select this item you will be prompted for a duct diameter, start point and an end point. If the distance between the start point and the end point is greater the 5 times the diameter, the function will be cancelled, and an error message will be displayed. This forces the user to adhere to the design rule-of-thumb that you should not use more than 5 diameters of flex duct to the outlet. If the distance is less than 5 diameters, the program will then draw a polyline connecting the two points.

You will be given an opportunity to modify the curvature of the polyline by moving the 2 middle vertices of the polyline. This allows you to adjust the flex duct to avoid objects, act as an elbow, etc. Some experimentation may be required to familiarize yourself with this step. When you are satisfied with the curvature of the polyline, answer 'N' to the "Adjust Bend" prompt. That polyline will then be spline fitted into a smooth curve, and a symbol indicating a turn down will be inserted at the end point.

DAMPER

This menu choice will prompt for a scale factor, you should respond by entering a duct width or diameter for the damper to be inserted. You will also be prompted for a rotation angle, and then will allow you to drag the damper into place.

BREAK

When you choose this item, the program will insert a break symbol and you can drag it into place. A duct will be connected to the previous fitting. The symbol inserted will be appropriate for round or rectangular duct.

FLEX

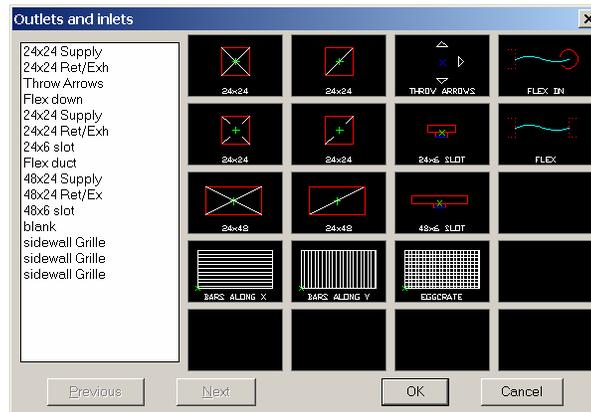
This function is identical to the FLEX DN choice described above except that it omits the turning down symbol.

OPEN END

This item will insert a line at the current duct cursor and allow you to drag it into place. A duct is then drawn connecting to the previous fitting. This indicates an open ended duct, if you want a capped duct, use the CAP item described above.

Outlets

The outlets menu item will display the menu of Grilles, Registers and Diffusers.



A few things to note about Grilles, Registers and Diffusers: When inserting a ceiling diffuser, the insert point is the lower left corner of the block. This is so the item can be snapped to the ceiling grid. Diffuser block have “point” entities that also help to align with a ceiling grid.

The throw arrows block is automatically exploded after insertion. This allows you to delete the arrows pointing in a direction that you don't want.

Instrumentation

This menu item will display the menu of thermostats, humidistats, etc.

Annotation

The Annotation icon menu item will be displayed. These items will be of use to label and identify your ductwork and outlets.

Equipment

This menu item has 3 sub-menu items.

Duct Coil – This item will prompt for a coil size, and optionally, a filter type, then it will draw coil with transitions on each side to connect to the current duct.

Fan Powered Terminal Units – This will display a menu of terminal unit sizes and will allow you to drag the unit in place as though it were any other type of fitting. It also converts the duct cursor to rectangular and sets the current duct size to the outlet size of the terminal unit.

VAV/CV Terminal Units – This will display a menu of terminal unit sizes and will allow you to drag the unit in place as though it were any other type of fitting. It also converts the duct cursor to rectangular and sets the current duct size to the outlet size of the terminal unit.

Terminal Units are based on sizes from units manufactured by Titus. Not all available sizes are shown. Air flow ranges indicated are approximate and chosen by the author to be representative for normal circumstances.

HVAC Tools

This menu item has 5 sub-menu items.

The following is a short description of each sub-menu choice:

Duct Sizing Tool - This menu choice runs a duct calculator program. The program can be used to size individual ducts or complete ductwork systems. It is designed to replace the HVAC designer's DUCTULATOR.

Explode a block – Explode a block using a specially programmed explode routine. When you explode a block using this routine, the block will be exploded and the entities that the block was made of are moved to the layer that the block was inserted onto. The routine can also explode mirrored blocks in the same way.

Break for Hidden – Special break routine to help depict a duct routed under another duct. This choice is an easy way to break the lines of a duct to indicate which duct goes under and which goes over. The program will prompt you to point to each line to be broken, after all lines are broken, it will then prompt you to point to the lines that will be changed to the seam color and linetype SSD (the hidden lines).

Freeze Non-Plot Layer – Freeze the non-plot layer so that construction lines and designer notes are not plotted.

Thaw Non-Plot Layer - Thaw the non-plot layer.

TOOLBAR MENUS

Misc Items Toolbar Menu

	This will initialize the system
	Set a New Duct Cursor
	Show Duct Cursor
	Show the Ductwork Option Dialog box
	Use the Duct Sizing Tool
	Show the Misc Items Icon Menu
	Show the Outlets Icon Menu
	Switch to Rectangular Duct Mode
	Switch to Round Duct Mode

Long Radius Elbows Toolbar Menu

	90 Deg Long Radius Elbow turning Left
	90 Deg Long Radius Elbow turning Right
	60 Deg Long Radius Elbow turning Left
	60 Deg Long Radius Elbow turning Right
	45 Deg Long Radius Elbow turning Left
	45 Deg Long Radius Elbow turning Right
	30 Deg Long Radius Elbow turning Left
	30 Deg Long Radius Elbow turning Right
	Double 90 Deg Long Radius Elbow turning Down, then Horizontal, Round
	90 Deg Long Radius Elbow turning Down, Round
	90 Deg Long Radius Elbow turning Up, Round
	Double 90 Deg Long Radius Elbow turning Down, Rectangular
	90 Deg Long Radius Elbow turning Down, Rectangular
	90 Deg Long Radius Elbow turning Up, Rectangular

Short Radius Elbows Toolbar Menu

	90 Deg Short Radius Elbow turning Left
	90 Deg Short Radius Elbow turning Right
	60 Deg Short Radius Elbow turning Left
	60 Deg Short Radius Elbow turning Right
	45 Deg Short Radius Elbow turning Left
	45 Deg Short Radius Elbow turning Right
	30 Deg Short Radius Elbow turning Left
	30 Deg Short Radius Elbow turning Right

Mitered Elbows Toolbar Menu

	90 Deg Mitered Elbow turning Left
	90 Deg Mitered Elbow turning Right
	60 Deg Mitered Elbow turning Left
	60 Deg Mitered Elbow turning Right
	45 Deg Mitered Elbow turning Left
	45 Deg Mitered Elbow turning Right
	30 Deg Mitered Elbow turning Left
	30 Deg Mitered Elbow turning Right
	Double 90 Deg Mitered Elbow turning Down, Rectangular
	90 Deg Mitered Elbow turning Down, Rectangular
	90 Deg Mitered Elbow turning Up, Rectangular

Transitions Toolbar Menu

	15 Deg Concentric
	15 Deg Eccentric holding Left side Straight
	15 Deg Eccentric holding Right side Straight
	30 Deg Concentric
	30 Deg Eccentric holding Left side Straight
	30 Deg Eccentric holding Right side Straight
	Rectangular to Round
	Rectangular to Round holding Left side Straight
	Rectangular to Round holding Right side Straight
	Round to Rectangular
	Round to Rectangular holding Left side Straight
	Round to Rectangular holding Right side Straight

KEYBOARD COMMANDS

Some menu functions have an equivalent command that may be typed at the keyboard. These commands will be active after the Ductwork system has been initialized.

The following is a description of each command:

NDC

The NDC (New Duct Cursor) command is equivalent to choosing the NEW CURSOR menu item from the pull-down menu. It will prompt for duct size, start point and direction.

SDC

The SDC (Show Duct Cursor) command will display the current duct cursor. It can be used to re-display the duct cursor after a ZOOM, PAN, REGEN or REDRAW.

DDW

The DDW command is equivalent to selecting Ductwork Options from the pull-down menu. When you type DDW the program will display the DUCTWORK control dialog box.