Panel Pro
MODEL 5925
SN 2049 and subsequent

OPERATION AND MAINTENANCE INSTRUCTIONS

copyright 2008 - 2018

Buller Enterprises, Inc.

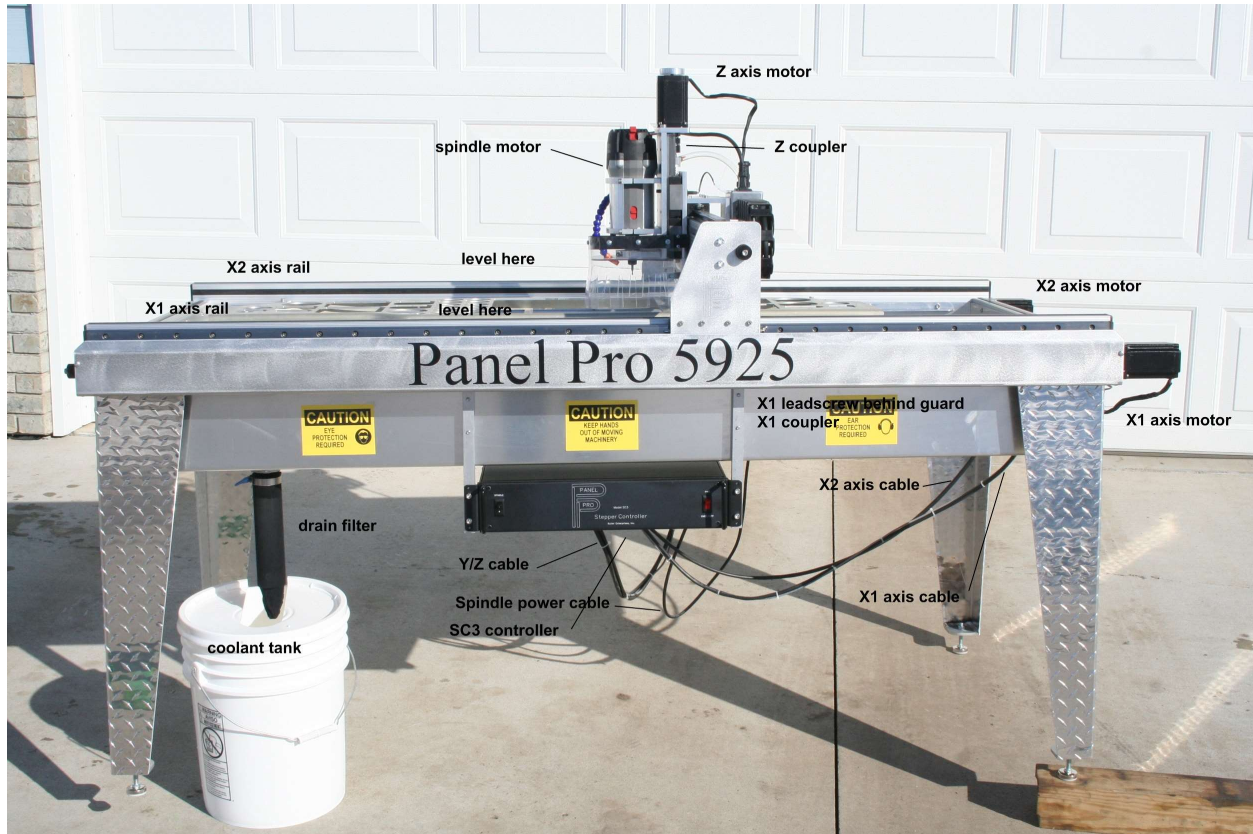## Table of Contents

DESCRIPTION OF THE PANEL PRO 5925

The purpose of the Panel Pro is to route complex assemblies of lines, points, circles, and arcs in sheet aluminum. It accomplishes this by reading a dxf file generated by popular computer aided drafting programs. This is especially useful since commonly used shapes such as instrument cutouts can be drawn and stored for subsequent combination into various instrument panels. The machine is also useful to fabricate various adapters and brackets that have many corners and cutouts.

Panel Pro 5925 system is comprised of the Controller, the software, and the machine.

The SC3 Controller is the interface between the computer and the machine. It controls:

- x , y, and Z stepper motor drive
- Switched GFCI protected ac power for the coolant pump and spindle motor.

AvCAM software is the operating software. The software is the key to the entire system. It generates all of the control signals to control the Panel Pro. Also included with the system is EasyCAD Ver 7.5x and the Drawing library which is an extensive library of predrawn instrument panels and instruments.

The Panel Pro shipping crate contains the following items:

1.   The Panel Pro base, x,y, and z axis assemblies
2.   4 legs to be attached by user
3.   3 stepper motors and motor to lead screw couplers for X and Y axis.
4.   1 stepper motor with knob and coupler for Z axis.
5.   3 1/2hp Milwaukee router with ER11 adapter installed.
6.   SC3 controller
7.   5 gallon coolant tank (drain & filter housing in tank for shipping)
8.   Submersible coolant pump
9.   AC power cord, X axis & YZ axis controller cables, and USB cable
10.   Tool kit with various tools, starter supply of end mills, etc.
11.   Software-AvCAM & EasyCAD, and Drawing Library (inside the 3 ring binder)
12.   Optional Measure Pro.
13.   Optional EG2 engraver.
14.   Optional Diamond engraver.
15.   Optional King air panel spacer kit.

This manual is intended to help with set up and get you started with operation. **Detailed function and operating information can be found in the AvCAM help file.**

Training

While most of our users are able to learn Panel Pro operation by careful study of the paper manual and help file, training is available either at your location or ours. For new machine owners, we can train at your continental U.S. facility for direct expenses incurred. You are welcome to travel to our facility for no charge training. Call us if you would like to schedule training 701-255-7640.

SETTING UP THE PANEL PRO

Planning the area:
You should have enough room for access on the front side (the deep side of the drain pan), left and rear sides. **The computer should be on a table that is located at a**

right angle so that the right hand can reach the keypad, and the left hand can reach the router.

Electrical Service:
The Panel Pro should be on its own 20 amp 120vac circuit. If there are any other loads on the circuit, they must be light loads and not heavy loads like an air compressor, air conditioner or other motor. Do not use extension cords or power strips.
The circuit absolutely MUST have a proper ground! The computer running the panel Pro may be on the same circuit. It is just essential that there is the same ground on both the Panel Pro and the computer.

The Milwaukee router draws around 12 amps at turn on. If extension cords are used or other loads on the circuit cause the voltage to dip, it may cause the processor in the controller to lock up or work erratically.

Nearby running water is highly recommended to wash chips off of hands and finished parts, and to replenish the coolant. A laundry tub works great for this purpose.
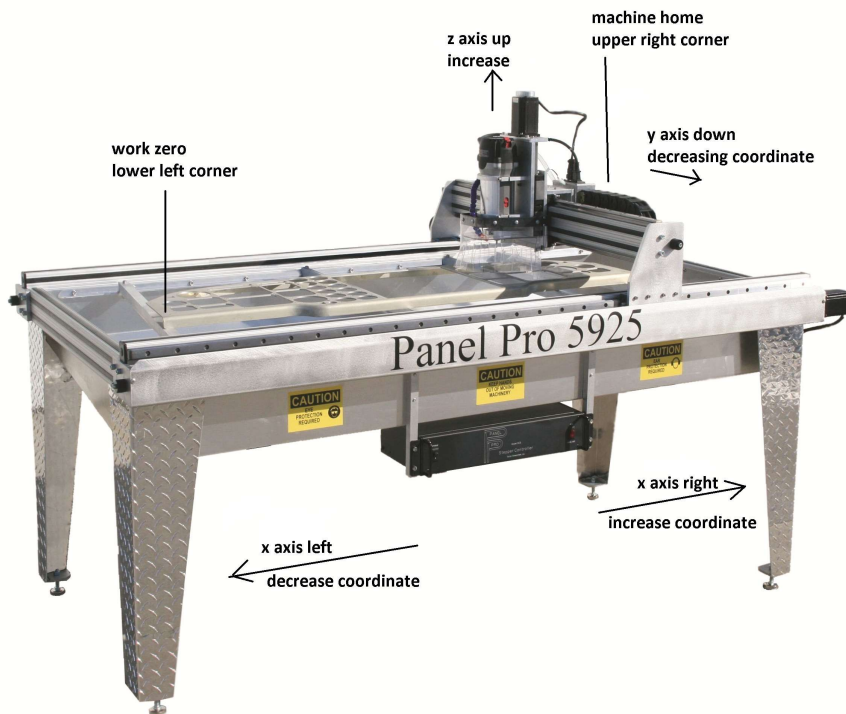
Hardware setup:
1. After removing the crate top, remove the 2x2s in the top ends of the crate.

2. Remove the screws in the shipping tabs at the ends of the Panel Pro. A long extension is helpful here.

3. When unpacking or lifting the Panel Pro, take care to lift only on the square structure on the ends, or the material mount bars mounted near the ends. Never lift or put pressure on the lead screws or the lead screw guards.

4. Attach leg glides (inside tool box) to legs. Set near maximum extension.

5. Remove the shipping tabs, discard the washers, keep the screws.

6. Have all of the 6mm leg mounting screws barely started.

7. Attach the legs with 4 6mm socket screws each, using a 5mm Allen wrench with an extension.
 A 5mm Allen bit is included in the tool box.
 Two people are required.
Stand the base unit on the end of the drain pan and have one person support it in that position while the other attaches the legs. **DO NOT APPLY PRESSURE TO THE LEAD SCREW, LEAD SCREW SUPPORTS or LEAD SCREW GUARDS!**

8. **Level the machine** by placing your most accurate level on the X1 bearing rail (the aluminum extrusion deep end of the pan). Adjust the leg glides for an exact left to right level. Repeat on the X2 bearing rail extrusion. Note that common levels are not sensitive enough.

When leveling is as close as you can get it, adjust the leg glides on the left end so that both x1 and x2 lead screws touch their stops simultaneously.

9. Run the x axis to about 6" from the right side stops before installing the x axis motors by turning both lead screw knobs located on the left end.
   Note for all motors. Install and tighten the 4 mounting screws, then tighten the coupler.

10. Install the "X1" motor (the motor nearest to the deep side of the drain pan) using 4 4mm screws located in the box with the motors. Rotate the coupler already installed on the motor shaft for access to the clamp screw before installation. The 4mm screws are fastened with a 3mm wrench found in the tool box. Tighten coupler to lead screw with the 3mm Allen wrench.
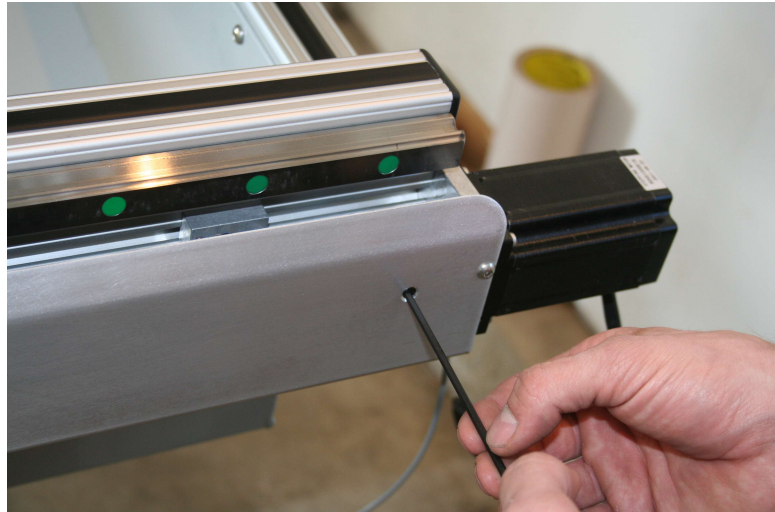
   Access to the coupler clamp screw is through a hole in the lead screw guard. **Make sure there is no slippage between the coupler and lead screw.**

11. Install the X2 coupler similar to step 10. Install the 4 motor attach screws and then tighten the coupler clamp.

12. After both X1 and X2 motors are installed and the couplers tight, move to the left side of the machine and grasp the 2 knobs. Turn counter clockwise until the X1 and X2 lead screws reach a hard stop. The stop is a set screw that extends through the motor mounting plate. The stop screws are set at manufacture and should not be changed. This is the point that the X and Y axis are square. If the machine is not properly leveled in step 8, you will find that when the first end reaches its stop, the other will feel like it is acting against a spring till you reach the stop. Re-level.

13. Install the "Y" motor in a similar fashion. Attach the Y motor to the connector closest to the motor. Tighten coupler to lead screw. Make sure it does not slip.

14. The Z axis is shipped in the "down" position. It will be necessary to lift it up to gain access to the coupler clamp screw as shown. It will be quite stiff. That is normal.

15.
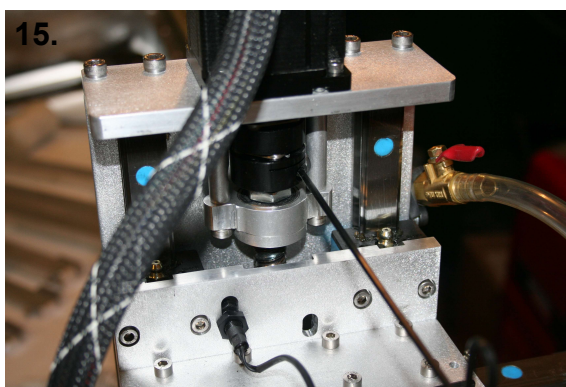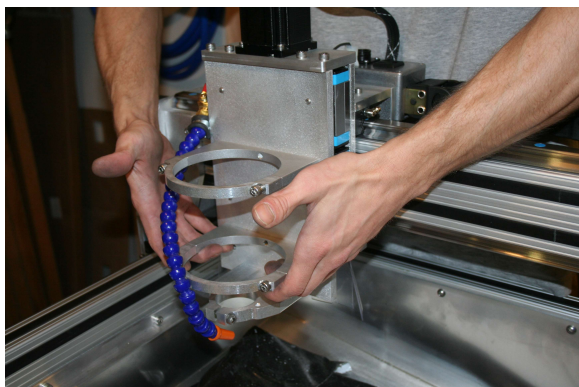
Install the Z axis motor with the 4

screws.   Tighten the coupler clamp screw. Make sure it is tight and does not slip.

16. The coolant system is used on the Panel Pro consists of:
    1.   submersible pump
    2.   5 gallon pail
    3.   modified pail lid
    4.   7 ft 3/8 ID tubing
    5.   ¼ female npt thread to 3/8 ID hose adapter
    6.   screen
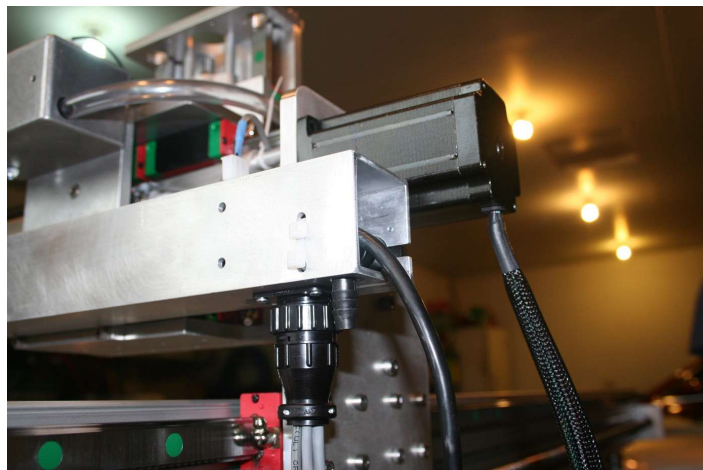   7.   1 gal Koolmist
    8.   Drain fitting in Panel Pro pan.

Attach 90 degree elbow (part of pump) and the hose adapter found in the same package as the hose with the hose pointing up.

Place in pail with pump inlet on the bottom.

Place screen on pail, position under the drain with tubing and cord facing the upper right corner of the Panel Pro.

.

Connect the 3/8 ID tubing from the coolant pump to the elbow near Y axis stepper motor
 Connect the coolant pump power cord to the GFI connector on the back of the controller.

Add about 3 gallons of coolant. The instructions on the Koolmist bottle indicate adding 4oz of Koolmist per gallon of tapwater. We recommend about 6 oz Koolmist per gallon. Take note of the resulting color. Future coolant additions can be made by approximating the color of the mix rather than exact measurement.

Check the coolant level before use by simply removing the lid and observing the level. If it is less than about 2/3 full, add a gallon.

During use, if the coolant looks milky in the hose leading up to coolant spout, then the pump is sucking air. Take a look at the screen to make sure it is not clogged, and clean as required. Take care not too add too much coolant during cutting to prevent overflow when all of the coolant drains into the pail.

The coolant level in the pail should cover the motor at all times for proper motor cooling.

You will find that you will need to add water frequently. It may not be necessary to add Koolmist every time, but if the color becomes less blue, then the mixture is too lean, and it loses lubrication capability.

The cutting process will create a sludge of very fine metal particles. Plan to replace the coolant and clean the pail every 3-4 months.

Plan to clean the chips out of the drain pan every day. The chips may be scraped uphill in the drain pan to facilitate draining.
.

17. Place the pump and tank on the floor with the large hole positioned under drain hole in the pan.
18. Install the drain fitting as shown with the rubber gasket against the bottom of the pan and the fiber gasket between the rubber and the nut. There is nothing attached to the drain. Its purpose is to prevent coolant splashing beside the screen in the pail when a large volume of coolant is poured in the pan.
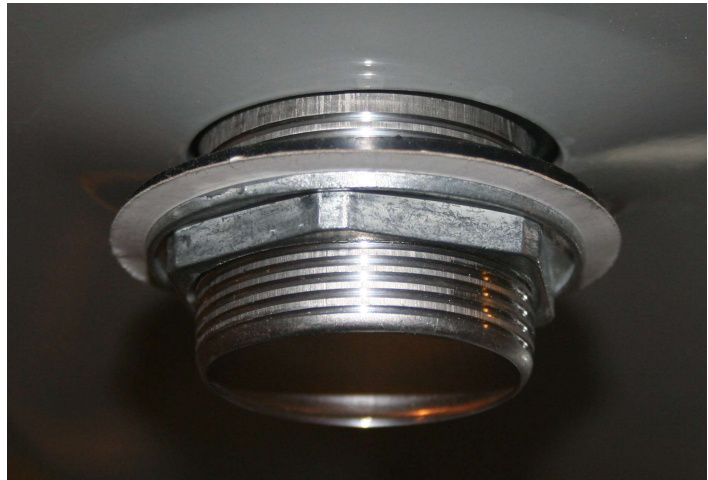
19. The controller mount bars (shipped in the tool box) are mounted to the front of the drain pan. Supplied with the controller mount bars are 8 each 6x25 mm socket head screws. Liberally apply silicone seal under the head of 4 of the 6mm socket head screws. Loosely install the controller mount arms to the drain pan with these screws. Attach the SC3 controller to the arms with the remaining 4 6x25mm screws. Line up the arms and tighten the screws.

20. Attach the X interconnect cable 16 pin Amp connector to the controller. The controller connector has a keying pin to prevent installation on the Y/Z connector. The X axis cable will have 2 connectors with angle brackets.
The X1 axis has a 3 pin white connector for the X axis limit switch.
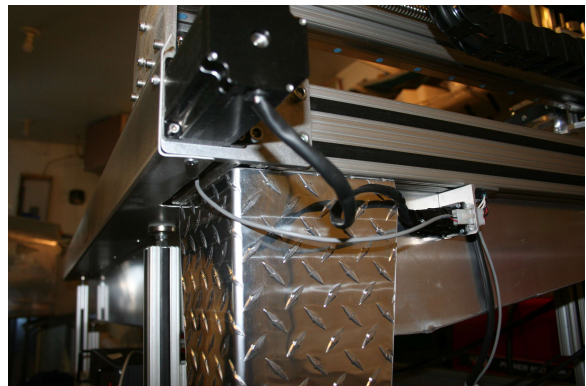
21. Locate the nuts with screws installed on the bottom of the right rail. Allow enough room to comfortably attach the motor plug. X2 axis is shown.
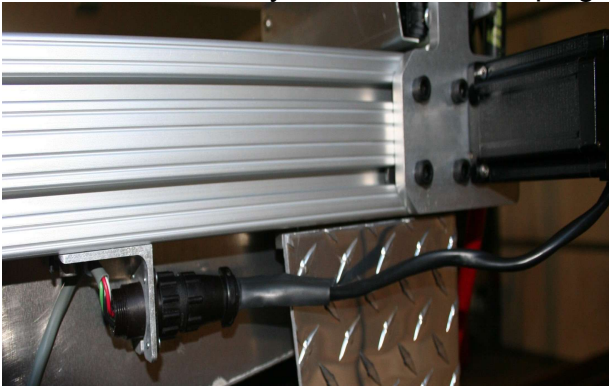
22.   Attach the Y/Z cable and route cable. The Y/Z cable is the same on both ends and it does not matter which end goes on the controller or the Y axis. Note in the picture the X2 axis lead screw guard is not installed and the spindle (router) power cord should run parallel with the Y/Z cord.
If you have the urge to tie up cables take precaution to leave plenty of room for the cables to move full travel left to right and provide plenty of room to flex. Leave a dip in the cable to provide a place for liquid to drip off before getting to the controller. The cables are generally not visible from normal viewing angles and do not require additional wire ties etc.
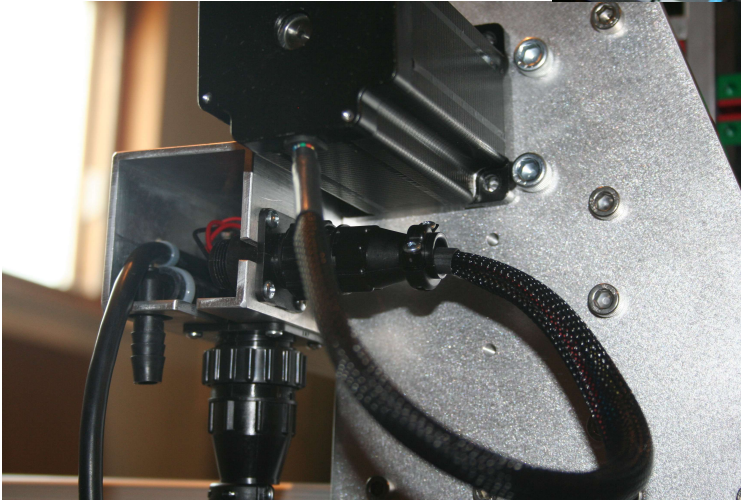
23. Route the pump power cord to the SC3 controller and connect to either AC receptacle on the SC3 controller.

24. The Milwaukee collet system supports a ½ or ¼ " router bit shank. Since it is desirable to accommodate many different sizes of tool diameters, we have installed an adapter to use an industry standard ER11 collet available in many sizes up to ¼ inch.   Place the collet into the nut without the end mill in place so the collet can compress and snap around the quarter moon shaped extractor ring in the collet nut. When properly installed, the collet should be nearly flush with the nose of the nut. If installed incorrectly, it will cause cutting problems. The picture below shows the collet when properly installed.

25. Loosen 2 router mount clamps on Z axis and install the Milwaukee router so that the top clamp is resting

on the bottom side of the top router housing. Snug the clamp screws equally. Don't over tighten.

26. The bottom 43mm clamp (foot) is used for the engraver and other accessories. The lower clamp tightening screw may be removed for normal use. Don't clamp it down tight without an engraver or touch probe installed or it may bend it making it difficult to install the engraver or other accessories.

27. Insert a 3/16 collet with a 1/8" end mill (double ended with 3/16 shank) with about 7/8" protruding from the collet nut. The end mill gage found in the tool box is helpful with this. Use one of the supplied 22mm wrenches on the black nut on the Milwaukee router. Use a 17mm wrench (not supplied) on the ER11 collet nut. This adapter uses industry standard ER11 collets available from machine tool supply houses like Enco or MSC. We stock 1/8, 3/16, an ¼ inch ER 11 collets. When installed correctly, the collet should be almost flush with the end of the collet nut. With the collet nut removed, look in the back at the threaded end. Note there is a quarter moon shaped ring at the bottom. To install the collet, angle it into the back of the nut so the groove in the collet engages that extraction ring. After the collet is installed, the end mill can be inserted.

28. Plug the router cord into the connector on the Z axis.

29. Plug the AC cord that exits the machine near the Y axis stepper motor into the GFI AC socket on the SC3.

Note: the GFCI test cannot be completed until the computer has commanded the spindle and pump power on, and the manual switch on the controller is on. It should be tested weekly.

30. Install the software before plugging the usb cable into your computer!

   See the following section on software installation.

31. Connect the AC Power supply cord to the SC3 socket. Connect the other end into a grounded 20 amp 110VAC circuit not shared by other equipment.

Recommended computer:
Effective AvCAM version 11.156 windows XP or Vista are not supported and AvCAM will not install.

We recommend using a desktop style computer running Windows 10 operating system. We also recommend 8GB memory and a video card that has its own memory. If a computer is used that has been used for other purposes, clear out any unused programs. The only programs you should have open is AvCAM and EasyCAD (or other cad program).

While a lap-top will run the Panel Pro, the numeric key pad is used frequently. An external key pad may be employed, however the Num Lock has to be on to use it, and then it remaps the main key board so that the U,I,O,J,K,L,M keys are now number keys. If you have to type in a file name, it becomes awkward switching the num lock on and off.

Also plan to have at least a 17" monitor with about 1024 x 768 pixel setting.
Arrange the computer so that the right hand can be on the keyboard or mouse and the left hand can reach the middle of the Panel Pro. Do not extend the supplied 10 foot USB cable.

Software Installation:

Install the software before plugging the usb adapter in!

You must have administrative privileges AND run as administrator.

The USB adapter driver, AvCAM, EasyCAD and the drawing library are located on your AvCAM USB drive.
All installations are done from the install.bat file on the thumb drive and should run automatically. If you have auto run on your computer turned off, then navigate to the cd. Right click the install.bat file. Click run as administrator.

The CDM21228.exe file installs the drivers appropriate to your operating system including 32 and 64 bit win 7 and win 8 operating systems.
I

The USB drivers load first, then AvCAM, then EasyCAD, then the drawing libraries. If you are asked to reboot the computer, say no and wait till the command prompt goes away. You will be asked to hit any key in between each install segment above.

If you wish to have more information on the USB drive install process, copy the following and insert it in a bowser address window or cntrl click to open

http://www.ftdichip.com/Support/Documents/AppNotes/AN_119_FTDI_Drivers_Installation_Guide_for_Windows7.pdf

This guide is also on the distribution thumb drive for your convenience.

AvCAM: load the AvCAM thumb drive into your computer. If the AvCAM install does not start automatically, go to Windows Start\run\E:autorun.bat where E is your usb drive number. This batch file installs AvCAM and EasyCAD, sets up the proper folders and copies the drawing libraries.

The initial installation must be accomplished from the thumb drive. Note the **application key** on the thumb drive envelope. It will be required on the first time the program is run on each computer it is installed on.
If you are installing this on a computer that has had AvCAM installed for a previous machine, you will need to tell AvCAM that you are changing activation keys by hitting shift + F11. Make sure the activation key for the proper Panel Pro serial number is used when operating the machine.

If the wrong activation key is used, it may result in large errors when cutting.
Important! A valid email address is required to provide you with AvCAM updates.

Install EasyCAD: EasyCAD should automatically install when AvCAM is installed.

To manually install EasyCAD:

Click Windows Start\run.

Type in E:\EasyCAD756.exe where E is your cdrom drive number.

I recommend installing in the default C:\ECW750 folder. Other files are dependant on this path name.

If you already have drawings in the C:\ECW750 folder, copy them to another folder to protect from overwriting.

EasyCAD license:

Your EasyCAD license is on a printed email in the binder pocket. If we did not have user information when the machine was shipped, call Linda at 701-255-7640 or email Linda@bullerent.com with the email where it should be sent.
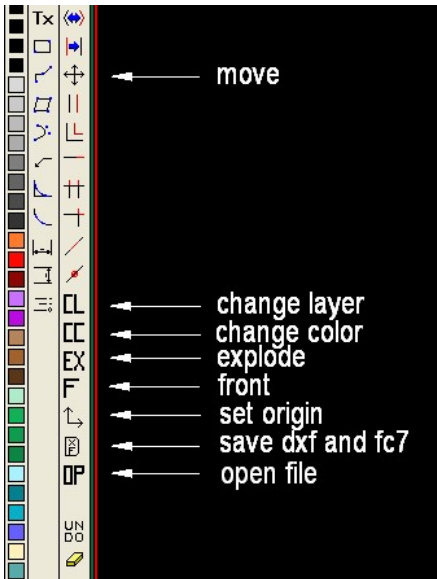
If you want a hard copy of the EasyCAD manual, contact Evolution Computing at www.fastcad.com v7manual.pdf is supplied on the CDROM.

If installed automatically, there will be additional icons that represent menu commands. These are commands frequently used drawing for the Panel Pro. If properly configured, there will be 2 rows of icons on the left side of the screen. To Manually install these icons, make sure EasyCAD is shut down, open the config folder on the install cdrom and copy all of the files in that folder to your EasyCAD folder. When prompted if you want to overwrite files, respond yes. When you re-open EasyCAD, the additional icons should appear.

If they still do not appear, click the hammer icon on the bottom center of the EasyCAD screen. At the top of the select screen tools dialog, open the drop down list at the top.

click panelpro.cfg in your root EasyCAD directory.

Click ok

Close EasyCAD, and then re-open. The addition icons should be available.

Drawing Library: the drawing libraries should also install automatically. To manually install: Use windows explorer (Windows +E), copy the aircraft and instrument folders into the same folder you have set up for EasyCAD.

Try it out:

Controller power up: If your controller has an emergency shut off switch, release the shut off by turning the knob right until it pops out. Press the green push button switch, the red light lights up. To turn it off, push the small red button below the pilot light. Pressing the emergency shut off or the red momentary switch will depower all drive and spindle operation.

Controllers with a rocker on/off switch have a similar action pushing the "0" side of the rocker.

Turning power back on after emergency or normal shut off will not cause any movement or spindle power turn on.

Normally, turn controller power on, then open AvCAM. This enables automatic communications once communications have been established for the first time. .

Normal turn off: Close AvCAM, then turn off the controller.

CAUTION!

There should be no reason to be injured while operating the Panel Pro if a few simple precautions and common sense are exercised.

The SC3 is powered by 110vac and switches 110vac for the coolant pump and router.

Any Drain pan leaks should be corrected before further machine use.

Operate only on a dry floor.

Test the GFCI outlet with the router running before each use. Press the test button, and the router should stop. Press the reset button to resume operation.

Do not operate the machine if the floor in the area is wet.

If any coolant leak is noticed, immediately disconnect the power from the SC3 from a dry location and repair the leak. Make sure any area where power cords run are dry.

Under no circumstances should the guard around the router bit be removed while the router is running. Coolant and metal chips will fly everywhere.

Eye guards are recommended. As the milling bit performs drilling operations, sometimes some chips can fly.

Ear protection is required.

We make no claims as to the medical properties of or continued exposure to aluminum. It is recommended that you avoid contact with the copious chips generated by the cutting action. The chips are sharp and can easily embed themselves in the skin. Nitrile gloves are quite effective at keeping chips at bay.

Chips should be flushed off with running water. If flushing with water does not remove chips, or metal slivers, then rubbing with clean Scotch Brite will often remove small metal slivers.

Wear safety glasses.

Keep fingers away from moving parts to keep them from getting pinched. When the pressure builds up the stepper motors will start skipping steps, but a painful bruise possibly a broken bone could result if fingers (or other parts of the body) are placed between moving and non moving parts.

Keep fingers away from the router bit. It will cut fast and sure. Again **DO NOT REMOVE THE GUARD! KEEP FINGERS CLEAR!**

Turn the SC3 power switch on. Click on the blue AvCAM icon on your desktop to open the AvCAM program. This is the preferred turn on sequence.
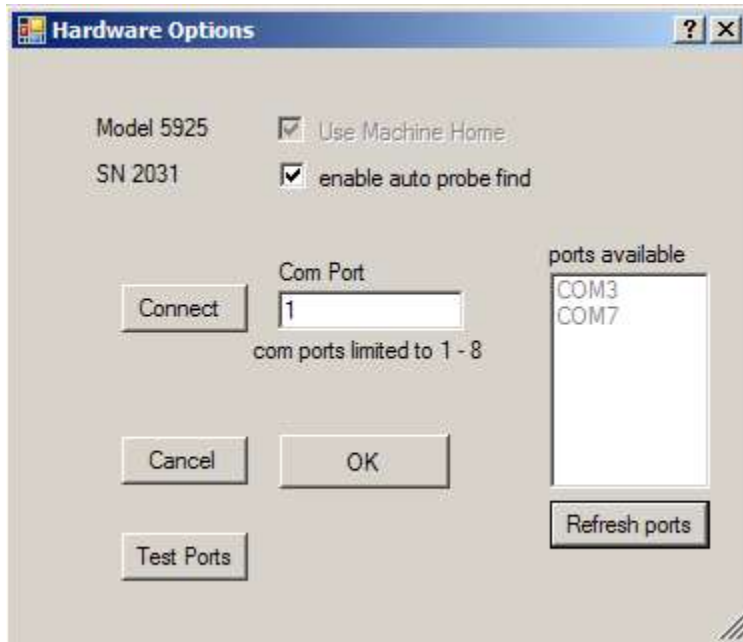
The first time the program is powered up, the com port needs to be set.

If you are connected to Com1 and the SC3 controller is working properly, the status bar will read "firmware version 1.59 found", and then after a few seconds, it will read "controller ok". This is your indication that the computer and controller have linked together.

If Com 1 was not the port connected to the controller then the status bar will read "controller not found". In this case, open the options > hardware menu.

If you know the port number used, enter it in the com port text box and click OK.

If the controller is connected to a serial port, but you don't know the number, double click the com port text box. The program will look at com ports one through 8 for the presence of the controller. If successful, a pop up window will inform you of the port it was found on.

The available ports are listed in AvCAM – Settings – hardware.
If you do not know which port goes to the Panel Pro, observe the available ports, disconnect the USB cable connected to the SC3 controller, hit refresh ports. AvCAM 11.139 has auto refresh, so the refresh button is deleted. The one you just removed will be removed from the list. Connect it back up, hit refresh ports and it should show up again. This does not guarantee that the port will work. See help – help – contents – troubleshoot – troubleshoot communications.

Once communication is established, verify all of the options. Open the various setting dialogs and review the settings.
Information on the options can be found in the help file. Click F1 to get context sensitive help on any open window. The help file is the main operating manual for the Panel Pro.

If the help file is not found, navigate to the folder where AvCAM is located if prompted and locate AC.chm.

After the machine is set up and communications established then hit the keyboard "J" or "1" key to enter the jog mode. If the jog buttons are visible on the upper left corner of the screen, you are already in jog mode.

On successful connection, a message box will ask you if it is ok to move to machine home. Unless you have a failed home switch, you always want to allow the home function to run so that the software position is synchronized with the hardware position.

The X, Y and Z axis may be exercised from the jog menu. Note that until Z Zero is set, all axis will move at slow speed.
The jog functions may be exercised using a mouse on the buttons on the upper left side of the screen, or equivalent key pad keys.

Look in the help file contents for shortcut keys.

To move the x axis left, tap and hold the 4 key. Assuming that the machine has been properly homed on power up, the software will limit travel to the extents of the machine. As a result, the x axis moving left as above will stop at the farthest left extension just short of the hard stop. If any axis hits a hard stop, it will normally not hurt anything, but position synchronization will be lost. That axis (or all axis should be re-homed).

The x axis, set in motion above may be stopped by releasing the 4 key
The 6 key will move the x axis right.
The 8 key moves the Y axis away from the operator, the 2 key moves it towards the operator. Note that until the Z zero has been set, all movement will be at a slow speed.

Z axis:
The home position of the Z axis is all the way up, just short of a hard stop and has a maximum travel down of about 3.125 inches.
When at any position, hold the 3 key to move move it down at a slow rate. The 9 key raises it all the way to the top, normally at the position where the home routine found the home switch. This does not seek the home switch however.
If you are transitioning from a pneumatic Z Panel Pro, the keyboard keys operate a little differently. The 9 key raises the Z axis at a rapid rate until the key is lifted. The 3 key lowers z at a slow rate. The 1 key commands z to the cutting level. (you will need to confirm with enter). The Page up key will raise z to the retract level. The 0 key will lower z to the z zero level.

There are 3 related z axis positions.
The **Z zero** is the point where the end mill or other tool is in contact with the surface of the material to cut. To set Z zero, hold the 3 key, then release it about .1" above the surface. Set the axis select under the main screen jog keys to z, and the increment to .001. Move the z axis using the mouse wheel until a piece of paper gets tight between the end mill and material. Tap the z keyboard key to open the z dialog. Tap Z again to set this position as Z zero.

Z retract is the position above z work zero that the z axis will raise to when commanded up by software. The goal is to use as little time traveling up and down without working as possible, but still have the end mill clear clamps or other obstructions. Initially set this at about 1". This can be set on the move options page or the z control dialog.

Cut depth is the distance below z zero that the end mill will descend to when cutting, or actually doing the work that a particular mode is used for. For instance cutting a panel with a 3/16 shank end mill with 1/8" flute diameter, and ¼" length of cut. (our standard double ended mill) Assume a material thickness of .090", and z zero set at the material surface. Cutting depth should be about -.125. Once Z Zero has been set, the X and Y axis will jog at the rapid speed if the Z is above zero. See the help file for a detailed discussion of the Z axis. With any dialog open, tap the F1 key for help relative to that dialog.

Home moves the z axis up until the Z home switch opens.

O moves the z axis to the zero position.
Pg up (key that is separate from the numeric key pad) moves the z axis to the retract position.

Pg dn (key that is separate from the numeric key pad) moves the z axis to the cut depth position. If the spindle is not turned on, it will turn on, and the z axis will start moving when the spindle delay times out.

Cutting a drawing:

We'll start our discussion by routing a single instrument hole. For instance, an altimeter drawing is an individual shape, its reference (drawing origin), was placed at the center of the instrument. Altimeter.DXF can be found in the Instrument > Standard folder of the drawing library. When the routing starts, the end mill must be at work zero or other known location.

  For instance, the 0,0 position of the altimeter.dxf file is in the center of the instrument. Since we want to just cut that instrument, the 0,0 position of the machine must be at the center of where you want the instrument cut out. The R key may be used to set the work zero at the current location.

Cut a file from metal larger than the finished part:

Select material of adequate size so the router clears the clamps, which are best placed in the corners.   Generally leave about 1 inch around each edge.

Material should be supported about every foot, and spaced away from the rails so you don't cut through the rails.

Material spacers are supplied in the tool box. These can be fabricated from inexpensive plastic lattice strips found in most lumber yards.

Cut a file from an existing blank:

Use a large carpenter square to square the blank with the x axis bearing rail.   Take care that clamps are placed in areas that will not be cut. Clearance must be maintained from the end mill, and the collet nut.

End mill:

If you are starting a complete panel, it is generally a good idea to install a new end mill. Used end mills may be used where tolerances or finish are not as critical. End mills may be inspected using a loupe or strong magnifying glass. **ANY** chipping on the cutting edge is cause for rejection.

Turn on controller:

The computer and controller may be turned on in any sequence, but normally, turn on the controller before AvCAM is opened, If AvCAM is started first, then the F2 key must be hit to establish communications.

Verify that the controller spindle switch is set to auto, and the router on/off switch is on.

Set the work zero using the "R" key or other position setting tools described in the help file > contents > cutting files.

If Z zero has not been set, set it now.

Verify coolant:

The coolant performs several functions.
- Cools the cutter bit.
- Flushes chips off of the material.
- Lubricates end mill. Keeps aluminum from building up on the bit. Material buildup will drastically increase cutting pressure breaking bits.

COOLANT:

The recommended coolant is Cool Mist #78. It does not stain aluminum when rinsed off promptly after cutting and provides good lubricity. Mix the coolant with 4-6 oz of coolant to 1 gallon of tap water, note the color of the mixed coolant. As the machine is used, coolant will evaporate. Often it is only necessary to add water. Watch the color of the coolant to maintain approximate mixture. It should have a pale blue color. If it is too weak of a mixture, then corrosion will be more of a problem.

Fill the coolant tank within 5" of the top. If the coolant is too low, it will not pump at all or there will be bubbles in the clear coolant hose. When bubbles appear dump about a gallon of water into the drain pan. Clean parts with clear water to remove residual coolant. Dried coolant leaves a sticky film.

Plan to replace the coolant and clean tank every 3- 6 months.

COOLANT FILTER:

The routing process produces a large quantity of metal chips. Most of the chips will stay in the pan, The screen on top of the coolant pail will catch what drains through.

Simulate the file before cutting.

The process of simulation does all the work of joining the dxf file entities into the correct order and direction as well as computing tool paths.

Open the file.

Select the layers to cut.

Select the operating mode (auto tool path for normal cutting)

Open the cut dialog, (blue icon on tool bar with a C in the middle), click nearest cutting order, move the sim delay to .001, click simulate. The joining and sorting is done and then the actual tool path is simulated. If a finish cut is specified, a red path indicates the rough cut and the blue path indicates the final or finish cut.

Cut the file

Ready?? Click cut the file. The router turns on, proceeds to the starting point, lowers to the cutting position and commences cutting. No further intervention is required. Assure that coolant is flowing. (Adjust the spindle delay time in move options to allow time for the spindle to come up to speed and the coolant to reach the top.) When routing is complete, the router will raise and power will be removed from the router and the coolant pump.

When cutting is completed, clean the machine. Wipe down the steel parts with a dry rag and spray with a light coat of LPS2. Spray LPS2 liberally under and around the linear bearings. Remove the collet and end mill. Clean out any chips and spray collet and collet bore with LPS2.

SC3 Control Unit

PWR: turns AC power on and off. It also acts as an emergency off. In the off position, it removes all AC power from the internal components. If the spindle is running, or the x or y axis is moving, everything will stop in the off position and will not automatically restart when turned back on. The light in the PWR rocker switch is lighted when the internal components are receiving AC power.

Spindle: The "1" position allows the computer to switch the ac power to the rear gfci socket. The "0" position removes control from the switch thereby removing power from the socket. Before performing any maintenance, remove the power cord from the SC2. If the internal ac switch shorts, power could still be applied to the rear socket even with the spindle switch off.

Positioning the Panel Pro:

Jog to the position you want to be 0,0 and hit the keyboard "r" key.

You can individually set the x or y axis to zero or to another position by clicking the x or y position on the status bar. For instance you have a 1/8" hole that you know is located at 5,3.4. Position the end mill so that it will fall freely into the 1/8" hole. Click the x position and enter 5 on the form and click ok. Click the Y axis position and enter 3.4 on the form and click ok. The position readouts should now say 5 and 3.4

Similarly if you have a panel blank that is clamped down and squared, you can move the Y axis so a 1/8" end mill just clears the bottom edge of the panel and enter -.0625 in the Y axis form. Using jog, move to the left side of the panel. Move the x axis with the mouse wheel so that the end mill just clears the left edge. Set the X position to -.0625

AvCAM leaves the X and Y axis engaged at all times to avoid inadvertent loss of position. It is possible to disable the x and y axis in machine > disable axis, but the actual position may jump as much as .002 from the reported position when the axis are energized.

Cut the panel:

Open the cut dxf file form.
Verify the correct layers are selected.
Click **move options** and verify the correct cut and traverse speed are selected. (about 12 inches per minute cut speed for 1/8" 2024t3, and 200 to 250 inches per minute traverse speed.

Ready? Click "cut the file"
The xy axis proceeds to the start of the first entity and cuts the file.
When complete, it will raise the z axis and stop the router and coolant.

Suspend cutting:
There are various reasons to stop cutting. One of the main ones is if a bit breaks. Another is if you want to reposition clamps.
To stop, hit the ESC key. Motion stops, but z stays down and the router continues to run.

If you want to just pause in position, you can switch the SC2 Z and spindle switches to

0. This is good for repositioning clamps. When ready to continue, turn the z and spindle switches back on and hit enter.
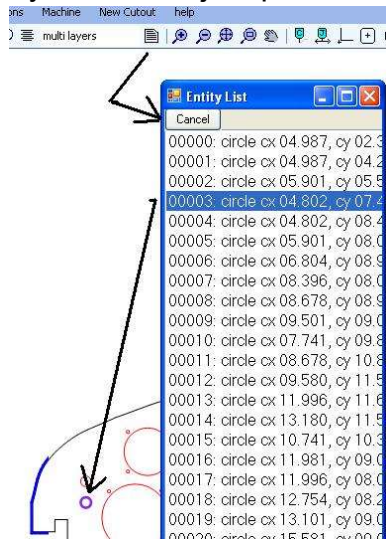
In the case of a broken bit (end mill) the xy axis will have traveled some distance before you hit ESC. In this case it is better to hit ESC a second time to completely halt operation. The Z axis will raise and the router turns off. After replacing the bit, you need to find the entity number to restart the cut.

Click entity list and highlight an entity entry. They are entered in the order they will cut. Using the mouse or arrow keys, move through the list until the entity is highlighted that you want to start on. Click cancel. The Entity listed will be entered in the cut file start entity.

The file does not need to be simulated again. Click cut the file.

You will get a warning that the starting position is not zero. Assuming you have not moved the xy axis hit enter to acknowledge this is ok. You will get another message indicating the starting entity is not zero. Hit enter to acknowledge this also. The skipped entities will be drawn, but not cut.

The Pause switch will stop movement even if there are communications issues that would keep the ESC key from working. If you need to change clamps etc. with the pause switch in the (1) position, turn the spindle switch off.
Switching the Pause switch to (0) resumes movement. Make sure the spindle is turned back on.

DRAWING FOR THE PANEL PRO

EasyCAD

EasyCAD is especially suited for use with the Panel Pro.

One of the most useful properties is the ability to insert instrument drawings (insert part). EasyCAD keeps all of the entities grouped so that the entire instrument can be moved, or erased, keeping all of its entities intact. When the entire file is exported as a dxf, EasyCAD exports the individual entities so it is not necessary to have libraries of dxf files.

EasyCAD tour:

EasyCAD uses a system of menus and toolbars to access commands. All commands can also be initiated with a text command.   For instance a line can be initiated by open-ing the draw>line menu, clicking the line tool on the tool bar, or typing the word "line" and hitting enter.

In this document when we refer to a command, it will take the form of the menu item ie draw followed by a ">" and the sub menus also separated by the forward arrow. So a line command takes the form of draw>line.

This is a good time to customize the drawing desktop for your preferences.
If you copied the configuration files from the distribution USB drive to your EasyCAD7 folder, some customization will already have taken place.
You should see a color bar, a draw bar, and an edit bar on the left side of the screen, and a standard icon bar on the right. See software installation for more information on extra Icons.

On the bottom of the screen you will see an icon with a hammer on it. Click on that to customize tool bar placement as desired. On the lower left corner of the pop up menu, verify that "use scroll bars" is checked.

When you invoke the file>new command, the settings specified in the standard.ft7 template file will be loaded so that text styles, line styles, layers and other settings will be loaded. See the EasyCAD help file for more information on templates.

Open specs > options and make sure the items are checked or unchecked the same as shown below. Two items are particularly important. "Group parts on insertion" makes sure that all of the entities associated with an instrument stay together when inserted into your cut file

"Display cursor tracking tool tip" will use up your computers resources slowing it way down after awhile.
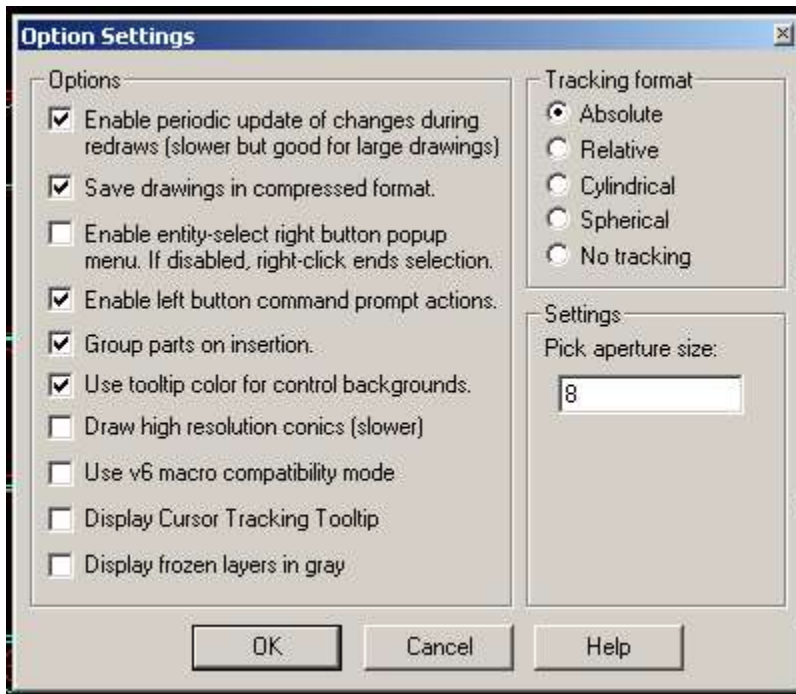
What is CAD

CAD (Computer Aided Drafting) is nothing more than a database of drawing entities and the properties that define those entities. CAD is a vector based program rather than a paint type program. Paint and drawing programs simply turn pixels on or off on a screen. They are simply visual and not scaleable since there is no definition of which pixels belong to what object. Vector graphics involve entities such as lines that have properties such as a starting and ending point. Such an entity may be scaled for display on a screen or paper.

EasyCAD is a 2 axis drawing program. Looking at the screen, left and right is the X axis, where moving right results in a higher number. IE moving from a 0,0 coordinate to a 10,0 coordinate places us at a position 10" to the right of the previous position.

The Y axis is viewed on the screen top to bottom and moving up yields more positive positions.

The view for drawing an instrument panel would be if the panel was on a table viewed from the top.

The plan of attack:

The most efficient way to make panels is to:

1. Create each cutout (instrument or even a round hole for a switch) as a separate file and store it with a name for future use, I.E. KI206.fc7.
2. Draw the panel shape and store it also as a file using the serial number of the airplane as a reference. I.E. BB421plt.fc7
3. Start a new drawing and insert the panel drawing, and the instruments as desired. Save it as a dxf as a "cut" file. I.E. BB421pltCut.dxf
4. Load the file in AvCAM and preview it.
5. Cut the file.

When future panels of the same type are required, your cut file (also saved as the native fc7 format) can be edited by simply deleting instruments not wanted and replacing them with different ones.

There are many Instruments and panels in the library supplied with the Panel Pro, and in many cases are ready to be used. At some time however, you will need to draw your own panels and instruments.

The following is an exercise to familiarize you with some of the techniques used in drawing an instrument for cutting on the Panel Pro. In most cases an instrument can be generated in AvCAM "new cutout" in about 30 seconds. Drawing them by hand could take 30 minutes.

Layers:
Think of layers as a layer of vellum or translucent material that different information is drawn on. For instance one layer of a house drawing would have the foundation drawn, another layer would have basement rooms, another layer could have main floor rooms, another layer the wiring, etc. Now if all of this information would be viewed at once, it would be a hopeless jumble of lines, however if we remove all but the foundation and basement rooms, we have a clear picture of that portion of the plan.

CAD is simply a file with the definitions of entities. Such as the start and end coordinate of a line. In addition there is provision in that definition for the name or number of a layer. We use that information to separate out different information. When AvCAM reads the file it ignores all layers except the layers selected in the AvCAM layer management dialog.

Any layer name can be used, however many of the drawing on the library inherited the layer structure from earlier days when only layer numbers were used, and I recommend using what is already in use.
**2**. The desired final dimension layer (i.e. 3 1/8 " hole for an instrument)

Bezel. The shape and size of the highest and widest parts of the instrument to avoid side to side interference.
TrayOD: The outside dimensions of the panel mount trays. It is useful to locate mounting rails.
Outside: The outside layer is the outer perimeter of the panel or part. The layer name "outside" is required to alert AvCAM to cut this on the outside and cut clockwise.

Whenever EasyCAD makes a new entity, it is drawn on the layer currently selected, and using the currently selected color.

When you chamfer the corner of 2 lines, EasyCAD creates a new line that represents the chamfer line using the currently selected layer and the currently selected color.
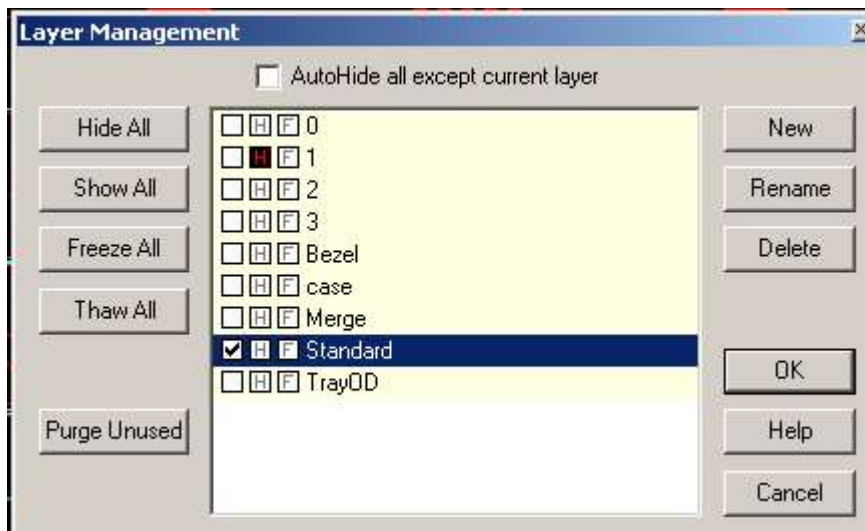
Open the layer dialog by clicking the [≡] layer icon, usually on the right side of the screen. Layers can be hidden by clicking the "H" on the layer you want to hide in the layer dialog. The example on the left shows layer 1 hidden, and all of the rest of the layers visible.

The check mark on "Standard" indicates it is the current layer.

A handy feature is the hide all and show all buttons which hide all of the layers except the current layer, and show all of course un-hides them. Freeze can be used to protect a layer from inadvertent editing. I don't use that often, because when an instrument is inserted, the individual entities are protected. One note is that it may be necessary to snap to entities on an inserted file. If the snap won't work, try showing all layers.

Do not use a layer named "block"! When AvCAM sees the word block it assumes that it should save the block definition. If you have a layer named block, the drawing will not be useable for AvCAM.

Drawing entities:

If you look at the draw menu, you will see the drawing entities that EasyCAD will draw. AvCAM will recognized line, arc, circle, polyline, and point entities.

Draw instruments:
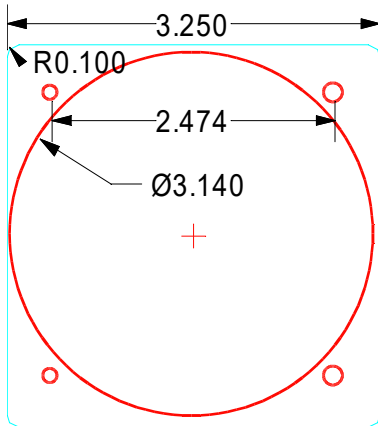
Consider the instrument to the left as a manufacturer may draw it. This is a standard cutout for a 3.125" instrument with allowance for paint.

When EasyCAD opens a new file, the current layer is "standard". It is useful to organize information on layers that can be turned on or off so as not to clutter other information. Many of the drawings included in the drawing package have their roots back in the "DOS" days when layers were numbered and not named. Back then we adopted layer 2 as the layer to contain the final desired cutout sized entities and have not changed it.
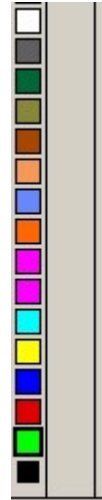
We will start by drawing the cutout. Select the layer icon ☰ (right side, icon with 4 horizontal solid lines). Click new and type in "2" for the new layer name. Click new again and repeat with "1". On the lines with the layer names there are 3 boxes. The first box if checked indicates the current layer on which any new entities will reside. Next to that is a box that if checked indicates that layer is hidden. For now check the layer 2 box to select it as current, and click ok.
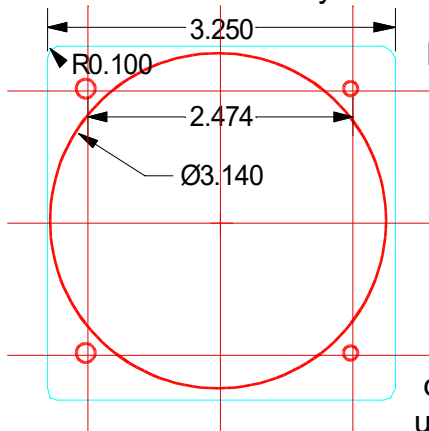
Next move the mouse pointer to the color bar and select the third color from the bottom "red".

Click draw>circles>diameter and center. There are a number of methods to define the entities. In this case we will enter the diameter of the circle and its center coordinates. Note the data entry / command bar on the lower left of the screen. It should say diameter (2.000) or some other number. The number displayed is the diameter that will be drawn when you right click or hit enter unless otherwise specified. In this case type the number 3.140 and hit enter. A 3.140 diameter circle will attach to the mouse pointer. We want a precise center coordinate, so type the number 0,0 and hit enter or right click on the mouse.

Now let's draw circles to indicate the location of the mount holes. We can calculate the coordinates with a calculator and enter each circle, but let's use the power of CAD to do some of the calculations.

Construction lines are temporary lines we draw to measure from.

Click the line icon (upper left side) or draw > line. Enter 0,-2 to start a line on the centerline starting at the bottom. Click the ortho button on the bottom. This forces lines exactly left/right or up/down. Next move the mouse so that the line extends beyond the top of the instrument. Left click to set the end of the line.

Repeat with a line from left center (-2,0) to right center.

Note that the horizontal distance between mount hole centers is 2.474. Divide this by 2 to get 1.237. Select the offset one icon (left side 2 vertical lines) When we draw a line, a number in parenthesis appear in the lower left data entry bar which usually is the last number used in that command. In this case enter 1.237. Either right click or hit enter to accept. The data entry bar now says "entity". Click on the horizontal line. Now pick a side by left clicking on the side of the line that you want the offset line to appear. Click on the top side, a line appears parallel to the horizontal construction line, offset by 1.237".

Repeat this command by right clicking. Accept 1.237 by right clicking. Select the center horizontal line by left clicking. Select the lower side by left clicking.

Repeat an offset on the left and right of the vertical construction line.

What we have now is 4 lines whose corners intersect at the centerlines of the mount holes. Select draw>circles>diameter and center.   Enter .125 for the diameter. Now instead of entering a coordinate for the center, we will use a "snap" click mod>intersection of. Click one of the intersection lines, and now the other.
A 1/8" hole appears at the intersection. Repeat with the other holes.

Note that we have numeric dimensions on our drawing. These are not necessary because the dimensions are inherent in the drawing, and only used in this case where the user does not have access to the cad program. Let's erase the construction lines no longer needed. Click edit > erase or the yellow eraser icon on the left lower side. Click on the 4 lines that intersect the mount holes. The lines change color when selected. Leave the center construction lines.
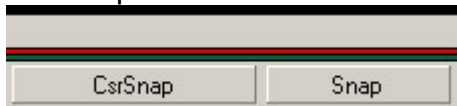
Snaps:

We mentioned snaps earlier. The picture at left illustrates the EasyCAD mod menu. The mod menu modifies a command to "snap" to a specific location, usually a part of an entity such as end point or mid point of a line, or center of a circle.

When you are asked (message on the status bar such as "1st point") to supply a coordinate, you can:
- Type the coordinate (i.e. 5.64,3.75) and hit enter
- Move the mouse visually and click (not very precise).
- Snap to a preset point on the screen (can set to 16ths or what ever) but usually we need finer resolution so to avoid snapping point we don't want, normally have the "snap button" off as shown.

Mod	Help	
Endpoint		
Endpoint of seg	F5	
Center	F4	
Midpoint		
Midpoint of seg	F3	
Mid of 2 points		
Mid of 2 EPTS		
Mid of 2 CEN		
Mid of 2 MIDS		
Nearest point ON	F9	
Intersection of	F6	
Distance Towards		
Parallel to	F11	
Perpendicular to	F12	
Angle to		
Percent Along		
Percent Along Seg	F7	
Distance Along	F8	
Degrees on		
Bearing angle		
Tangent to		
Change @ Ref. Point		
Same X (vertical)		
Same Y (horizontal)		
Same Z		
Like	F2	
Keep Like		

CsrSnap   Snap

- Snap to a point on an existing entity. This is what I use the most. This actually uses the "mod" menu on the left, the "snap buttons on the bottom tool bar should be left off, (out) as above.

For instance you want to draw a line that starts precisely at the end of another line.
You would first invoke the line command, and when status bar says "1st point" you would open the mod menu and click on "Endpoint of segment" (or simply hit F5) then click the line that you want to reference the end point of. This precisely selects the coordinate of the end point of that line as the starting point of your new line.

There are 4 Function "F" keys you should learn.
1. **F3** is the midpoint of a line or arc (if the arc started at 0 deg and ended at 180 deg, the mid point would be at 90 deg)
2. **F4** the center of an entity. In the case of a circle or arc, it is the center, in the case of a line it is the same as mid point, in the case of a closed polyline, it is the center of all of the enclosed area.

3. **F5** Endpoint of a line or arc or polyline segment.
4. **F6** Intersection of two lines.

See the EasyCAD help file for more information.

Now it's time to draw the bezel. It's important to include an accurate bezel dimension so side to side panel space conflicts can be resolved. Click on the layer icon and enter a new layer called "bezel" and select it as the current layer.

Select the cyan color. (color 5 on the left hand color bar)
The width and height of the bezel is 3.25 / 2 = 1.625
Offset the center vertical and horizontal lines by 1.625
Now you have a box centered on 0,0.
To fillet the corners, click draw>fillet/chamfer/offset>fillet and trim
Select the 2 lines to fillet. Enter the fillet radius (.1), hit enter.
Repeat with the other 3 bezel corners. We can now erase the center construction lines.

Note that AvCAM must have totally enclosed regions in order to compute tool paths. This means that the lines and arcs used to form that region must not have gaps or overlaps at their end points. Also, there cannot be entities that overlay another entity with a common endpoint.

Mount holes:
AvCAM uses the circles that depict the mount holes. If the circle is equal to or smaller than the end mill, Panel Pro will plunge down and back up, leaving a hole just slightly bigger than the end mill. If the circle is larger than the end mill, it will cut it at actual dimensions.

The object here is to introduce you to drawing principles. I urge you to explore the EasyCAD help file which has information on every command.

Grouping:
Grouping is the characteristic of EasyCAD to keep selected entities together when moving or deleting them. This results in all of the entities staying together and not getting misplaced or moved out of position inadvertently.

An important consideration is that you need to verify that specs > options > group parts on insertion is checked.   DXF files generated by Panel Pro can be inserted without change. When this is set, then when parts files such as a KI206.fc7 or KI206.dxf are inserted, they will be grouped.

However, be sure that you don't <u>open</u> a DXF file consisting of inserted parts for editing because the grouping will be lost. The native EasyCAD file format file extension is .fc7. files saved as an .fc7 will retain the grouping. Files saved as .dxf will not retain grouping.

An individual instrument may be edited in either a dxf or fc7 format since we are not concerned about grouping.   It is when we have a panel with instruments that grouping needs to be considered.

Create a "cut" file

1. Draw each individual instrument and preferably save in FC7 format.
2. Draw the panel outline on layer "outside" to cut the outside dimensions of the panel.
3. Open a new file and insert > insert part the panel.FC7 followed by insertion of the instruments.
4. Save the file as a panelcut.FC7 (I use the aircraft serial number and then the letters Plt, Ctr, or Cp and the word cut as a naming convention   IE BB538PltCut.fc7) for future editing, then as a panelcut.dxf file. This is the file that Panel Pro will use. Avoid using N numbers for naming. N numbers change and only identify the owner at that time, where as a serial number is permanent and identifies specific makes and models.   For instance BB538 is a King Air 200. This is useful for re-use of drawings.

Use an existing cut file.

1. Open an existing panelcut.FC7 file (opening a dxf file will not keep the entities grouped, and is vulnerable to errors)
2. Immediately save to a newnamecut.FC7 file to avoid contaminating an existing good file.
3. To change an instrument, draw a circle in the center of an existing instrument to make a handy location reference of its center. Delete the instrument not wanted and insert the desired instrument.FC7, snapping to the center (f4) of the circle. Delete the circle.
4. Save as FC7 and then dxf.

Use a DWG file from Easy Cad.

1. Load the dwg file. This has the same effect as loading a dxf file in that the

instruments may be ungrouped.

2. Turn the cutout layers back on, and draw circles in the middle of them for reference. Use mod > center (F4) to snap to the center of existing circles. Hint,draw the circles on a temp layer, then turn that layer off and erase the other entities.

3. Insert the instruments and panels in a FC7 format using the circles as reference. This is often easier than using AutoCAD directly.

EASY CAD LIST COMMAND:
The list command allows viewing of the details such as start and end points for lines, radius, center coordinate, start and end bearing for arcs, and the direction of lines.

Offsets:
Using the offset command is very useful to make construction lines for precision location referencing another entity.

Items to remember about the offset command:
• The offset entity will reside on the current layer using the current color.
• Offsets drawn directly on an inserted instrument or panel or other group becomes part of that group. It is often useful to draw construction lines base on panel edges. The best practice is to draw a line from 0,0 to say 0,15 for a vertical reference. Use a color different from your panel drawing to help differentiate it, and make it long enough so that it can be selected without selecting the underlying panel. You can draw lines based on snaps (F5 end point, F3 midpoint etc) to use as temporary lines to offset from.

For instance, you have an existing panel and need to position a ATI3 instrument in the same place as the original. Make a line from the left edge of the panel extending upwards (ortho on). Make another line starting at the end of (F5) one of the drawing entities from the lower edge of the panel you will be measuring from and extend it left or right (ortho on).

Now measure from the left edge of the original panel to the left side of the opening of the ATI hole you want to copy. Using the offset command (color and layer don't matter, it will be erased) offset the line you drew by the amount you measured.

Do the same with the lower edge of the ATI hole measured from the lower edge of the panel. We can use these temporary lines to line up the instrument we wish to insert.
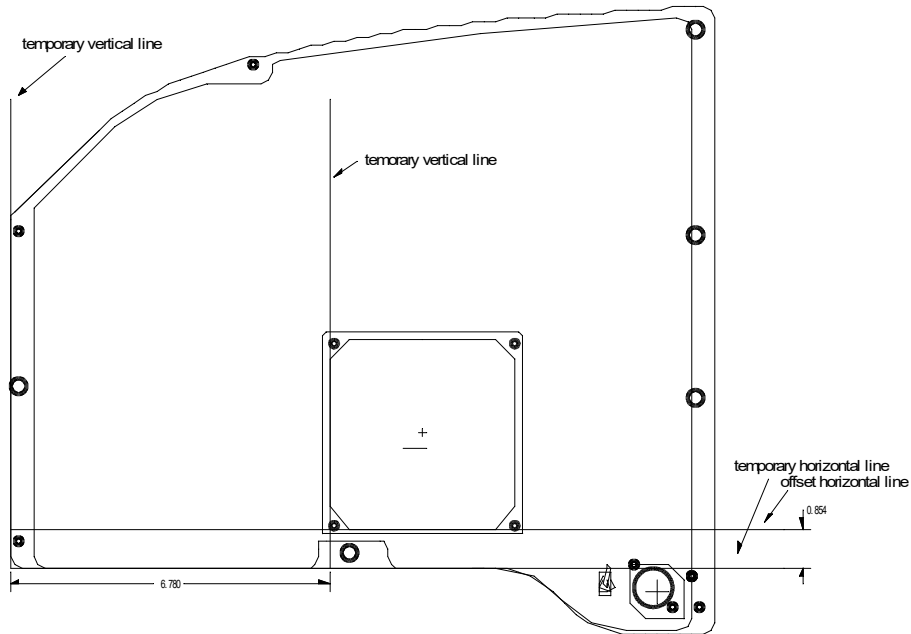
You can now draw a construction line from the center of the instrument and then draw offsets from that to place other instruments on the same vertical or horizontal centerline. If you have two intersecting lines you can place an inserted instrument (instruments have there 0,0 point in the center) by clicking mod>intersection or F6, then clicking on the intersection of the two lines you want to place it on.

Another technique, to adjust an instrument so that it moves directly onto an existing line, in the illustration below, we want to move the instrument so that it is directly on the vertical line. Click edit > move, click the instrument you want to move, right click. It will ask where you want to move from. Hit F4 (center) then click on the circle that defines the instrument hole. You will be asked where to move to. Hit the F6 key (intersection). Click on the vertical line, then click on the horizontal line that comprises the center mark of the instrument. The instrument will move from the center of the instrument to the intersection of the vertical line and the horizontal line of the center mark.
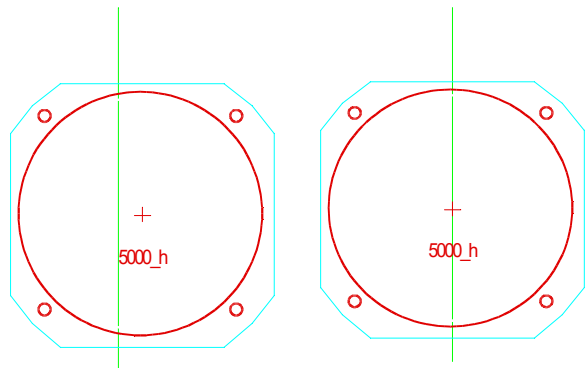
Draw a panel:

The preferred technique for measuring panel perimeters is to use the Measure Pro.

This is a discussion of techniques to hand measure a panel.

 You have a 206 copilot's panel to draw. Here is how. Place the panel on a large piece of paper and draw a line around it with a fine tip pencil. Measure the easy parts with a caliper if possible, or a good quality 24" steel rule. This panel is basically square with a curve at the top. It measures 12.706 wide and 11.998 high (we used a 24" caliper). On a new file make a line from 0,0 to 11.998,0 on layer 2, red color.

Draw another line from 12.706,0 to 0,0 for the bottom line.
Now draw vertical lines on your paper that are parallel with the left side line. Make the distances easy to measure like 3.75. What we are trying to accomplish is to generate the curve by defining control points. If a curve is real gentle, a point every couple inches or so is sufficient. If the curve changes a lot, then we need points every half inch or so. After the vertical lines are drawn measure the vertical distance where the vertical drawn line intersects with the top curve.

Using those coordinates, draw circles on your screen. The circles should be about ½" diameter for easy selection. We will remove them later.

PANEL PRO
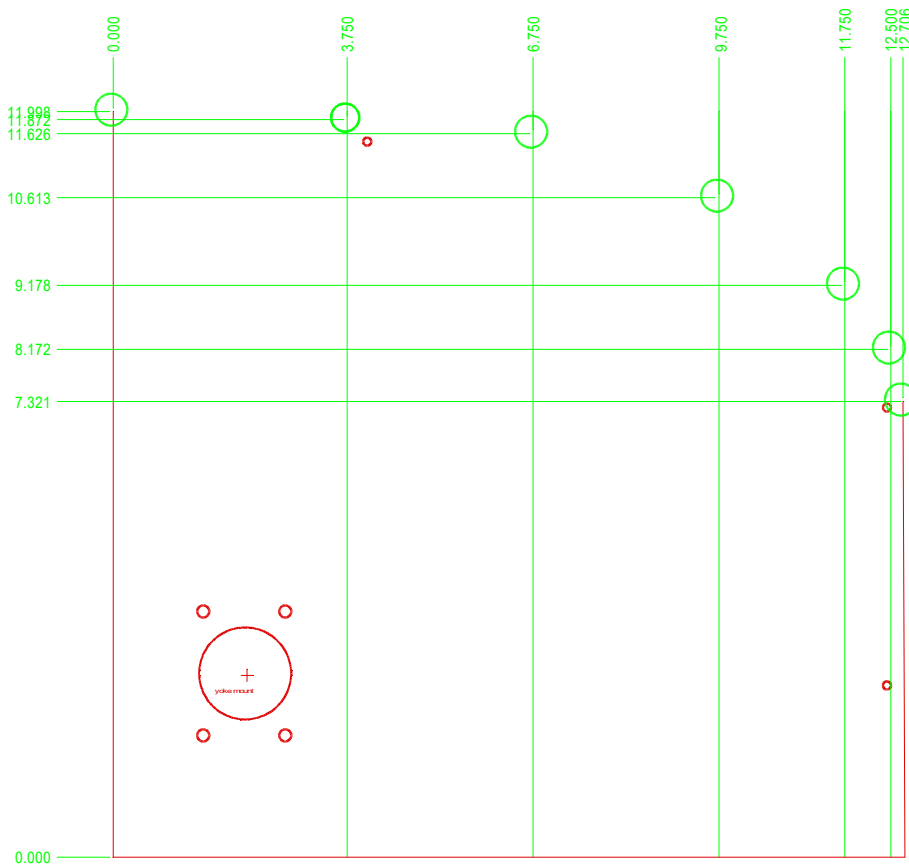
Now we will connect these points using the center snap (F4) with a parabolic spline. AvCAM does not support parabolic splines, however, when exported to a dxf file, EasyCAD breaks it down into a normal polyline with a bunch of segments.
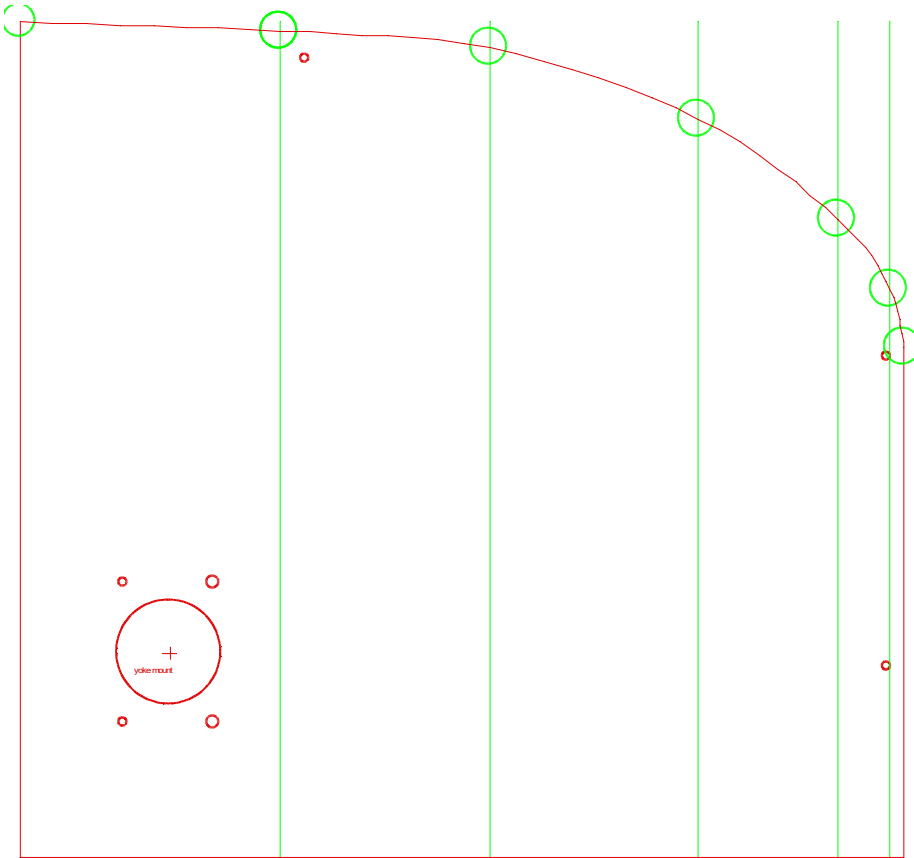
You don't need the vertical lines on your screen drawing, they are on this illustration to show how they would be placed on your paper drawing. If you are happy with the shape of the curve, you can erase your temporary circles.

Measuring the control yoke hole:
First let's measure the diameter of the yoke hole with a caliper at 1.5". Then measure from the lower edge of the panel to the lower edge of the hole and find that it is 2.188". 2.188 + ½ the yoke hole diameter (.75) is 2.938, the vertical coordinate of the hole. Measure the left edge of the panel to the hole = 1.398. 1.398+ .75 = 2.148. You can place a circle at this coordinate, but a better solution is to generate a 1.5" round hole (you can even include the mount holes) with AvCAM and insert it at 2.148,2.938.

You can use the same technique to locate other holes. I do not recommend cutting the panel mount holes, since they likely will not match another panel, and they are quite difficult to measure accurately. What I normally do is match drill to the existing panel.

AUTOCAD DRAWINGS FOR THE PANEL PRO

The following describes techniques used to create a DXF file that Panel Pro will use to cut out an instrument panel.   This assumes that the reader is already familiar with AutoCAD and highlights techniques used with the Panel Pro.

The entities to be cut need to be on the desired layer, usually layer 2. Entities not intended to be cut such as bezels or text notes should be on another layer.

IMPORTANT!
An efficient instrument panel drawing technique breaks a drawing into manageable pieces. Draw each instrument cutout and save it in a convenient directory organized by manufacturer. The same can be done with the drawing of the panel outline itself. These drawings can then be combined at a later date to create whatever panel is desired. The process to do this is open a new drawing, insert > block panel name.dxf or dwg at 0,0. Then insert>block instrument names at wherever. Save the file as a dwg. Then save as a dxf. See a later discussion on the save as procedures.

Drawing concepts:

The following describes the techniques used to hand draw an instrument. It is presented to familiarize you with the techniques used to draw an instrument or other cutout.

 When actually preparing a panel to cut however, you should insert the instruments and other cutouts as blocks either from the drawing library or if they are not in the library, use the "new cutout" utilities in AvCAM. These tools will create a dxf file with only the instrument entities in it. A typical instrument cutout can be made in about 15 seconds using this method.

AutoCAD has the ability to "cut and paste". **Avoid** using this technique for panel drawings. AvCAM supports originally drawn and block type entities.

Some methods of drawing also make use of symbol libraries. This method is also not supported.

The best place to start is by drawing a single instrument cutout, but first a couple of set up items.

Open a new drawing using model space as opposed to paper space. The drawing must be made in full size. Paper space is used to scale large objects for a given sheet

of paper. It is normally not needed for instrument or panel drawings, as they can be scaled to fit the paper at print time.

Use the world coordinate system (WCS) not a user coordinate system (ucs). A user coordinate system may be used to make intermediate calculations by setting the 0,0 coordinate to a different location, however, when the drawing is saved as a dxf file, it reverts to the world coordinate system, and the 0,0 point may where you expected.

For this exercise we will assume an ATI shaped hole that we will cut out to 3.2" wide 3.2" high that has a diagonal measurement of 3.92" and a distance between mounting holes of 3.06". In addition, the 0,0 (insertion point) will be at the center of the instrument. The insertion point could be at the lower left corner, however since different instruments have different dimensions, it would be difficult to align a row of instruments based on an edge.

Layers:

Many of the drawings were made back in the days of DOS based CAD systems. At that time, only numbered layers were used. Layers separate out common items of interest. AvCAM will cut the entities on any one selected layer. The entities that comprise the cutout dimensions are on layer 2. Later versions of CAD allowed alpha layer names, and the bezel entities are on the "bezel" layer.   For panel mount radio cutouts there is a trayOD layer, and the panel perimeter is the "outside" layer.

Do not use a layer named "block"! When AvCAM sees the word block it assumes that it should save the block definition. If you have a layer named block, the drawing will not be useable for AvCAM. Also do not use a layer called text or line or any other drawing entity name.

Colors:

Normally colors and line styles have no effect to AvCAM.

The default background in AutoCAD is white. Most of the drawings in our library were made in EasyCAD with a dark background. This will display as black in AutoCAD, however some of the other colors may appear strange as the colors don't necessarily map out the same between EasyCad and AutoCAD.

Draw an ATI3 instrument.

the top, left, bottom and right side lines

A standard ATI3 cutout dimensions are 3.21 wide, 3.21 high, 3.92 diagonal across the corners. The distance between mount holes is 3.06.

We will first draw the cutout.

Select (or create layer 2)
Divide the height and width (3.21) by 2 = 1.605
Divide the diagonal 3.92 by 2 = 1.96
It is good to start and finish on the top center of a ati or square type instrument.

Create a line from 0,1.605 to – 1.605,1.605 to create the left half of the top line. Note that it extends left, which when connected into a polyline with the pedit command will rotate counter clockwise.
Create a line from –1.605,1.605 to –1.605,-1.605, the left side of the cut out.
Create a line from –1.605,-1.605 to 1.605,-1.605, the bottom line.
Create a line from 1.605,-1.605 to 1.605,1.605, the right side line.
Create a line from 1.605,1.605 to 0,1.605, the right half of the top line

Draw a line from the lower right corner using object snaps (end point) diagonally to the left top corner, also using the end point snap to precisely locate the end point.

construction lines to make the diagonals

PANEL PRO
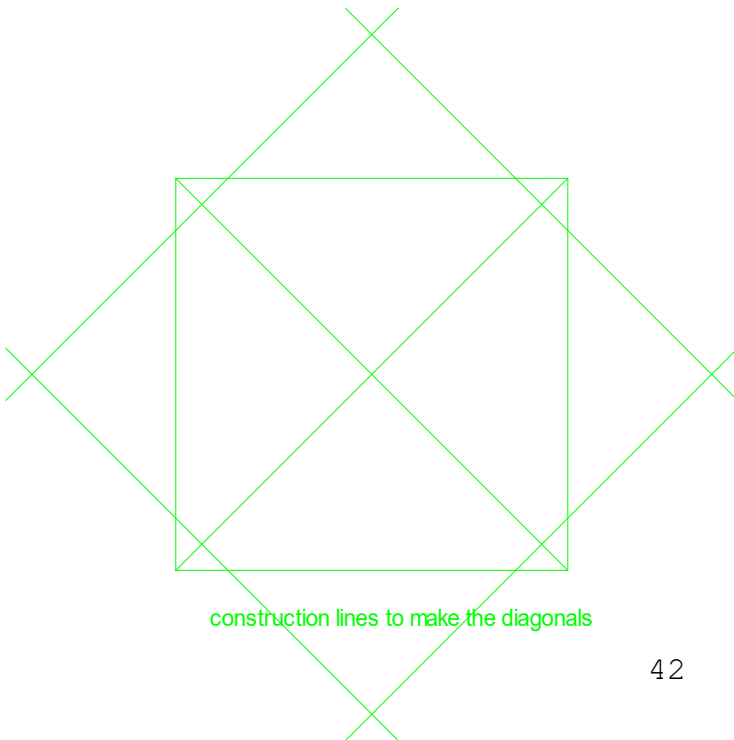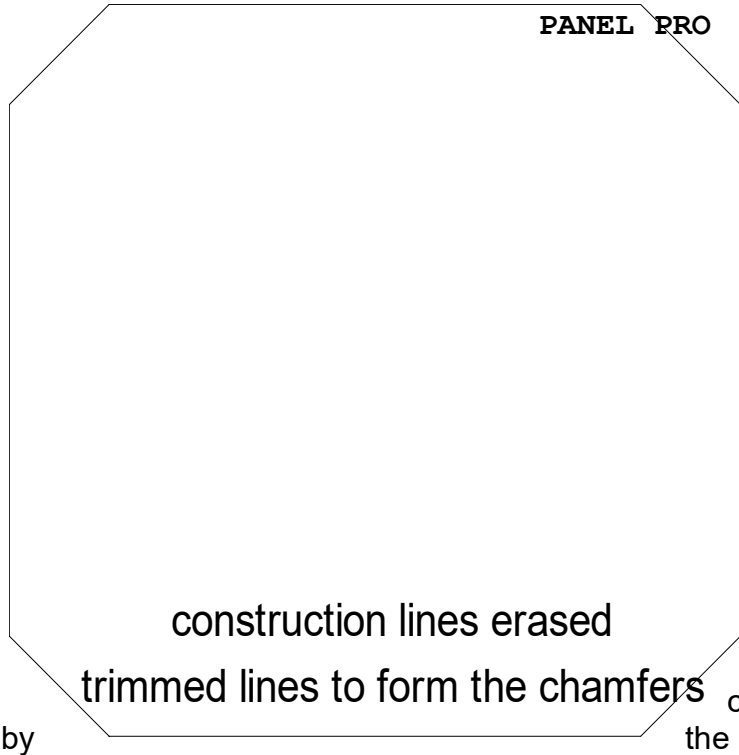
Offset that line by 1.92 on the lower and upper sides.
Draw a line from the lower left corner to the upper right corner.
Offset that line by 1.92 on the lower and upper sides.
This forms the diagonal corners.

If we knew the actual chamfer, we could use that with the chamfer command, but usually the instrument manufacturers drawings specify a diagonal measurement.

construction lines erased

trimmed lines to form the chamfers

by

We can use the chamfer command to trim the lines created the offsets.

The construction lines drawn from corner to corner can be erased now.

ATI3
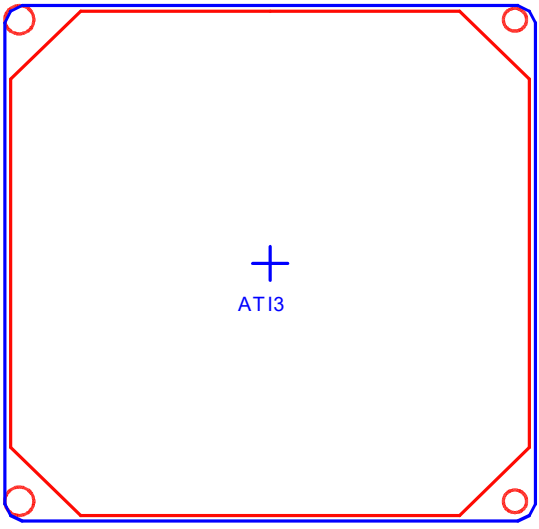
Select the chamfer command. It first asks you to specify the chamfer distance. Enter 0.
Select the chamfer command and select the top line and the top left diagonal line to trim the ends. Repeat with the other lines until we have the octagonal ATI shape.

Now we will create the mount holes.

Make layer 2 current
Draw a .125" circle at 1.53,1.53, -1.53,1.53, -1.53,-1.53, 1.53,-1.53.

You can draw the bezel to verify clearance between instruments or structure.

Tool paths are automatically generated by AvCAM and are not required in your drawings.

An easy way to generate an instrument dxf file:
Open AvCAM

Click on the ATI tool.
Type in the height, 3.21
Type in the width, 3.21.
Type in the distance across the corner chamfers or type in the chamfer distance 3.92.
Type in the upper right mount hole coordinate 1.53,1.53. (1/2 of the center to center distance of the mount holes)
Optionally type in the size of the case or bezel
Click "OK"
Enter the name of the file to save, ie ATI3.

A dxf file with the cutout and mounting holes has been created with the proper layers. This process takes just a few seconds.
The dxf file can be inserted directly into panel drawings using the insert > block > browse command.

If you wish to add more detail, open the dxf file directly from the file > open command. You can save it as a dwg file if desired.
Make the panel outline:

For AvCAM, place the outside perimeter entities on layer "outside" .

Similar techniques are used for Panel cutouts. There will be inside cutouts like switch holes, mounting holes and the like.

If you have accurate mounting hole information by all means cut them with the Panel Pro. In many cases each aircraft has panel mounting tolerances that make this difficult. It is quite difficult to manually measure mounting holes on an existing panel.

Start a new drawing as above.
Execute the purge command to make sure there are no old blocks hiding in memory.
Make layer "outside" current.
Start with the lower left of your drawing at 0,0. (world coordinate system)

Draw any combination of lines, arcs and polylines to create the perimeter of the panel. Curves are supported in AvCAM. Different CAD programs name them differently; however the one we can use is the parabolic spline where the control points are on the line.

AutoCAD file issues.

When you open a New file, it will be a dwg type. You can save it as dxf, but it will hold the dxf file open. It must be explicitly closed in autocad before another program such as AvCAM can read it.

Creating a cutfile:
We now have a 560 pilots panel and an ati3 instrument in our library. To assemble library parts into a cut panel proceed as follows.
Open a new drawing.
From the Insert > block > browse menu, specify the file 560(dwg or dxf) and insert it at 0,0.

Insert the file ati3 at 3,6.
Insert the file ati3 at 9,6.
Insert the file ati3 at 3,11.
Insert the file ati3 at 9,11.
Or use the various snap options.

Blocks are supported in AvCAM with these limitations. They can be nested only one deep. That means that a block may contain blocks, but no deeper nesting is allowed. Depending on the drawing complexity, rotated blocks MAY work. Rotated blocks that include engraved text will probably not work. Simulate in AvCAM to verify.

Save the file as DXF.
Close the file in AutoCAD.
Open AvCAM.
Open the cut dialog. Verify the endmill size. Verify auto tool path is checked. Click simulate.

AutoCAD and DXF are trade marks of Autodesk, Inc.

Trouble shooting
Bit breaks:

- Use only high quality high strength end mills. Such as Metal Removal PN 159-3453-27 (M30293) or Atrax PN 85297083 supplied in started kit. The preferred end mill is the double ended 1/8" end mill with the 3/16 shank.
- Bit breaks when the interior slug parts from the parent metal. Use a lead in line length greater than 0, set in options > lead in line length. Never use single ended end mills other than the M30293. Other single ended end mills are not strong enough and will break in short order.
- Bit is chipped or dull, taking excessive cutting force. Even a very minor chip on the cutting edge will result in deteriorated cut finish and accuracy.
- Excessive feed rate. A normal feed rate for 1/8" 2024 T3 is around 12" per minute.
- Cutting material that is too thick. Any thing thicker than .125 aluminum should be cut with multiple passes not exceeding .125 per pass, removing chips from the slots between passes. A good coolant flow will help remove the chips.
- Moving and running into obstacles without the router running.
- End mill is not secure in the collet allowing the end mill to slip down to the non cutting area on the shank. The router will sound like it is laboring.
- Improper volume or maladjusted coolant. The end mill must be lubricated to avoid material build up, and chips must be flushed away.
- If an end mill has broken inside the collet, it may have left a burr. Run a 1/8" fine file through the collet to remove burrs.

Inside dimensions are too small:
- End mill chipped or dull.
- A normal cut is usually about .001 to .002 smaller than drawn.
- Finish cut should be checked.
- Using excessive cutting speed
- Using wrong end mill size on the cut dialog.
- If only the x or y dimension is too small suspect backlash or loose parts. Also make sure that the motor to lead screw coupler is not broken or loose.

Inside dimensions too large:
- End mill is bent or crooked in collet
- Wrong end mill size specified on the cut dialog.
- Make sure collet is clean.

Outside dimensions too large:
- Verify "use holding nibs" is checked on the cut dialog.

Finish poor:
Make sure work is clamped securely so it cannot move vertically or horizontally.

- Use rough cut and fine cut
- Use sharp end mill.
- Make sure there are no loose components on the machine such as the Z axis bearings.
- Use holding nibs. See help > index > holding nibs.

Panel Pro will not respond to jog commands (status bar reads "controller not found" on power up.

- RS232 cable not hooked up
- Power turned off
- Proper port selected in the defaults menu. (double click on options > hardware > port to auto locate controller). Must be port number 8 or less.
- Microcontroller problem in controller (contact Buller Enterprises, Inc.)

X or Y axis will not move, or move very slowly.

- Check options > hardware > steps per inch should be approximately 5080.
- Check options > move > traverse speed should normally set at 200 to 250. If a large number like 1000 is used, the movement may be very slow.
- The z axis is less than .2" above z zero.

Jerky or erratic movement

- If only one motor is mis-behaving, one of the two driver circuits may be open anywhere between the drivers in the controller and the motor.
- Make sure motor to lead screw coupler is not dragging on surrounding structure.
- Make sure both X axis motors are running. Disconnect the x axis ball nuts from the Y axis and jog to see if one is not running.

Mis-alignment from one hole to another. The Panel Pro has lost steps.

- Check that panel is mounted so that full travel can be achieved. If the X or Y axis hits a stop (or any other obstruction) the axis that hit the obstruction will be offset.
- Never leave tools or parts on the machine as the X or Y axis may hit them and cause a jam.
- Confirm there is no slippage between motor and lead screw.
- Check that motor to lead screw coupler is not broken.
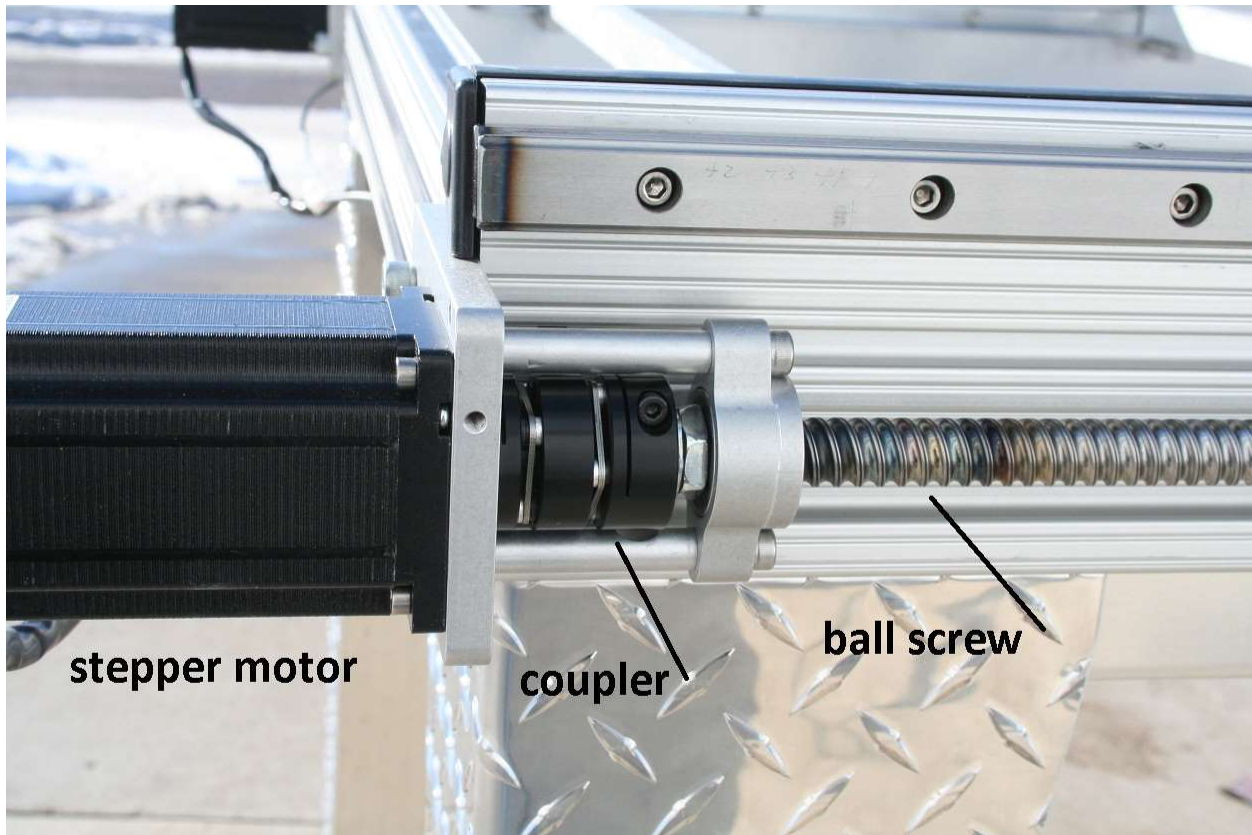
The picture shows the X2 axis with the guard removed. We have used various couplers, but the arrangement is the same regardless of which coupler is used or the axis it is on. To check for slippage, turn on the controller. The motor will magnetically lock in place. Grasp the ball screw with a pliers (you won't hurt it, the critical area is the groves)and turn. At some force, you will be able to overcome the magnetic detent, but there must be zero slippage until that happens. Tighten the coupler until there is no slippage. Inspect the coupler for breaks, cracks or loose hardware. The screws holding the pieces together on the coupler above can work loose. If that is the case, the coupler must be disassembled, tightened, and reinstalled.

MAINTAINING THE PANEL PRO

PREVENTATIVE MAINTENANCE: After cutting, wipe the ways (linear bearing rails) with a clean cloth or paper towel. Make sure there are no chips left on the ways. Spray a light coat of oil such as WD40 or if you are in a high humidity environment, LPS2 on the ways and bearings. Using the jog menu, hit "7" to turn on the coolant. Remove any remaining chips. Hit "7" again to turn the coolant off.

If the machine is not going to be used for a couple days, cover it with a cloth.

There are 16 grease zerks. Grease once a month with general purpose grease. One or 2 shots of grease should be adequate.

Collet maintenance:

The picture on the left shows a collet after cutting a King Air panel. It should be cleaned whenever the end mill is changed. An Exacto knife or a 6" rule can be used to clean the collet slots out. When the major crud has been removed, blow out the collet and collet bore with an air hose.

Any chips in the collet system will cause the end mill to run out of true. This will cause the end mill to break more frequently because the flutes are not equally sharing the load.

 If an end mill breaks inside the collet, gently run a 1/8" fine round file inside to remove burrs. Plan to replace the collet every 6 months or so. To avoid end mill slippage, the collet should be installed dry. That however invites corrosion so It is a good practice to remove, clean and dry when not in use. The collet nut threads should be oiled.

Adjust x to y axis square:

Make sure the machine is level. With the power off, move the x1 and x2 lead screws using the knobs on the left end of the machine simultaneously until both touch their stops. The stop is a 6mm dog point (blunt) set screw that is Lock-Tited into the Motor mounting plates on the X1, and X2 axis.

 Both should normally hit their stops at the same time, but if an obstruction gets in the way of one x axis, it will stop, but the other will continue until there is enough binding to stop it as well. At this point the X and Y axis will be out of square with each other and the position will be lost.

Turn off SC3 power and relieve any obvious binding. Turn back on and go through the home sequence. Verify both xq and x2 contact their hard stops at the same time. If they don't, turn the controller power off or disable the drivers from the AvCAM > machine menu.

Adjust Ballnut backlash:

The X and Y axis ball nuts have an adjustment for back lash. To check for backlash grasp the axis in question near the ball nut mounts and wiggle back and forth. If there is backlash, a clunking sound will be heard. Make sure the ball nut mount screws are tight. The adjust screw is located between the mount screws and uses a 3mm Allen wrench. Tighten slightly until clunking sound disappears. Traverse the axis end to end and listen for any unusual sounds or binding. Some areas of the lead screw may be slightly tighter than others. The ball nut needs to be adjusted for the tightest location. The picture shows the X2 axis, but the X1 axis and Y axis have a similar arrangement.

BALL NUT
ADJUST
ATTACH
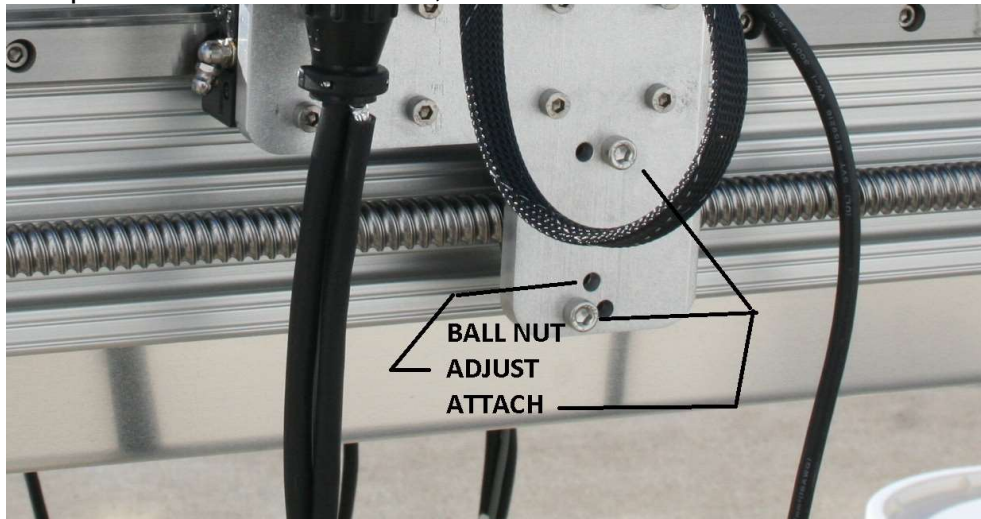
ADJUST LEAD SCREW BACKLASH:

This adjustment preloads the lead screw bearings.

The Panel Pro 5925 X and Y axis are similar. They use a double bearing at the motor end and a floating bearing at the knob end. The knob end has two Bellville washers that the knob tightens against with the screw in the middle of the knob. This eliminates backlash with constant preload on the bearings. The pointed end of the Bellville washers should oppose each other, one end pointed to the flange bearing, and the other to the knob.

Hold the lead screw (on the screw part, not the smooth machined part) with pliers near nut end. Remove the 6mm screw (5mm allen) and remove the old locktite.

Tighten the 6mm screw in the center of the knurled nut against the Bellville washers until backlash is eliminated plus ½ turn. Proper torque will allow enough preload to turn the lead screw and motor (power off) with the knob. If it is too loose, the knob will not turn the motor. The 6mm screw should be tightened with LockTight 242, and left overnight to set up.

STORAGE

Make a habit of covering the Panel Pro after use. Keep the ways clean and oiled with LPS2. For long term storage coat the steel parts with a preservative oil like LPS3.

3 axis operations with the Panel Pro 5925

The Panel Pro 5925 utilizes a full Z axis that can be software controlled within its travel.

In most cases you will still use a 2D cad file and use the z axis cut depth to control how deep the end mill will cut.

There are several defined positions on the Z axis.
Home is the position at the top of the travel where the Z home switch opens. It is at or very near the absolute mechanical up limit.

Maximum travel from the home position is approximately 3.125" and is also close to the mechanical travel limit.

The 3 main defined positions are:
- Retract
- Zero
- Cut depth

The retract and cut depth are relative to work zero. When AvCAM commands a Z down to cut depth, it will travel at the currently selected rapid traverse speed to zero, and then at the cutting speed to cut depth.

What ever tool you are using will need to have a zero reference. Normally the Z work zero will be the position where the tool (i.e. end mill) tip is on the surface of the material to be cut.

To set Z work Zero:
Use the jog keys (see the help file) and jog to a position somewhere near where your x/y zero will be.

Use the 3 key to move the z axis down to about .1" above the surface. Use the mouse wheel set to move the z axis (right click   any where on screen to move between x, y, and z) and the increment set to .001 per mouse wheel detent (left mouse click on screen to move between .0002, .001,   and .01 inches per mouse wheel detent)

Place a strip of ordinary paper which is about .004" thick between the end mill or other tool.
Using the mouse wheel move the z axis down until you can not easily pull the paper out. Tap the Z key on the keyboard.
A pop up will ask if you want to set the current location to zero, respond yes. If you inadvertently run the z axis down too far, it can damage your tool or more likely cause the z axis to lose position. If you suspect that you may have gone too far, tap the home key to reset the Z axis position. Then re set the z zero. Tapping the "0" key will lower the z axis to the zero set point. If position has been lost, the tip of the tool will be above zero.
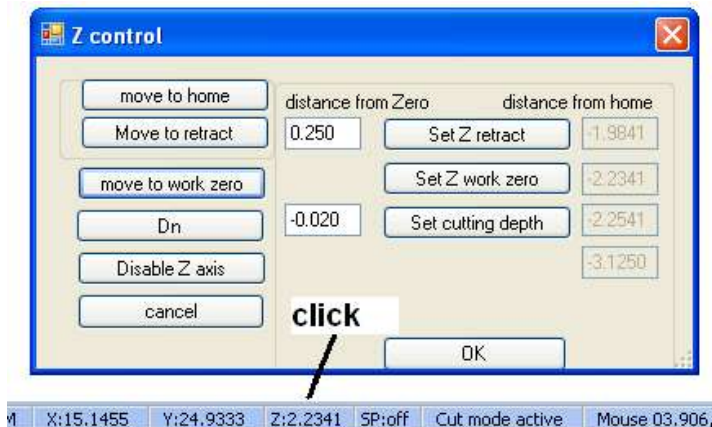
Be aware that the Z Zero will change for each tool, and each change in material thickness.
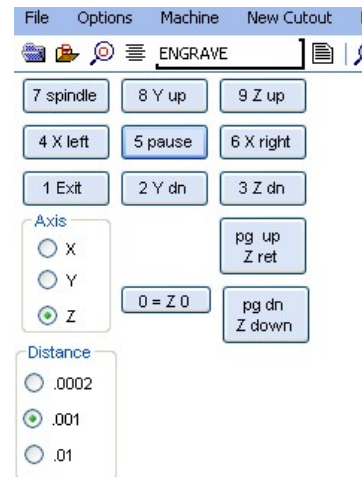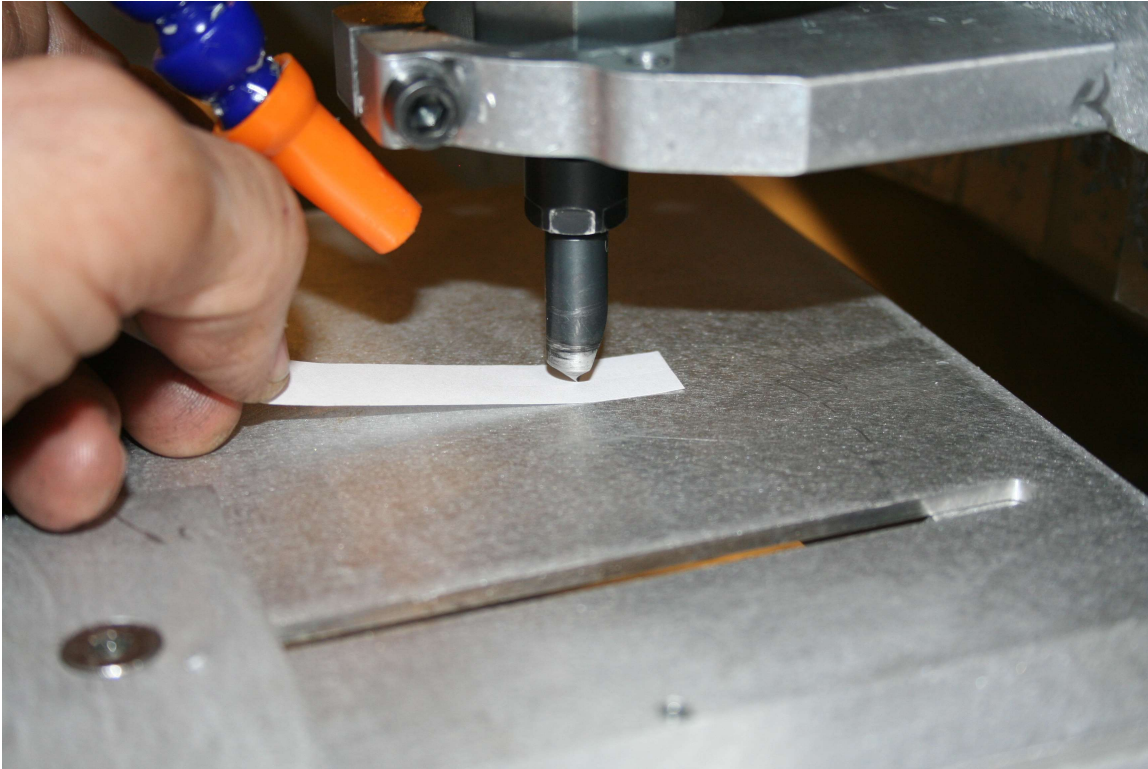
The tool installed in the picture is a 100 degree countersink. It can be used for countersinking and chamfering.

The retract setting is where the z axis will move to when it is not cutting and moving to its next cut location. It needs to be high enough to clear any clamps or obstructions. If there are no obstructions, then a setting like the .250 in the picture will save time. It can be entered directly as a positive number in the text box, or you can move the z axis where you want the retract position to be, open the z control dialog by clicking the Z status box and clicking the "Set Z retract" button.

Similarly, the cutting depth can be set by direct entry or the set cutting depth button. We will talk about cutting depth again later.

The countersink supplied with the Panel Pro is a 100 degree included angle, ½" diameter countersink with a ¼" shank. It has a single cutting edge and the cutting edge extends all the way to the point.

Having a sharp point helps to determine how deep we want to cut. The sharp point gives us a way to measure the depth we need to achieve a certain countersink diameter. If the end mill has a blunt point we have to measure or estimate how much it is cut off. Also a blunt point makes it impossible to pierce down into the metal unless there is already a hole there. While it is possible to pierce down into the metal with a sharp point, it is still preferable to have a pre-existing hole.

There are a couple of techniques to accomplish countersinking. First of all in your cad file, you need to have a separate layer for your countersink tool. Call it something imaginative like "countersink".

Countersinks are normally specified by the diameter of the widest part. A number 8 countersunk screw may have a head diameter of .3", however the actual countersink has to be larger than that to make the screw head flush because the edges of the head are rounded off.
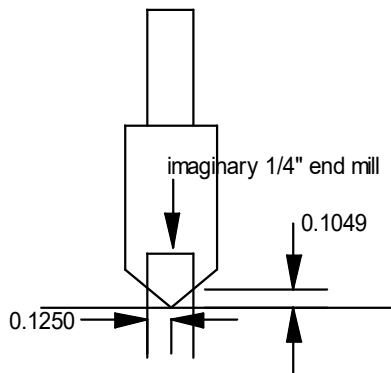
The technique is this.

- Draw your countersinks the diameter you want in your countersink layer.
- In the AvCAM cut dialog, select the auto tool path mode, and enter a ¼" end mill diameter.
- Set the z zero to between the tip of the countersink and the material.
- Set the cutting depth to -.105

Cut the file. Using this technique, the smallest countersink you can make is .250. Using the auto tool path mode, and ¼" end mill diameter, any circle equal to or less than the stated end mill diameter will proceed to the center of the circle, plunge to the cut depth and raise back up. Any circle larger than .25 will cut the chamfered edge or countersink.

You could set the end mill diameter to something smaller such as .125, but then the cut depth would also need to be less. In order to cut something like slotted instrument mount holes this would be required. A typical slotted mounting hole would be slotted for a #6 screw which is .144. In order for AvCAM to correctly compute the tool path, the radius of an arc must be at least .010 larger than the radius of the end mill. i.e. the radius of a 1/8 mill is .062. The radius of a .144 arc is .072.

If you need to make both very deep/ large countersinks and very small/shallow countersinks on the same panel, you will need to either use a 3D cad and set different depths or put the shallow cuts on one layer of your 2D dxf file and the deep cuts on another. You then run one layer at a time, each with it's own cut depth.

To cut a chamfered edge, draw a figure with its edge where you want the chamfer edge to be. This can be cut in the same layer as the countersinks.

Caveats:
Even though the Panel Pro is fully capable of creating the countersinks, it is a fair amount of effort to do so. Consider having a microstop countersink for each size of screw. It takes no set up time except the first time you set the depth and to change out tools.

If the chamfer or counter sink is not the size you want it, then adjust the cut depth lower. Try increments of .010.

We have made a great effort to make the Z axis as accurate as possible, but you may still see .010 difference from area to area. We have an optional dial indicator accessory that can be clamped in the accessory tool holder to check various areas for uniformity. The material itself may not be perfectly flat.

Make sure your material mount bars are clean, free of burrs and chips. A chip between the material and mount bar could easily result in a .010 or greater error.

Install the dial indicator, navigate to your xy zero spot.   Use the 3 key to move the dial indicator tip down below the level it touches about ¼". Set z zero there. Turn the dial on the indicator until the zero is at the dial pointer end.
Set your retract to about 1"

Move the z axis up and then navigate to the area you want to confirm. Tap the 0 key to move the z axis to zero and observe the dial. The difference from your reference zero is the surface z error.

If you have a critical application you can use the Measure Pro to make a Z map of the surface. It makes a correction table that will correct for surface irregularities. The entire surface does not have to be mapped, but it should be mapped at least an inch or more beyond the critical area. It maps out the surface in even 1 inch increments and interpolates the z error between points. Unmeasured points have a correction of zero.

Even with a Correction table, you may notice some inconsistency because of material flexing. You should have a lot of support and stiff material. Material thinner than .062 will probably not yield satisfactory results unless it has some sort of backing.

This piece was done using the method above.

Inlets can be made in a similar way, but use the same tool used for cutting through. If you have a 3D capable CAD you can simply set the Z depth of the lines and arcs.
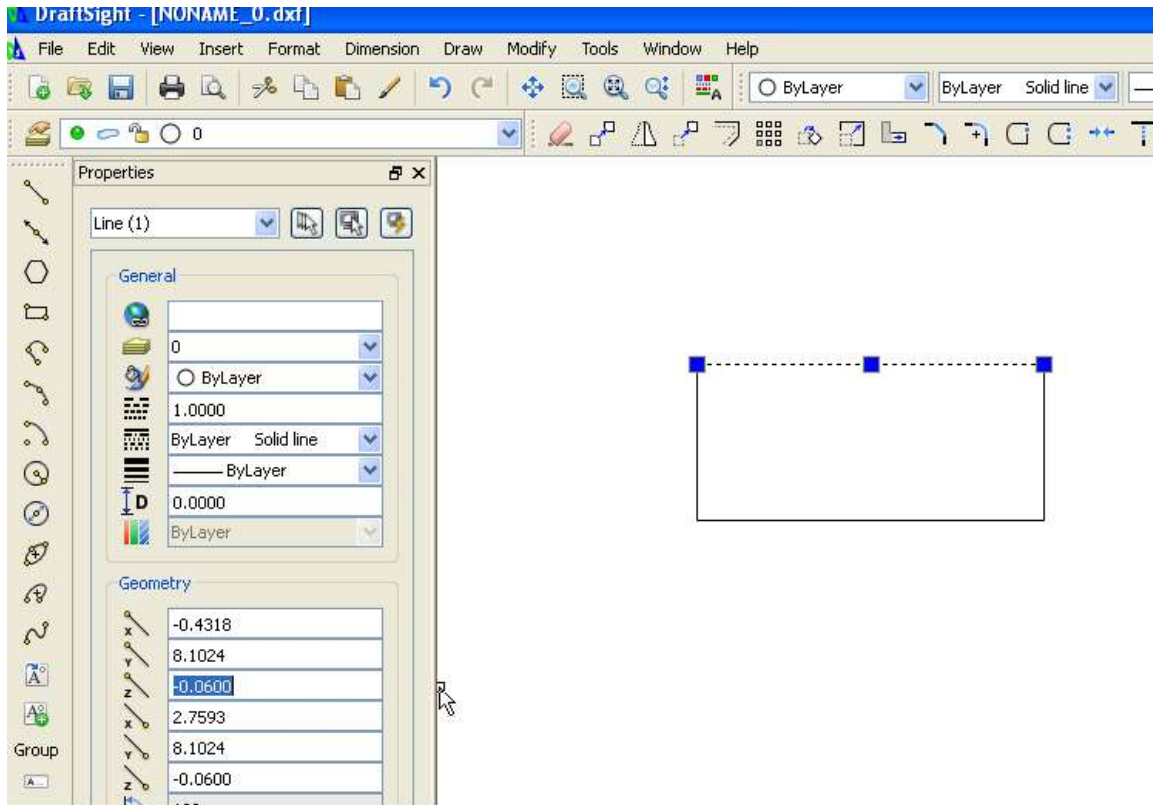
Note the selected line and then the starting and ending Z value on the properties. The cad used here is the free DraftSight program.

No 3D cad? No problem. Just put your insets on a separate layer, and cut them before the through cuts, setting the z depth to your inset depth.

Important! All entities that have a z axis coordinate of 0 will cut at the cut depth entered into the cut depth on AvCAM.
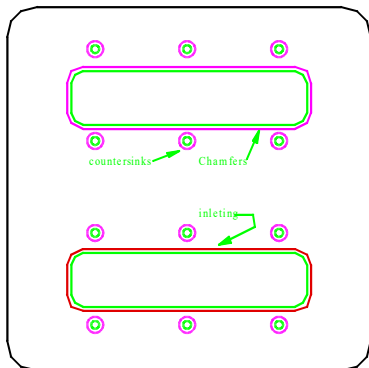
In this picture, the green entities were cut through, the red line on the bottom cutout defined the inlet, the purple entities were on a countersink layer and defined the countersinks and chamfers.

Just remember when you do your tool changes to reset z zero, the end mill diameter and cut depth.

It will take some practice to absorb the methods discussed and become proficient.

The safest approach is to set your z depth more shallow than expected and reset and repeat as required.

Check list:
- Draw the file. Inside cuts on any layer NOT named outside. All outside cuts must be on the layer called outside. Save the file to dxf. If your CAD does not close the DXF file when saving, it must be explicitly closed. EasyCAD and DraftSight properly close the file on saving.
- Open the File in AvCAM.
- Select the layer(s) you want to cut in this operation. If you are cutting countersinks and or chamfers, it is preferable to have existing holes rather than cutting all of the material with the countersink, so cut the inside cutouts and leave the outside layer un-selected on this pass.
- Set the end mill diameter in the cut dialog
- Simulate the file
- Install the tool on the router
- Set the x/y zero. This only needs to be done once for the file.
- Set the Z zero, verify retract level and cut depth. The retract may remain the same for all tools, however the Z zero and cut depth will likely change for each tool.
- The Cut depth will change for different passes with the same tool if you are making widely different sizes of countersinks.
- Verify router switch is on and the spindle switch on the controller is on.
- Verify cut speeds. The cut speed should be in the 12-18 IPM range.
- Verify adequate coolant in tank and pump plugged in.
- Repeat Z zero, cut depth and end mill diameter settings for each tool change.