MACH MOTION / TUBE PROCESS

Tube Bender Control

X15-250-300 User's Manual

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Things you need to know about how to operate a MachMotion Tube Bender Control.

Contents

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Your Tube Bender Control

Congratulations on purchasing your MachMotion Tube Bender Control. This software was designed to be very simple and easy to learn, while not compromising on functionality. It offers you complete control of each of the functions of the machine in addition to many complicated automatic procedures. In this manual you will find everything you need to know to operate your tube bender.

Note: This is a user's manual, not a teacher's manual! This manual assumes you know the basics of tube benders and their functions.

****

Emergency Stop

In case of an emergency, press the large red E-Stop button located on the operator's panel (Figure 3 on page 8), rear electrical cabinet and the side of the machine. All motion will stop immediately.

NOTE: FEED HOLD OR CYCLE STOP WILL COMPLETE THE CURRENT MACHINE ACTION BEFORE STOPPING.

****

Getting Started

To operate your machine, begin by turning on the computer. Rotate and release the key on the back right hand side of the control. When the computer has completed its startup procedure, double click on the **Tube Bender** icon on your desktop (Figure 1).

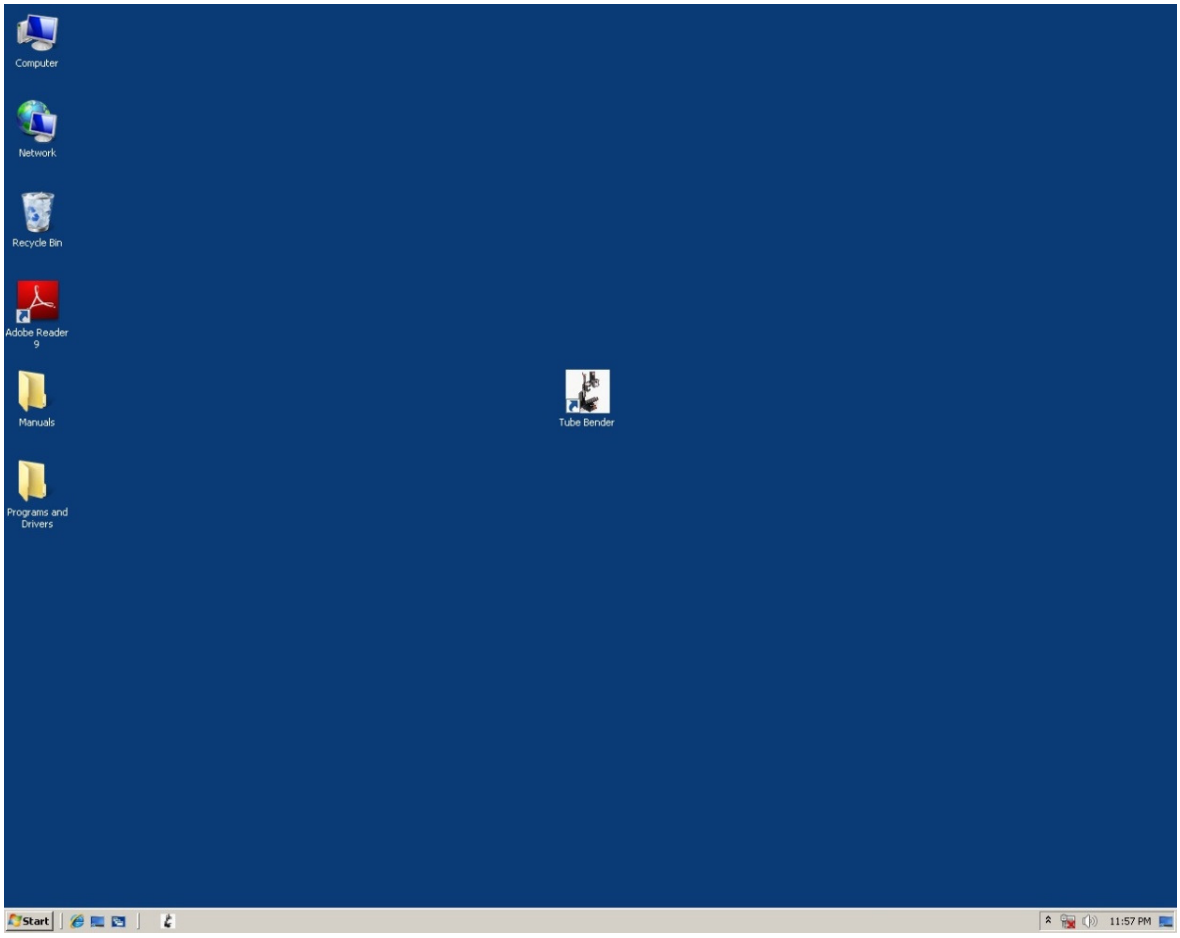

Figure 1 Tube Bender Icon

The MachMotion Tube Bender Control will open.

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Warning

Severe damage may be caused to the control by turning off the power of the tube bender without first shutting down the control properly. See Shutting Down the Control on page 50.

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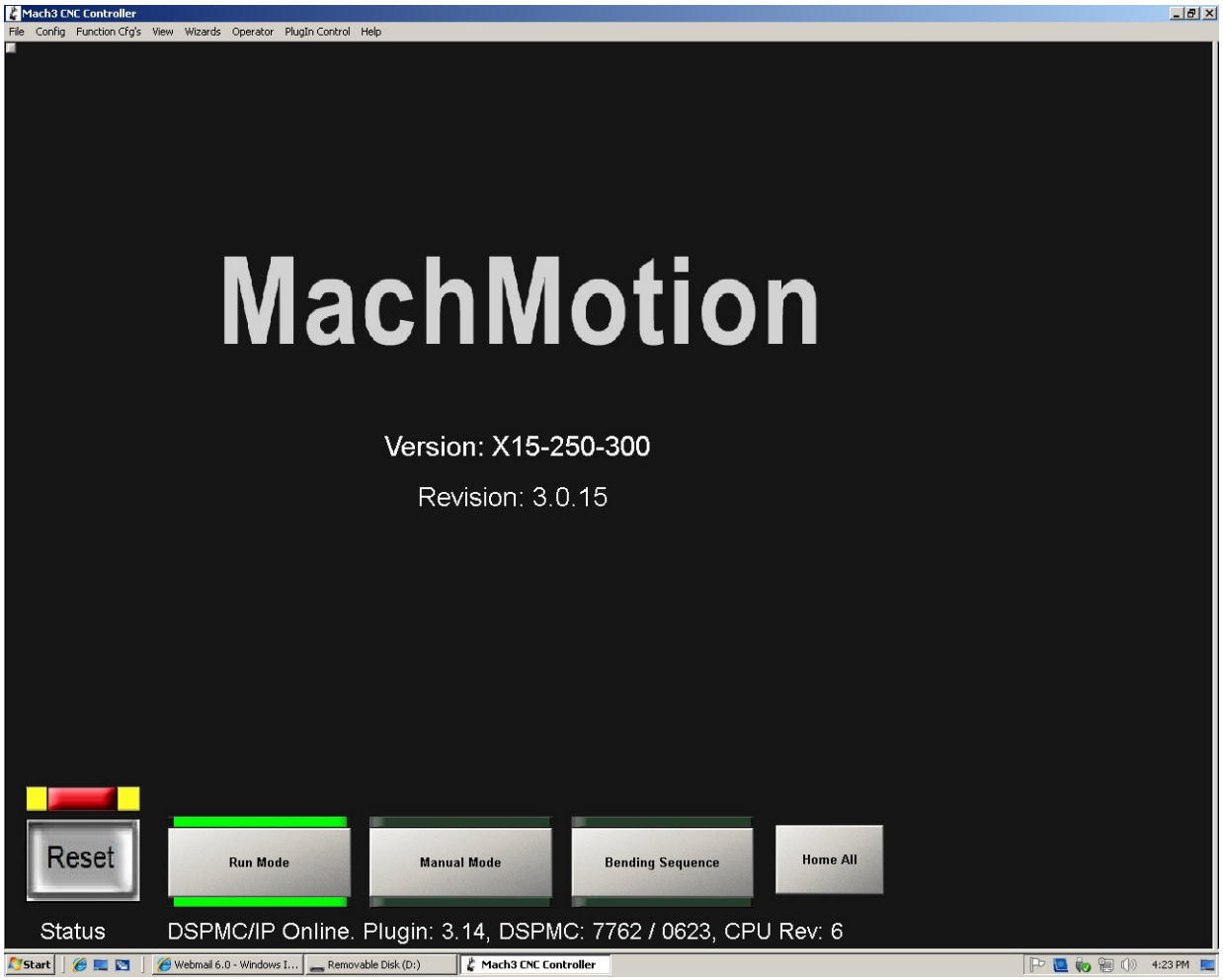

Figure 2 Mach Motion Tube Bender Control

This control has three modes: **Run Mode**, **Manual Mode**, and **Bending Sequence**. Before you can proceed to any of the modes, the tube bender must be homed. To home, pull out the **E-Stop** button on the operator's panel. See Figure 3 below. Then push the **Power On** button to start the hydraulic pump and supply power to the servo drives.

Figure 3 Operator's Panel

Then, using the track ball click the **Reset** button as shown below:

Figure 4 Reset Button

Now click on the **Home All** button (Figure 2 on page 7). The tooling will be commanded to its open position, the bend arm will move and the carriage will travel toward the rear of the machine. When the tube bender has stopped moving, the homing routine has completed. Now you can proceed to the other modes. During normal operation you can use the three buttons at the bottom of the screen to switch modes. Whichever button is selected will be lit up by colored bars (Figure 5).

Figure 5 Different Modes

Note: If for some reason you had to operate the tube bender before homing, if for example the machine was coming out of an emergency condition and the pipe was jammed up, you can navigate to Manual Mode by clicking the ***Manual Mode*** *button at the bottom of the screen (Figure 2* above*). Use caution as the indicated position of the bend arm and carriage will not be correct and the tooling to machine interference checks will not be operational.*

Manual Mode

In Manual Mode you have control of each moving part of your tube bender. Each function, such as the pipe clamp and pressure die, can be operated in this mode. You can also do manual bends. This is a good place to start when learning the control.

In this section you are going to begin by learning how to operate the Y, B, and C axes. Then you will also discover how to operate each of the other functions of the tube bender independently. Finally you learn what semi-auto mode is and how to use it. To begin, click on the **Manual Mode** button (Figure 2 on page 7). You will see the following screen:

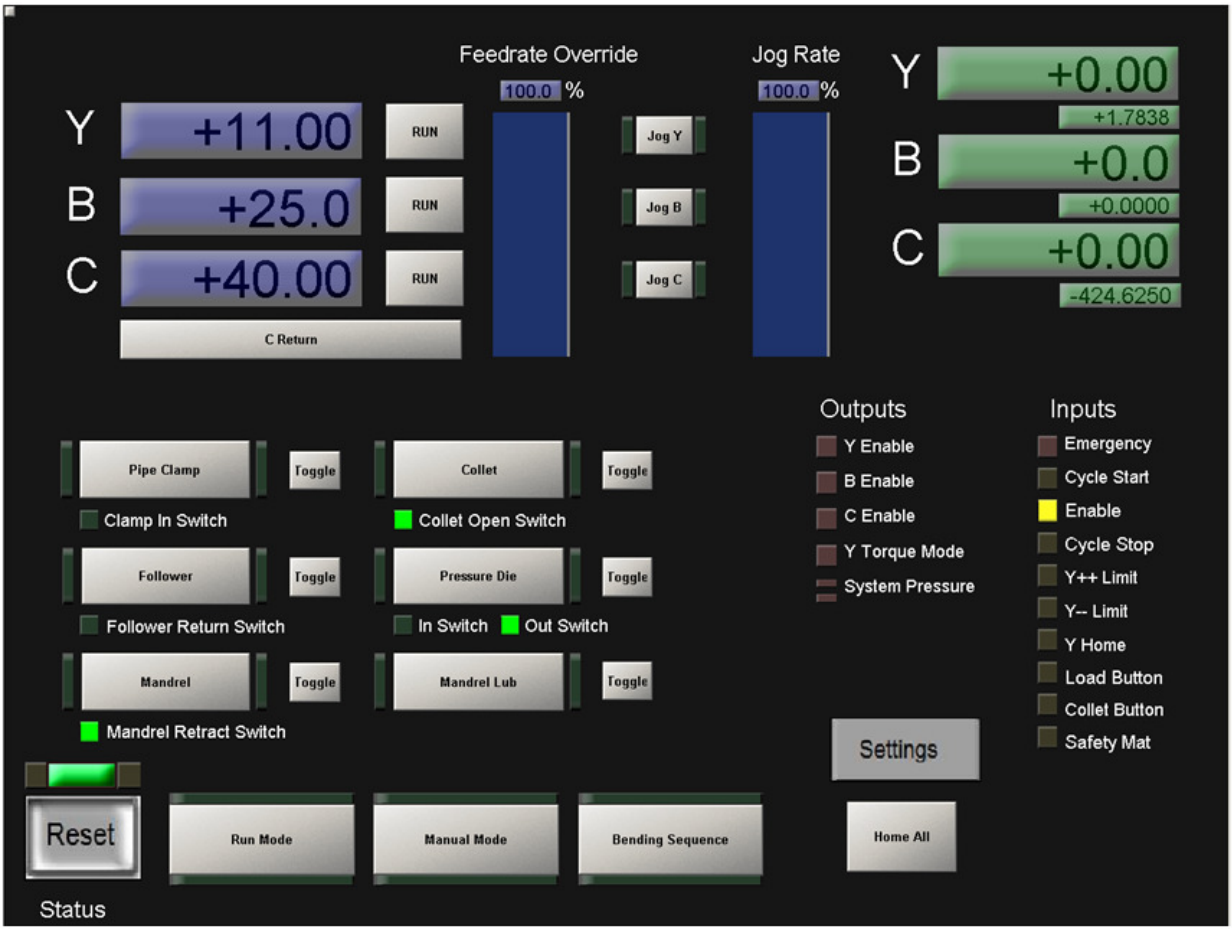

Figure 6 Manual Mode

The Carriage

The carriage, or Y axis, can be moved forward or backwards. All moves are incremental, meaning that the carriage moves however far you command it to move *from the current position*. The first input field on the left of the screen labeled “Y” is the + or - distance for the carriage to move along the linear rail (Y) (Figure 7).

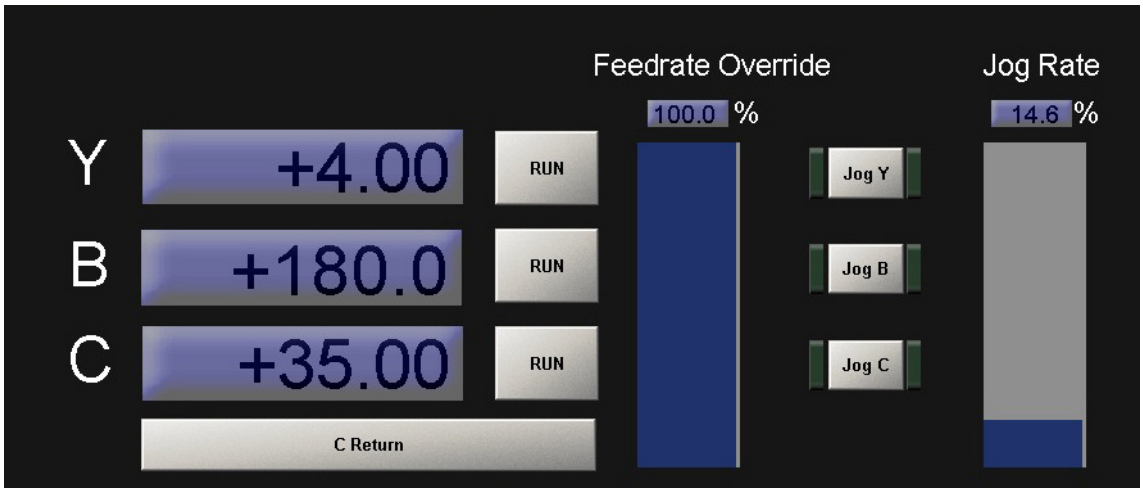

Figure 7 Input Fields

The distance value is in inches or millimeters depending on how your machine is configured (See Unit on page 50). To move the carriage, enter your distance into the input field, adjust the **Feed rate Override** vertical slider to set the speed between 0 and 100% and click the **Run** button next to it. The carriage will move the distance that you commanded it.

If you command it to move farther than the machine limits will allow, an error will pop up (Figure 8).

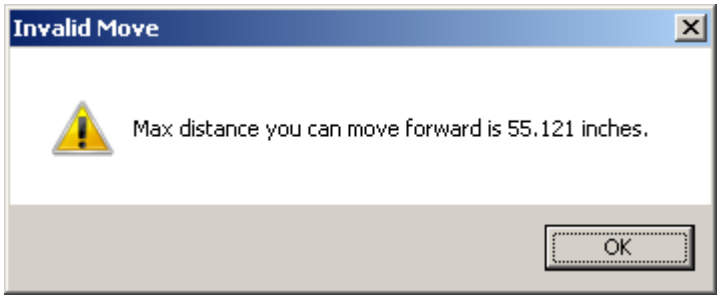

Figure 8 Invalid Move

To manually jog the carriage, or Y axis, click on the **Jog Y** button to the right of the Feed rate slider. Then, while holding the enable button (green pushbutton switch to the left side of the control console), press + or – push buttons (black pushbuttons on the operator’s panel). The Y axis will move as long as you hold the buttons. Adjust the **Jog Rate** slider to control the speed.

****

DANGER:

You can crash the carriage if you are not careful! If you hit a limit switch at high speeds the carriage will continue to coast and may collide with the end of travel stop or the tooling at the front of the machine.

****

On the right side of the Manual Mode screen there are Digital Read Outs (or DRO's) labeled Y, B and C. They indicate the current position of the carriage and bend arm. The small DRO below shows the absolute machine coordinates. This is the real position of each axis measured from the homing switch. The large DRO indicates the commanded distance remaining while the axis is moving.

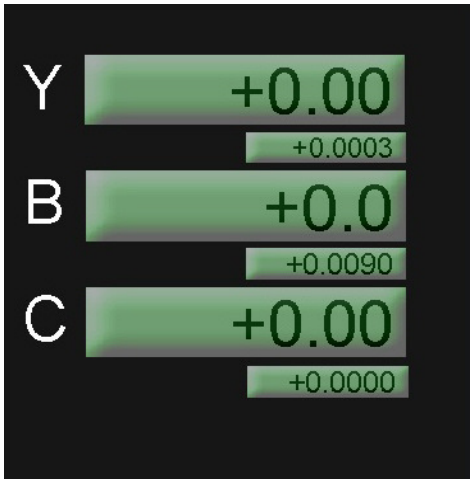

Figure 9 Y, B and C Axis DRO

Limit Switches

If the Y axis over travel limit switch is hit, the control disables all motion. An error will be displayed in the status bar at the very bottom of the screen. See Figure 10 below.

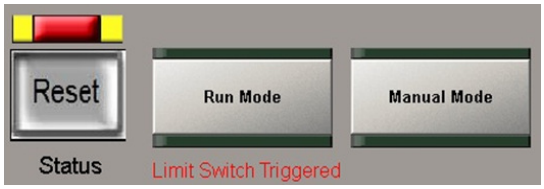

Figure 10 Limit Switch

To reset from a limit switch condition, follow the procedure outlined below.

1. Move the carriage off the limit switch and beyond the home proximity switch manually.
2. Press **Reset** (Figure 4).
3. Home the machine by clicking the **Home All** button (Figure 6 on page 9).

You should now be ready to continue operating your machine.

The Rotary Axis

The rotary axis, or B axis, can do positive or negative rotations. All movements are incremental. The second input field on the left of the screen labeled “B” is the distance for it to move in degrees. Viewing the B axis from the front of the tube bender, positive is counter-clockwise and negative is clockwise.

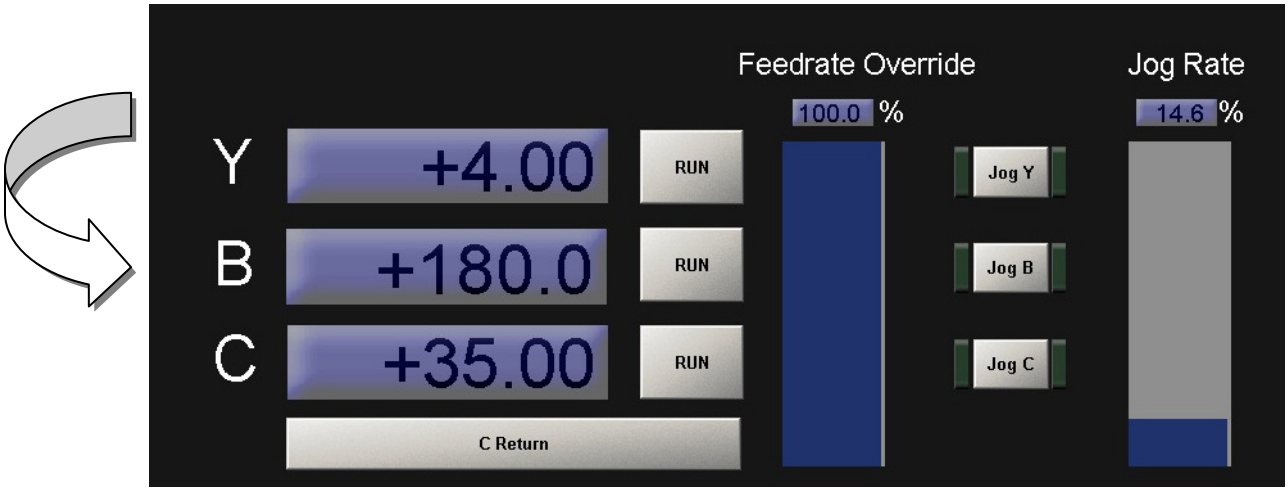

Figure 11 B Input Field

To move the rotary axis, enter your distance into the input field and click the **Run** button next to the input field. The B axis will rotate however many degrees you commanded it to. The B axis can rotate at different speeds. To change the speed, adjust the **Feed rate Override** vertical slider to set the speed between 0 and 100%

Note: Changing the Feed rate slider also changes the Y and C axes speed.

To manually jog the B Axis, click on the **Jog B** button to the right of the Feed rate slider. Then, while holding the enable button (green pushbutton switch to the left side of the control console), press + or – push buttons (black pushbuttons on the operator's panel). The B axis will rotate as long as you hold the buttons. Adjust the **Jog Rate** slider to control the speed.

The second large DRO on the right of the screen labeled B is the current position of the B axis (Figure 12). The absolute machine coordinates are in the small DRO below it. This is the distance from the home position.

Figure 12 B Axis DRO

The Bending Arm

The bending arm, or C axis, can only bend positive angles. All bends are in absolute coordinates, meaning that they are referenced from the home position. The third input field on the left of the screen is for the C axis. Again the value is in degrees.

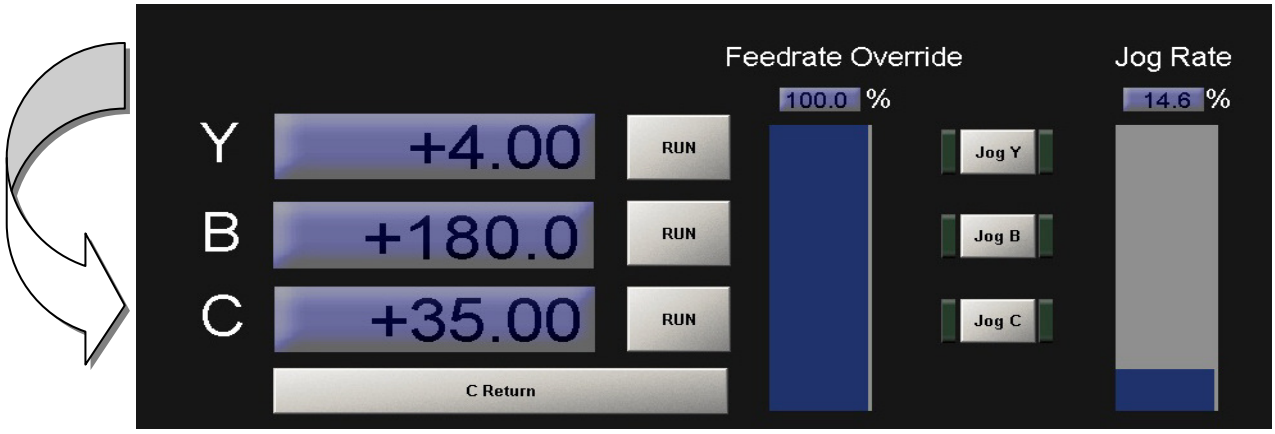

Figure 13 C Input Field

****

DANGER:

Stand clear of the C arm or serious injury may be incurred. During each C bend the pipe clamp, pressure die, mandrel and mandrel lubricator can all function. Keep your hands and all other objects far away.

****

Make a Bend

To move the C axis, enter your angle into the input field and click the **Run** button next to the input field. The clamp and pressure dies will close, then the C axis will bend to whatever angle was commanded.

If the carriage is in the pressure die interference zone (i.e. the pressure die will collide with the carriage if the die closes). The clamp will close, the collet will open and the carriage will back out of the interference zone. The pressure die will then close and the C axis will move to the commanded position.

While the C axis is bending, the Y axis changes to torque mode. In torque mode a set amount of force is applied to the carriage. Immediately after a bend, the carriage switches back to the normal mode.

The C axis can also move at different speeds. To change the speed, adjust the **Feed rate Override** vertical slider to set the speed between 0 and 100%

Note: Changing the Feed rate slider also changes the Y and B axes speed.

To manually jog the bend arm, click on the **Jog C** button to the right of the Feed rate slider. Then, while holding the enable button (green pushbutton switch to the left side of the control console), press + or – push buttons (black pushbuttons on the operator's panel). The C axis will move as long as you hold the buttons. Adjust the **Jog Rate** slider to control the speed.

The third large DRO on the right displays the current position of the C arm.

Figure 14 C Axis DRO

Return the C Arm

To return the C axis, press the return button below the C input field (Figure 15). The clamp and pressure die will open, The Y axis will feed forward to clear the clamp insert and the C axis will return to zero.

Figure 15 Return C Axis

****

DANGER:

You can be killed or seriously injured if you get behind the bend arm when it is closing. Stay far away from the machine when the C axis is returning.

****

Bender Functions

This section explains how to operate each individual function that can be controlled in Manual Mode. Use Figure 16 for your reference.

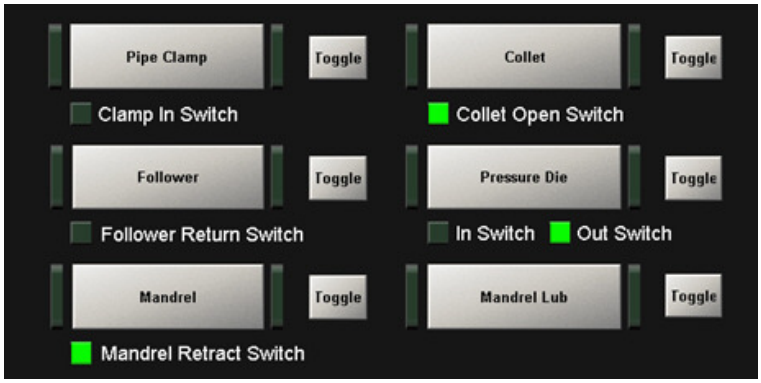

Figure 16 Bender Functions

Note that each function box has vertical bars that light up when the box is selected. When the function is selected you may move it incrementally by holding the Enable (green) button on the left side of the console and selecting the direction with the + or – (black) buttons on the console. The function will be commanded to move as long as you hold both buttons. The motions are activated at a low system pressure for safety and to avoid damage to the tooling. When you release the buttons all pressure is removed

To the right there is another smaller box labeled “Toggle”. When you are certain that the tooling is properly installed and aligned, or is adjusted so that there is no danger of tooling damage, the Toggle button can be selected to move the selected function at full system pressure. When the function has completed its full range of motion, it will be held at full pressure in that position. Clicking on the toggle button again will reverse the direction of the selected function

Note that the switch status for each function is shown by an illuminated box just below the function button. The switches are used by the control to monitor the position of tooling during machine operation. If the box is lit the switch is active. Other inputs and outputs connected to the control can be monitored by the status of the input and output boxes to the right of the function buttons.

Pipe Clamp

To manually operate the pipe clamp, click the **Pipe Clamp** button (Figure 16). Holding the enable button and pressing + will move the clamp toward the bend die to grip the tube. Holding enable and pressing – will move the clamp away from the bend die to its open position. If the toggle button is selected the clamp will change position. For instance, if the pipe clamp is closed, clicking the button will open it up. Clicking it again will close the clamp.

Collet

To manually operate the collet, click the **Collet** button (Figure 16). Each click of the button clamps the collet or releases it. Jog and toggle mode operate the same for the collet.

Follower

To manually operate the follower (pressure die forward and backward), click the Follower button (Figure 16). Holding the enable button and pressing + will move the pressure die forward.

Holding enable and pressing – will move the pressure die back. If the toggle button is selected the follower will move full stroke. For instance, if the follower is retracted, clicking the button will move it forward the full length of the cylinder stroke. Clicking it again will retract the cylinder.

Pressure Die

To manually operate the pressure die, click the **Pressure Die** button (Figure 16). Holding the enable button and pressing + will move the Pressure die toward the bend die to grip the tube. Holding enable and pressing – will move the pressure die away from the bend die to its open position. If the toggle button is selected the pressure die will change position. For instance, if the pressure die is closed, clicking the button will open it up. Clicking it again will close the pressure die.

Mandrel

To manually operate the mandrel, click the **mandrel** button (Figure 16). Holding the enable button and pressing + will move the mandrel toward the bend die. Holding enable and pressing – will move the mandrel back, away from the bend die. If the toggle button is selected the mandrel will change position. For instance, if the mandrel is forward, clicking the button will retract it. Clicking it again will advance the mandrel.

Mandrel Lube

To manually activate the mandrel lubrication pump, click the **Mandrel Lube** button (Figure 16). Each click of the button operates the mandrel lube pump. Jog and toggle mode operate the same for the mandrel lube function.

****

DANGER:

If you are doing a C bend, any of the above functions may operate if they are enabled.

****

Settings

Clicking on the Settings button will open the following screen which allows setting the parameters for several machine constants as well as selecting options for various equipment included on your particular machine.

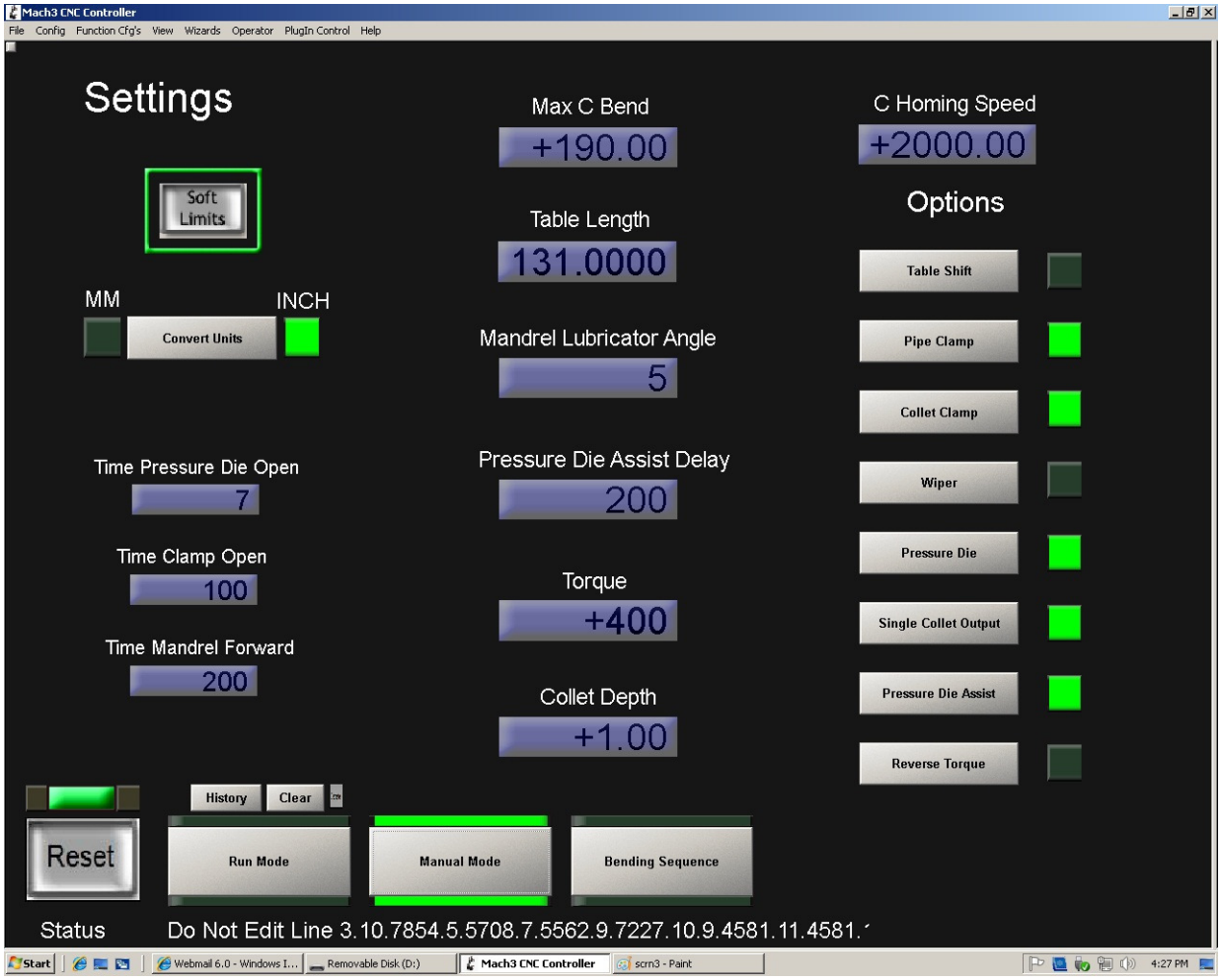

Figure 17 Settings

Soft limits This button is used to bring up a screen that allows changing the forward limit of travel for the y axis. This value will change automatically depending on the dimensions of the tooling installed on the machine.

MM – Inch These selection boxes are used to indicate the units of length for the Y axis. You must use the procedure on page 51 to change units.

Time fields The three fields immediately below allow changing the time allotted for the pressure die, clamp and mandrel to move to their commanded positions.

Max C Bend This is a field that sets the upper limit of the bend arm travel.

Table length is the distance from the tangent point on the bend die to the front of the collet when the carriage is at its rear limit of travel (at the Y home limit switch).

Mandrel lubricator angle is the increment of bend arm motion when the mandrel lube pump is activated. ie. A value of 5 means that the lube pump will be activated once every 5 degrees of bend arm motion during the bend cycle. If it is enabled, the mandrel lubricator will turn on every X number of degrees (X being whatever number is in the input field). It will stay on for X/2 degrees and then will be off for X/2 degrees.

Pressure Die Assist Delay is the time delay after the start of the bend when the pressure die assist is activated.

Torque is the command sent to the Y axis during bending to allow the carriage to follow the tube as it is being drawn into the arc of the bend.

Collet Depth is the distance the end of the tube is inserted into the collet.

C Homing Speed is the command sent to the bend arm to move it slowly to its home position when the home all command is issued.

Options buttons on the right side of the screen allow selection of the functions present on your particular machine.

> **Table Shift** is for machines that move the carriage to the side to provide clearance for feeding and rotation.
>
> **Pipe Clamp** is for machines with a separate clamp valve for activating the clamp mechanism
>
> **Collet clamp** is for machines that have a powered collet closing mechanism.
>
> **Wiper** is for machines with a retractable wiper die mechanism.
>
> **Pressure die** is for machines with a separate powered pressure die closing mechanism.
>
> **Single Collet Output** selects the type of control valve used to close the collet. When active this button selects a single signal for collet control. i.e. if the signal is on the collet is closed. If the signal is off the collet opens. When not active the control assumes the collet open signal is separate from the collet close signal
>
> **Pressure Die Assist** enables the powered follower. When disabled a spring or gravity return of the follower is assumed.
>
> **Reverse Torque** changes the direction of the Y axis command during the bending action.

The small buttons at the lower left of the screen are for troubleshooting. The history button opens a window that lists the sequence of steps the control has issued. The clear button erases the history file.

Bending Sequence

The Bending Sequence is where you will create or edit your programs. This is designed to be very user friendly and easy to understand. You can even bend pipe as you create your program to make sure that everything will work correctly. To begin, click on the **Bending Sequence** button.

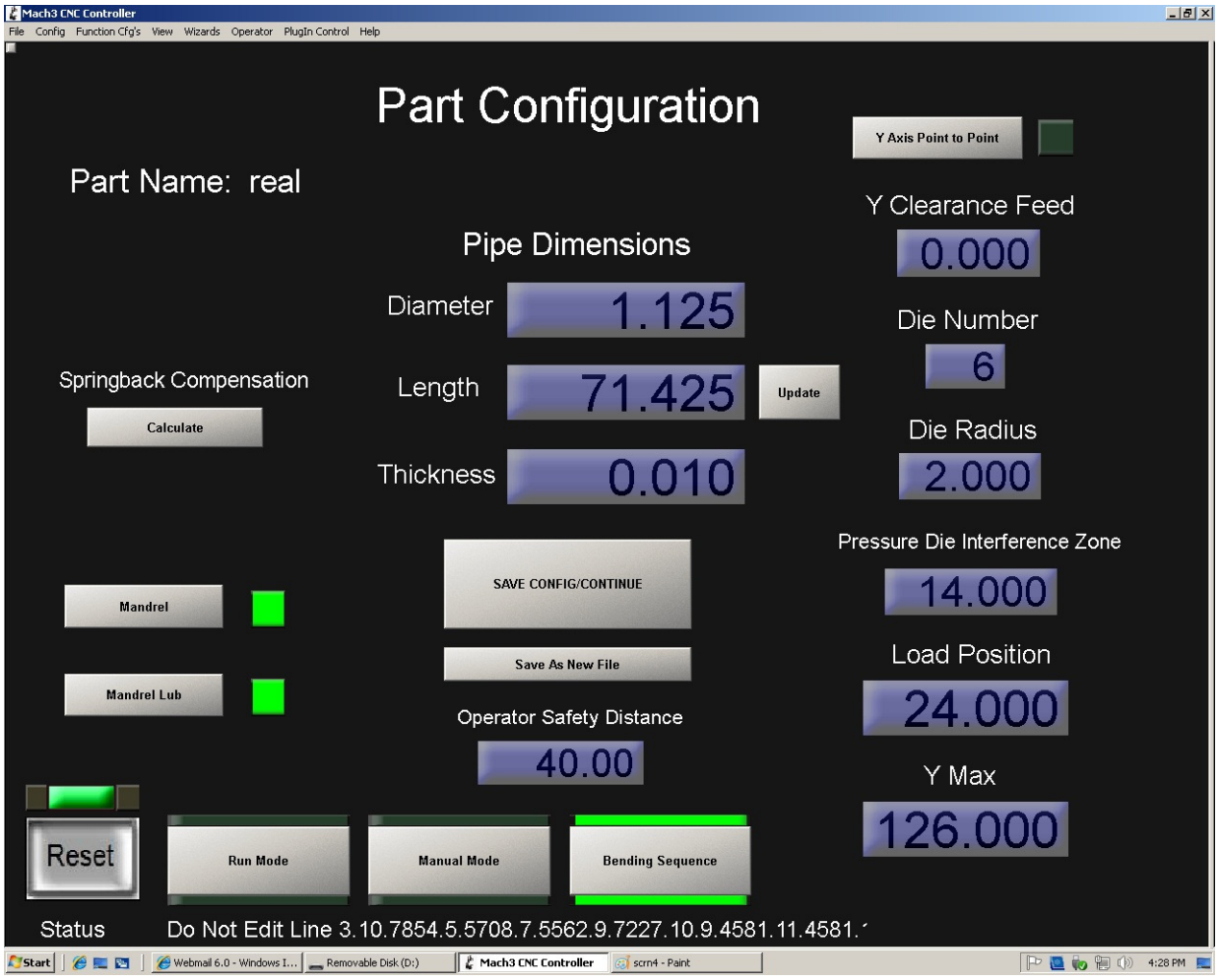

Figure 18 Bending Sequence

Part Configuration

The part configuration screen is where all the settings for the part program are entered. This will be saved in the code so that when you load your file months later all the settings will be loaded with it.

Pipe Dimensions

Under **Pipe Dimensions** you can enter the diameter, length, and thickness of your pipe (Figure 19). Only the pipe length is used in calculations in the machine. The other values are for your reference.

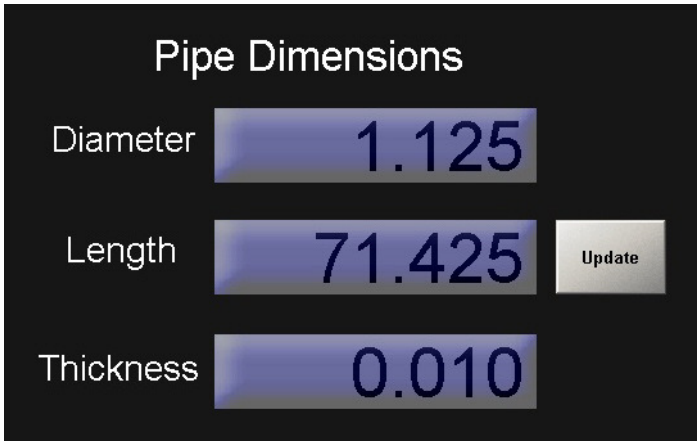

Figure 19 Pipe Dimensions

If you don't know the developed length required for the part, you may leave this value to be calculated after the part dimensions have been entered. At that time the Update button can be selected to enter the calculated tube length.

Enable Options

The enable options have the following buttons:

- Mandrel
- Mandrel Lube

Click the buttons to turn off and on the LEDs. If a LED is on, that corresponding function will be enabled for that program.

Create a new part file

To create a new part file, do the following:

1. Close the current program. Under Run Mode, close the program (See Close a Program on page 47).

2. Click the **Bending Sequence** button (Figure 5 on page 8).
   It will give an error saying that no file is loaded.

Figure 20 No File Loaded

3. Press **OK.**
   A window will appear with a place for you to enter in your program name.

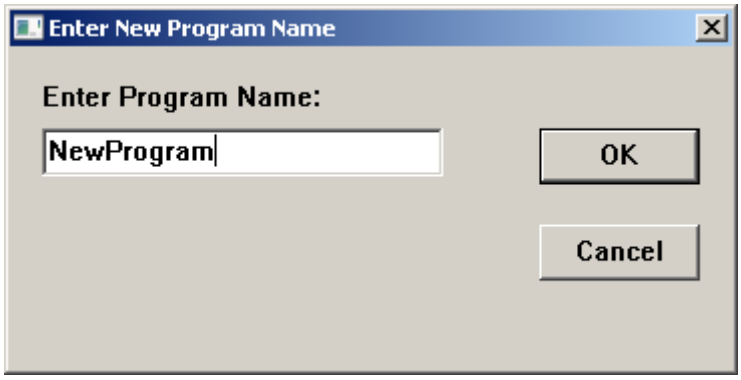

Figure 21 Enter New Program Name

4. Enter your new program name.
   As shown above, the program name is “NewProgram.”

5. Press **OK.**

6. A window will pop up giving you the location and name of the new file.

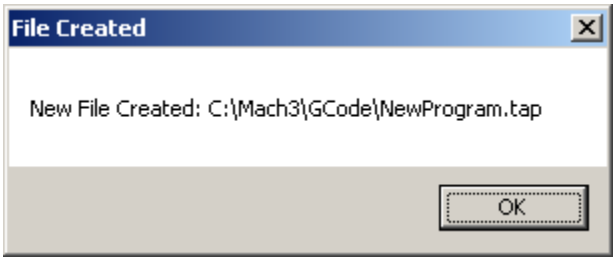

Figure 22 New File Created

If another program with the same name exists, it will ask you if you want to overwrite the existing file.

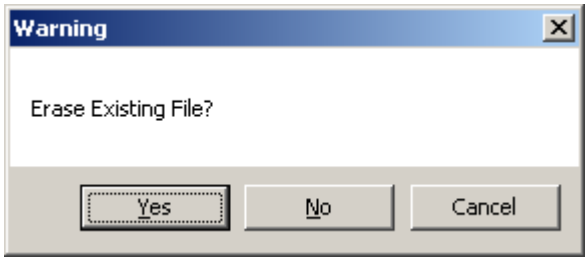

Figure 23 Erase Existing File

If you press **Yes** it will pop up with a new window showing where the new file was created (Figure 22 on page 23). If you press **No** or **Cancel** start at step two again and enter a different name.

7. Press **OK**.
   The part configuration screen will be loaded (Figure 18 on page 20).

Y Axis Point To Point

To turn on **Y Axis Point to Point data entry**, click on the button and the LED will toggle.

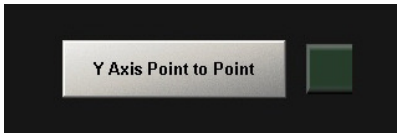

Figure 24 Y Axis Point to Point

Y axis Point to Point turns on vector intersection mode. In this mode, you enter in the distance from the vector to vector intersection point that defines each bend. See the diagram below. The length of each red arrow is the distance you would use for Y Axis Point to Point data entry. The

tube bender control calculates, based on the die radius, how far to move the Y axis forward so that the distance between bends will be correct.

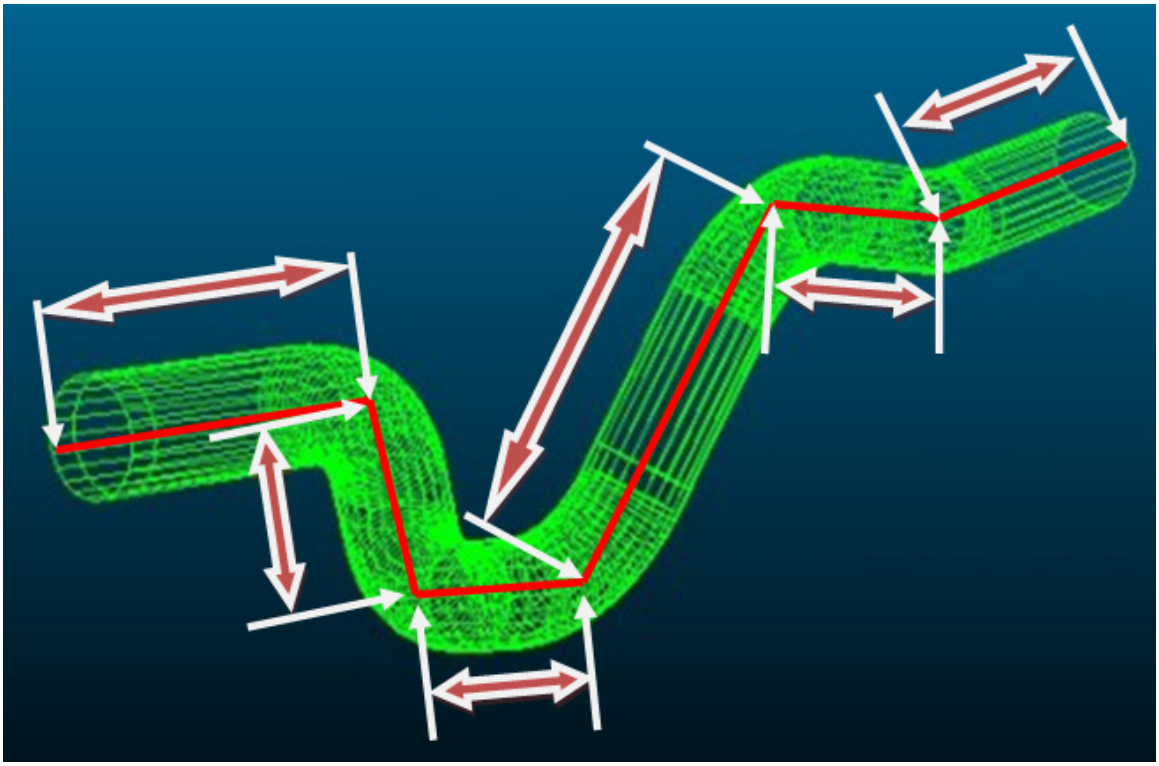

Figure 25 YBC Bending

Note: You can only bend less than 180 degrees in Y Axis Point to Point mode. When you save the bend it will give a divide by zero error if you try to bend more than 180 degrees.

If you do not use YBC bending, you have to enter in the distance between the tangent points of each bend. The distance of the red arrows in the diagram below would be used if YBC was disabled.

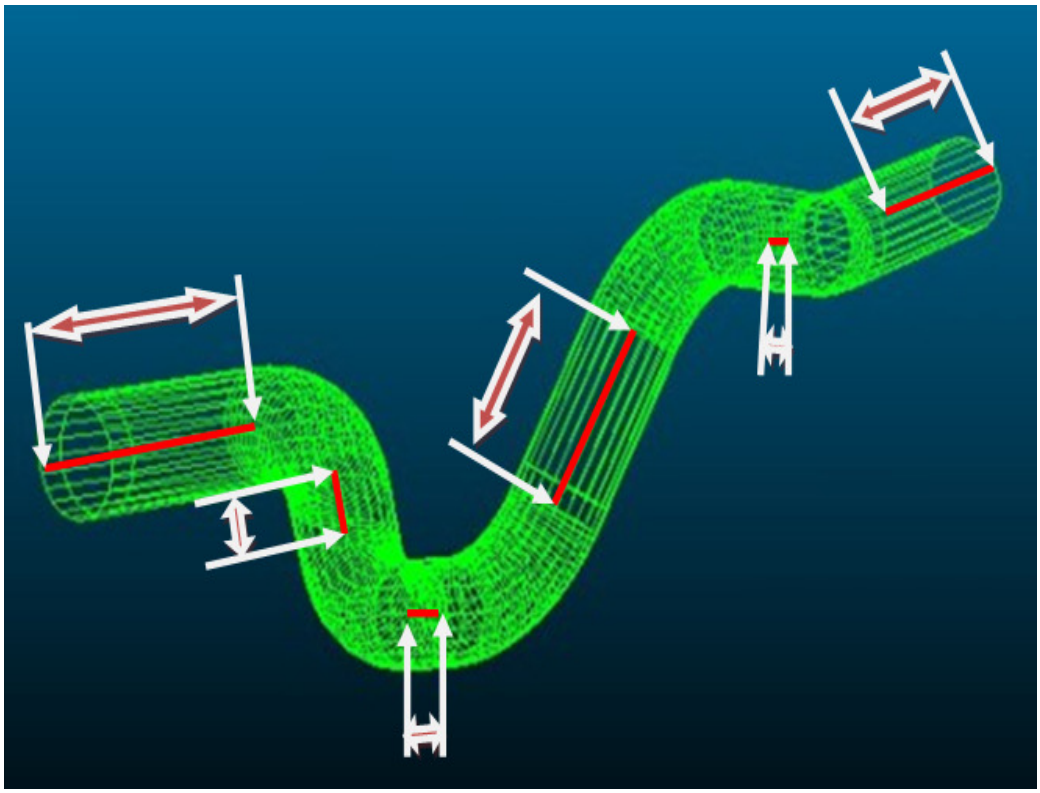

Figure 26 Distance Between Bends

Y Clearance Feed

The Y clearance feed is an automatic function used to keep the tube from getting caught in the machine during the C arm's return. The clearance is the distance that the carriage moves forward before returning the C axis. If returning the C axis would cause the pipe to jam, entering a number here causes the machine to *always* move that distance forward before returning the bending arm. The next move will be the Y axis move minus the clearance feed length.

For an example, let's assume that the Y clearance value is 5 inches. After the first bend, the carriage will move forward 5 inches and then return the C axis. If the next commanded length was 8 inches, the carriage would move forward 3 inches (length – Y clearance feed).

Note: Advanced Mode allows you to do the same thing as Y clearance feed but with more control (See Advanced Mode *on page 31).*

If the value for Y clearance feed is changed after creating bends in a part, each bend must be resaved in order to recalculate the Y axis move for that bend.

Part Specifics

These values are added for your convenience.

Die Number

You can also reference a die number.

Figure 27 Die Number

Operator Safety Distance

This is the distance that the operator should stand away from the machine to be safe. This is configured manually and is only for your reference.

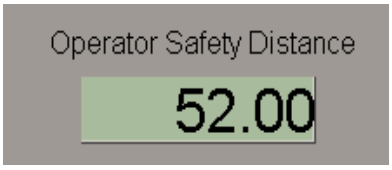

Figure 28 Operator Safety Distance

Load Position

Load position is the distance from the tangent of the bend die to the face of the collet. The collet can be any distance from tangent as long as the carriage is within the limits of the machine. When the **Load** button is pressed before running a program, the carriage moves to this position so the tube can be loaded.

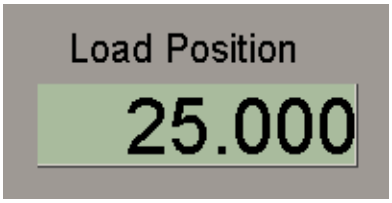

Figure 29 Load Position

Die Radius

The die radius is the radius of the main die on the bend arm. It must be correct for the pipe length calculation. If die radius is changed after creating bends in a part, all bends must be resaved in order to recalculate the tube length and Y axis moves.

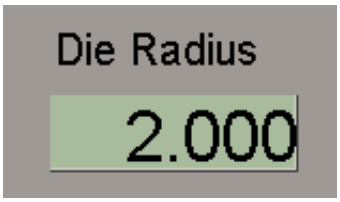

Figure 30 Die Radius

Pressure Die Interference Zone

Normally equal to the pressure die length, makes sure that the pressure die never closes without moving the carriage out of the way. The bending sequence is modified so that

the clamp closes to hold the part, the collet opens, and the carriage moves out of the interference zone before the pressure die closes.

Figure 31 Pressure Interference Zone

Springback Compensation

Springback compensation is used to calculate how much over bend a pipe needs so that when the clamp releases, the pipe springs back to the correct angle. This will have to be set up for each different kind of pipe. To calculate your springback compensation, use the following procedure:

1. Click **Calculate.**

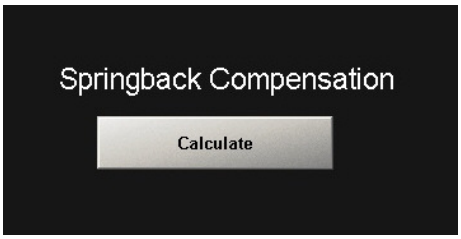

Figure 32 Springback Compensation

A new screen will be displayed.

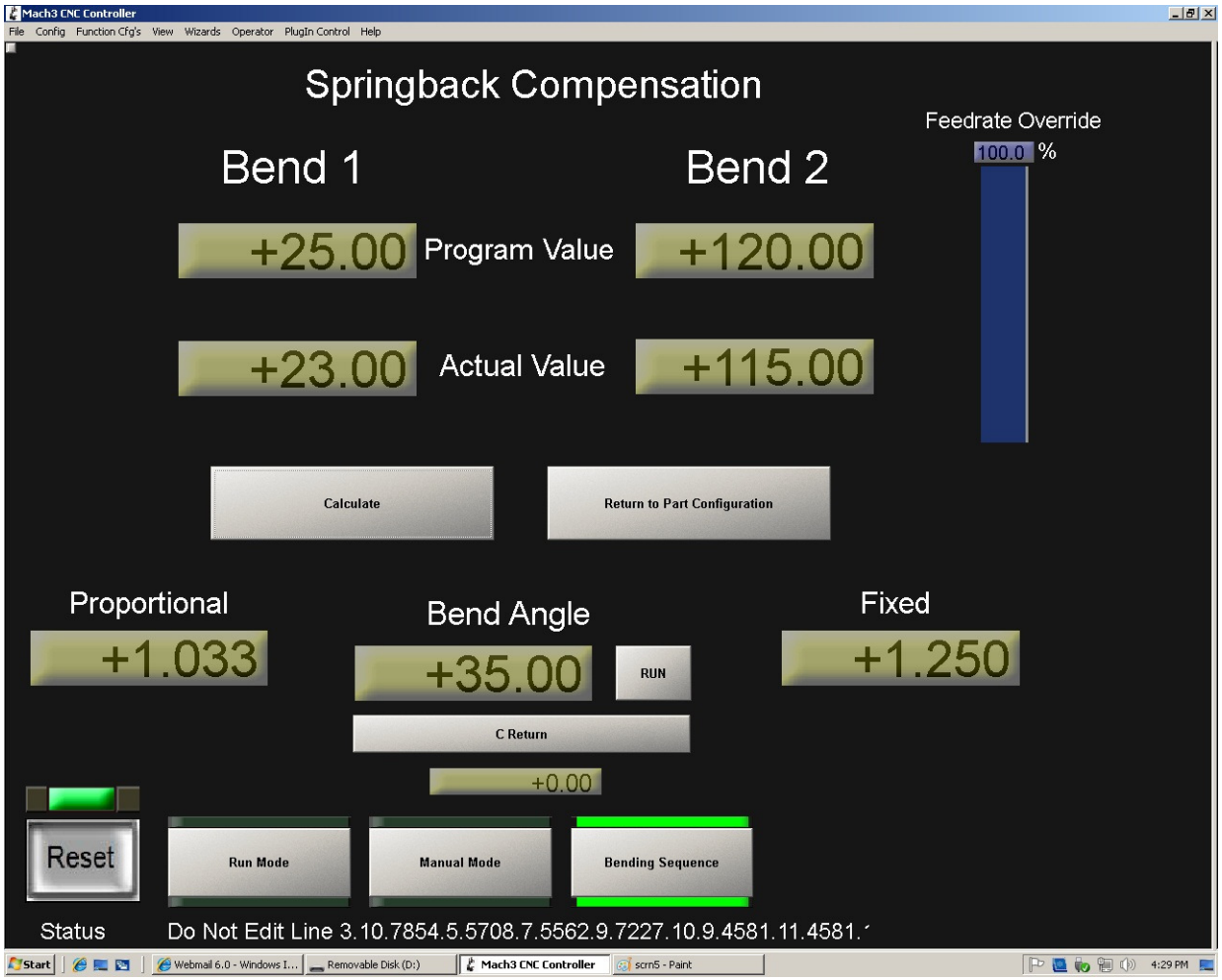

Figure 33 Springback Calculator

2. Enter in a small angle such as 20 degrees in bend angle.

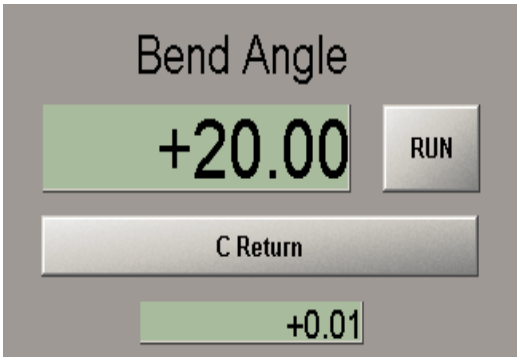

Figure 34 Bend Angle

3. Load a pipe into the bender.

4. Press **Run** (Figure 34). When the bend is completed, press **C Return**. The Y axis will move forward to clear the clamp insert and the bend arm will return to zero.

5. Enter the commanded angle (the value in bend angle field) into the first input field under Bend 1. This is the programmed value (Figure 33 on page 28).

6. Measure the actual angle of the tube. Enter this value under the second input field for Bend 1. This is the actual value (Figure 33 on page 28).

7. Repeat steps 2-6 for Bend 2 and use a larger value, such as 120 degrees for the bend angle.

8. Press the **Calculate** button.

   The proportional value is the difference in spring back constant depending on the size of the bend. The fixed value is always added to the bend.

Note: To disable spring back compensation, set proportional to 1 and fixed to 0.

Return to the settings page by clicking the **Return to Part Configuration** button.

Create Bending Sequence

After you have all the settings adjusted correctly in the part configuration, you are ready to begin actually programming the different bends. Click the **SAVE CONFIGURATION / CONTINUE button.**

Figure 35 Save Configuration

A new screen called **Create Bending Sequence** is displayed. At the top right of the screen it shows **Current Bend: Bend 1**. As you save your bends the current bend number will increment. There is no limit to the number of bends per program.

The input fields in the Bending Sequence mode are laid out in the same order that the program actually executes them. For instance, in Normal Mode the Y axis can move forward, then the C axis can return, then the B axis can rotate, and finally the C axis can do a bend. Any of these values can be zero and that function will not move.

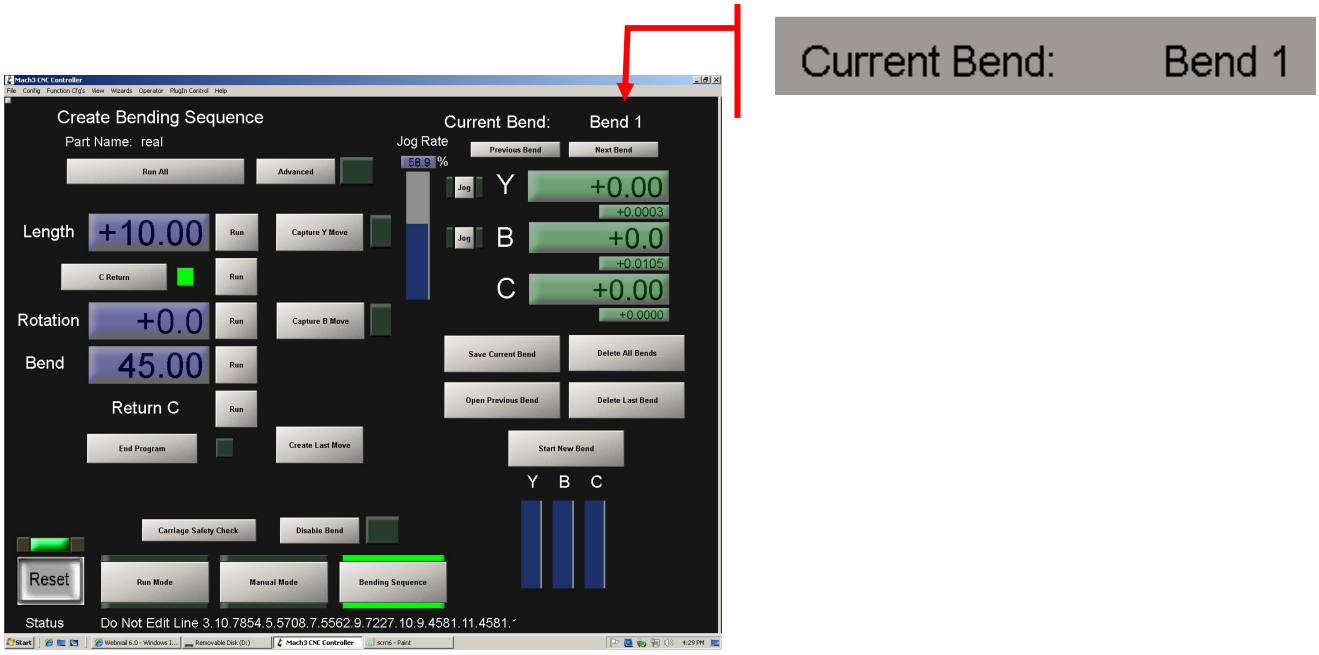

Figure 36 Current Bend

Normal Mode

Most of your programs will use Normal Mode. When the LED by the **Advanced** button is off, Normal Mode is on (Figure 37).

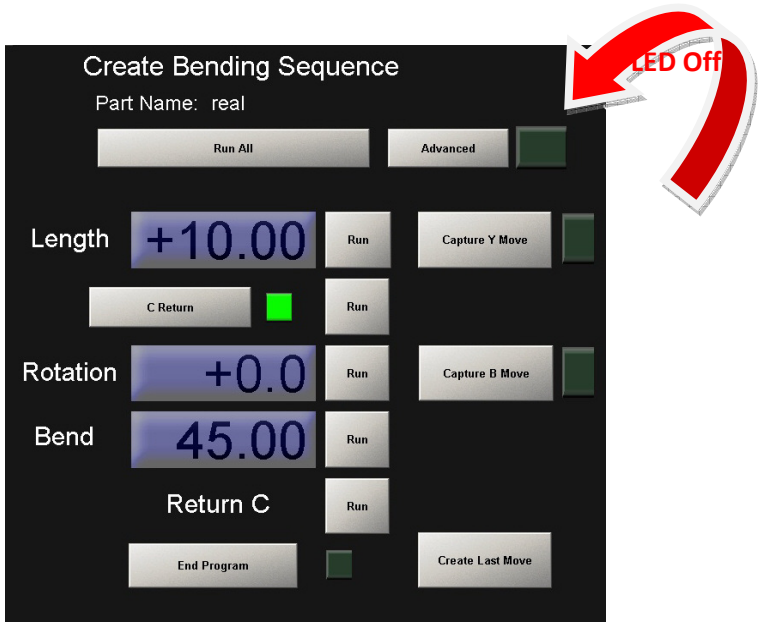

Figure 37 Normal Mode

Length

Length is the distance for the Y axis to move forward or backwards in inches or mm. Positive is forward and negative is backwards. It is the distance between the bends. If YBC bending is enabled, length becomes the distance of the vectors between each bend (Figure 37).

C Return

Click **C Return** to toggle the LED. If the LED is on, the tube bender will return the C axis immediately after doing the Y move. However, if it is not selected, the C axis will not return until after the B move or right before the C axis does another bend (Figure 37 on page 30).

Rotation

Rotation is the number of degrees for the B axis to rotate (Figure 37 on page 30). Viewing the B axis from the front of the tube bender, positive is counter-clockwise and negative is clockwise.

Bend

This is the angle that you want your pipe to be bent (Figure 37 on page 30).

Note: The label "C Return" underneath the bend input field is there only for test runs (See Test Bend on page 32). The C axis does not actually return in a real program right after doing a bend.

Speeds

You have complete control of each axis's speed. On the bottom right of the screen there are three feed rate sliders. See Figure 38 below. You may move the sliders to control the speed of each axis move. These values can be different for each bend.

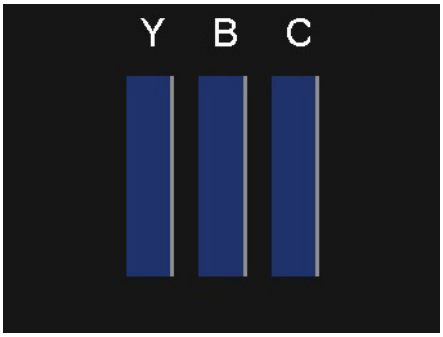

Figure 38 Speeds

Advanced Mode

Advanced mode gives you more control of the machine. When the LED next to the **Advanced** button is on, Advanced Mode is enabled. See the Figure 39 below.

Advanced Mode allows you to move the Y axis and rotate the B axis before returning the C axis. In the second length and rotation entry, you can continue the Y axis motion and the B axis motion to their final position for the next bend. The total move is the distance of both those lengths /rotations added together. This can be used for avoiding collisions from the tube and machine. The other input fields in Advanced Mode function the same as in Normal Mode.

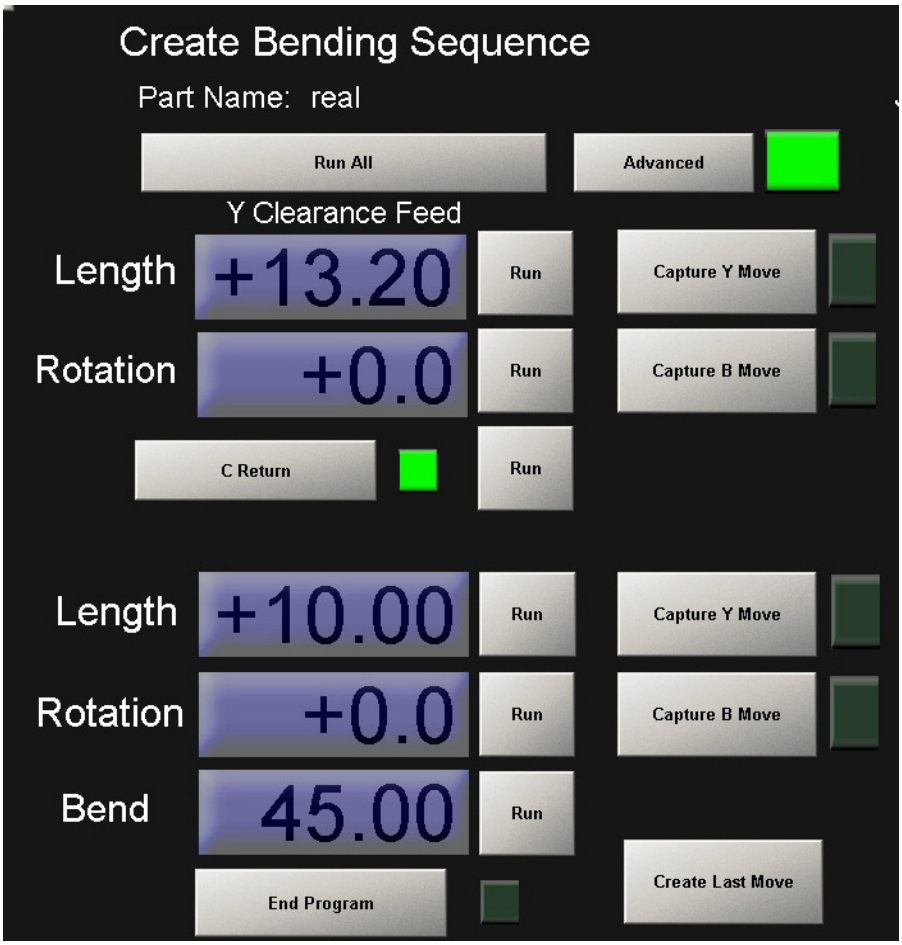

Figure 39 Advanced Mode

Test Bend

While creating a bend, you can actually bend pipe to make sure that everything is working properly. Also, you can make sure that you have enough pipe length. In both the normal and Advanced Modes next to each function there is a button called **Run**.

Figure 40 Run

To run the tube bender while creating a program, enter your value, such as length or rotation. Next press the **Run** button (Figure 40). The tube bender should move to the correct place or angle. You can continue doing this for each input field. However, if you would prefer to test the whole bend at once, rather than pressing each **Run** button separately, just click **Run All**.

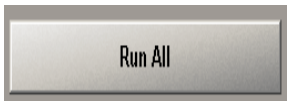

Figure 41 Run All

*Note: **Do not** use the **Run** buttons in Y Axis Point to Point Bending.*

****

DANGER:

Pressing the Run All button is equivalent to running a program. Stay clear of the machine as every function may operate.

****

Capture Move

Another special feature for programming a bend is called **Capture Move**. This button is used to capture or record a move. If you are figuring out the length to move forward before the C arm returns, such as in an advanced move, you could use this feature. Also, if you are just creating a bend for the first time, you can capture a move. To use it, do the following.

1. Click **Capture Y Move** or **Capture B Move**. The LED next to the button will turn on.

Figure 42 Capture Y Move

Jog the machine to the correct place. You can use the **Run** button or to manually jog each Axis, click on the Jog button to the right of the Feed rate slider. Then, while holding the enable button (green pushbutton switch to the left side of the control console), press + or – push buttons (black pushbuttons on the operator's panel). The axis will move as long as you hold the buttons. Adjust the Jog Rate slider to control the speed.

2. Click **Capture Y Move** or **Capture B Move** button again. The LED next to the button will turn off and the distance that you moved will be loaded into the input field next to the button.

The **Capture Move** buttons record the initial position of the desired axis and then the final position and writes the difference of the two into the corresponding input field.

Save Bend

When you have entered all the correct values for your first bend, you must save that bend. However, make sure that the LED next to the **End Program** button is off (Figure 47 on page 35). Otherwise only the first bend in your program will be run. Now press **Save Current Bend**.

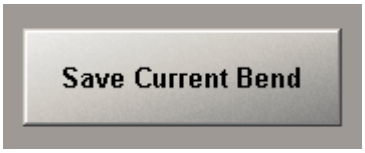

Figure 43 Save Current Bend

A window will appear asking you if you want to post the code to the file.

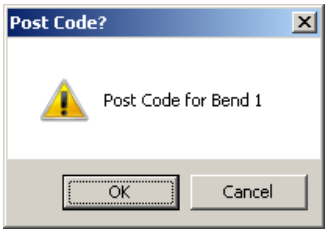

Figure 44 Post Code

Click **OK**. The current bend will increment to the next bend (Figure 36 on page 30).

Carriage Safety Check

After you save a bend you can check to see if the carriage will be in the pressure die interference zone by pressing the **Carriage Safety Check** button (Figure 37)**.** If a window appears stating that the check passed then the carriage will still be behind the pressure die. Press **OK** to proceed.

Figure 45 Check Passed

Otherwise the carriage is in the pressure die interference (PDI) zone. If the tube bender did a C bend the carriage would have to move back so that the pressure die could close. The message gives both the bend number and the distance that the carriage will have to move back. If more than one bend will enter the PDI zone then the carriage will lose the pipe on the first bend.

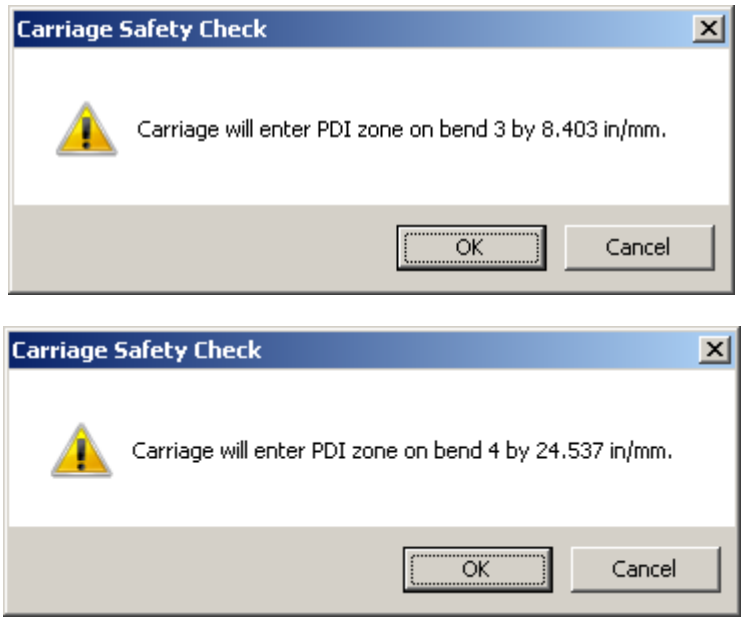

Figure 46 Check In PDI Zone

For example, the program in Figure 46 will enter the PDI zone by 8.403 in/mm on bend 3. To execute the C bend on bend 3, the carriage will move back to the load position. Then on the 4th bend the carriage will move forward from the load position and will not move the pipe at all.

Continue to enter data for the next bend by clicking on the **Start New Bend** button. The current bend number will increment and you can enter the Y, B and C values for the next bend choosing either the normal or advanced modes.

Last Bend

At the end of your program or at your last bend, always press the button **End Program** to toggle the LED on.

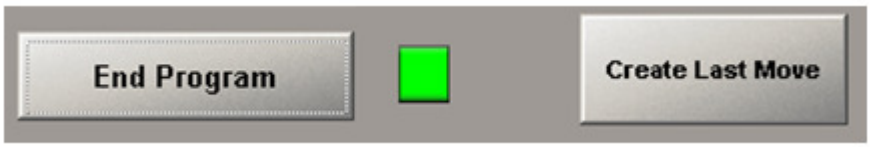

Figure 47 Last Bend

Set up the final bend by doing the following:

1. With the end program LED on, click **Create Last Move** (Figure 47).
   The following screen will be displayed:

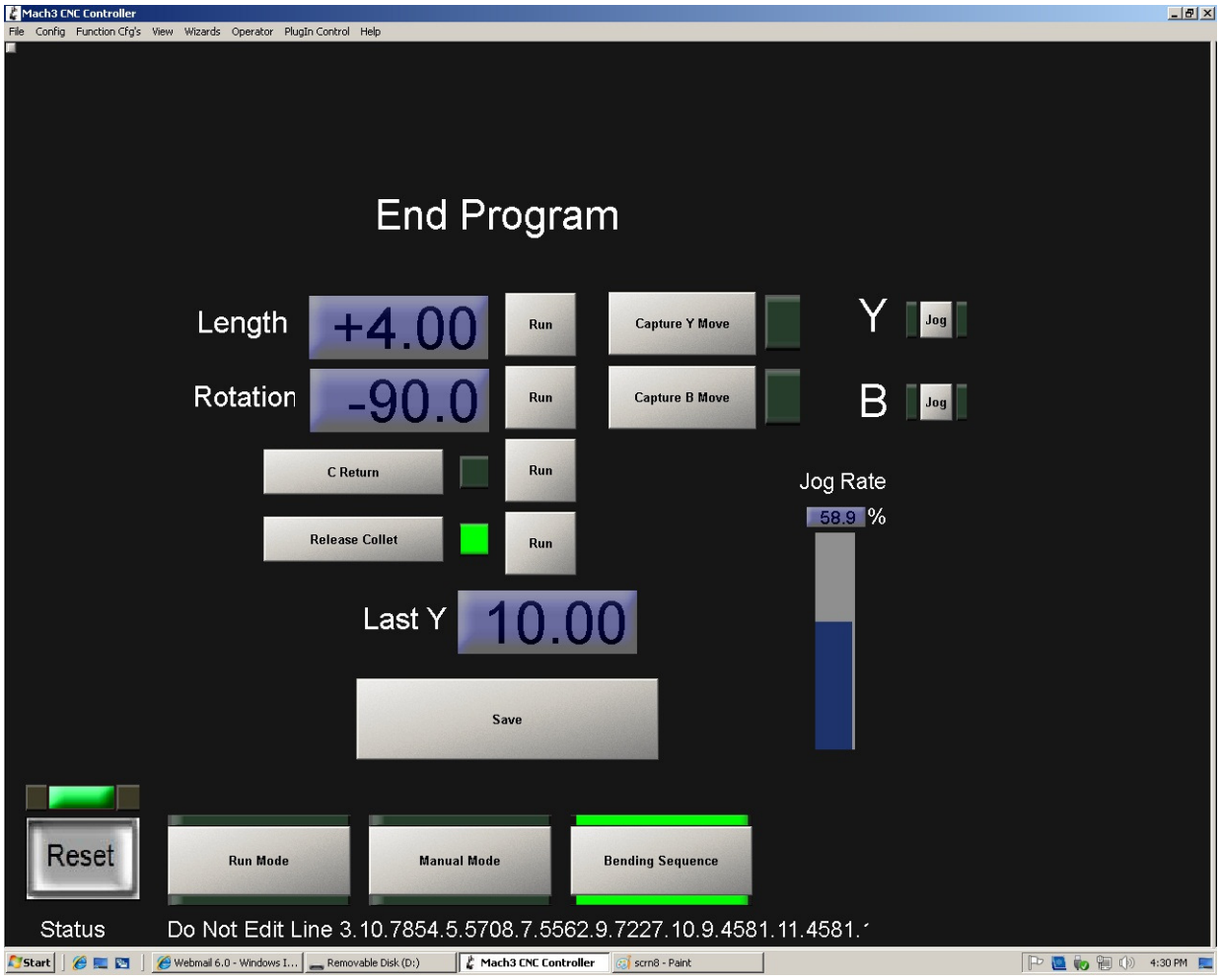

Figure 48 End Program

2. Enter in the length you want the axis to move forward or backwards after the last bend.

3. Enter in the number of the degrees you want the part to rotate after the last bend. (These values will allow moving the part to a more convenient position for unloading.)

4. Press the **C Return** button to toggle the LED on if you want the C axis to return.

5. Press the **Release Collet** button to toggle the LED on if you want to collet to release when the program is done.
6. Enter the last Y length from the end of the last bend to the end of the part. This value is used to calculate the required tube length.
7. Press **Save.**
   You will now be back in the Bending Sequence page.

WARNING: Your last bend is not saved yet. Click save current bend to finish your program.

All the programs are automatically stored in C:\Mach3\GCode. You can manually copy the files to where ever you want for backup or file organization purposes. The file type is “.tap”.

Delete a Bend

At times when creating a program, you will need to delete a bend. You have two options.

Delete Last Bend

To delete the last bend, click on the button **Delete Last Bend**.

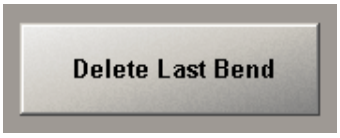

Figure 49 Delete Last Bend

A small window will pop up asking you if you are sure that you want to delete that bend.

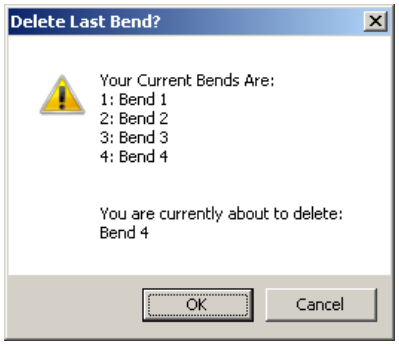

Figure 50 Delete Last Bend

Click **OK**. A window will pop up notifying you that the last bend was deleted. Again, click **OK.**

Figure 51 Bend Deleted

Delete All Bends

If you want to start your program over, click **Delete All Bends**.

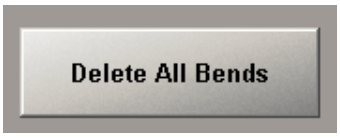

Figure 52 Delete All Bends

A window will pop up saying that the delete was successful. The program will revert back to bend one.

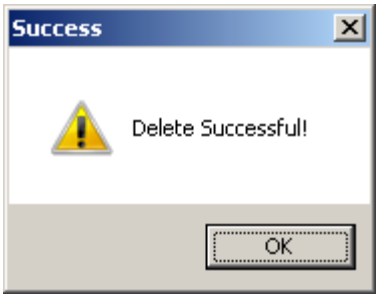

Figure 53 Delete Successful

Disable a Bend

If you decide to you do not want to use a bend in the middle of a program, you can disable it by clicking the **Disable Bend** button. The button toggles an LED and when the LED is on the bend is disabled. Make sure to click **Save Current Bend** or the changes will not be implemented.

Figure 54 Disable Bend

Note: If you create a program and it does not do anything when you run it, make sure that the disable bend LED is not on.

Change a Program

To change a program that is already loaded, simply click the Bending Sequence button (Figure 5 on page 8). You can make any changes you want in the part configuration. You must press Save Configuration before leaving that screen for the changes to be saved.

After you press **SAVE CONFIGURATION**, Bending Sequence will come up. The current program displayed will be one plus the number of bends. This last bend is NOT saved and is not part of your program.

Change Previous Bend

To change a previous bend click on **Open Previous Bend**.

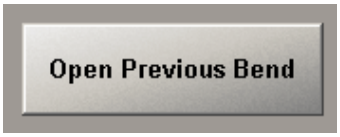

Figure 55 Open Previous Bend

A window will pop asking you to choose a bend. Select your bend. Click **OK**.

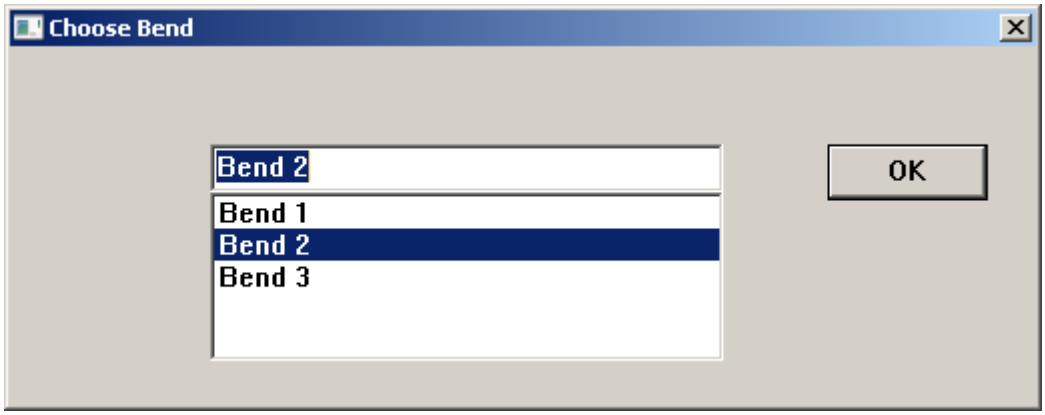

Figure 56 Choose Bend

The screen is loaded with the values from that bend. Make your changes. Click **Save Current Bend** and then at the prompt press **OK**.

When you are finished with your program, you can open Run Mode and your program will load automatically. Your program should stay loaded until you close it or shut down the control.

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Run Mode

In Run Mode you can execute your programs and bend tubing. This is where you will spend most of your time. Almost everything is automatic in this mode. You can also test your programs by running only segment of them at a time.

In this section you are going to learn how to open a program, step through a program, start and stop a program, and much more. To begin, click on the **Run Mode** button (Figure 2 on page 7). You will see the following screen:

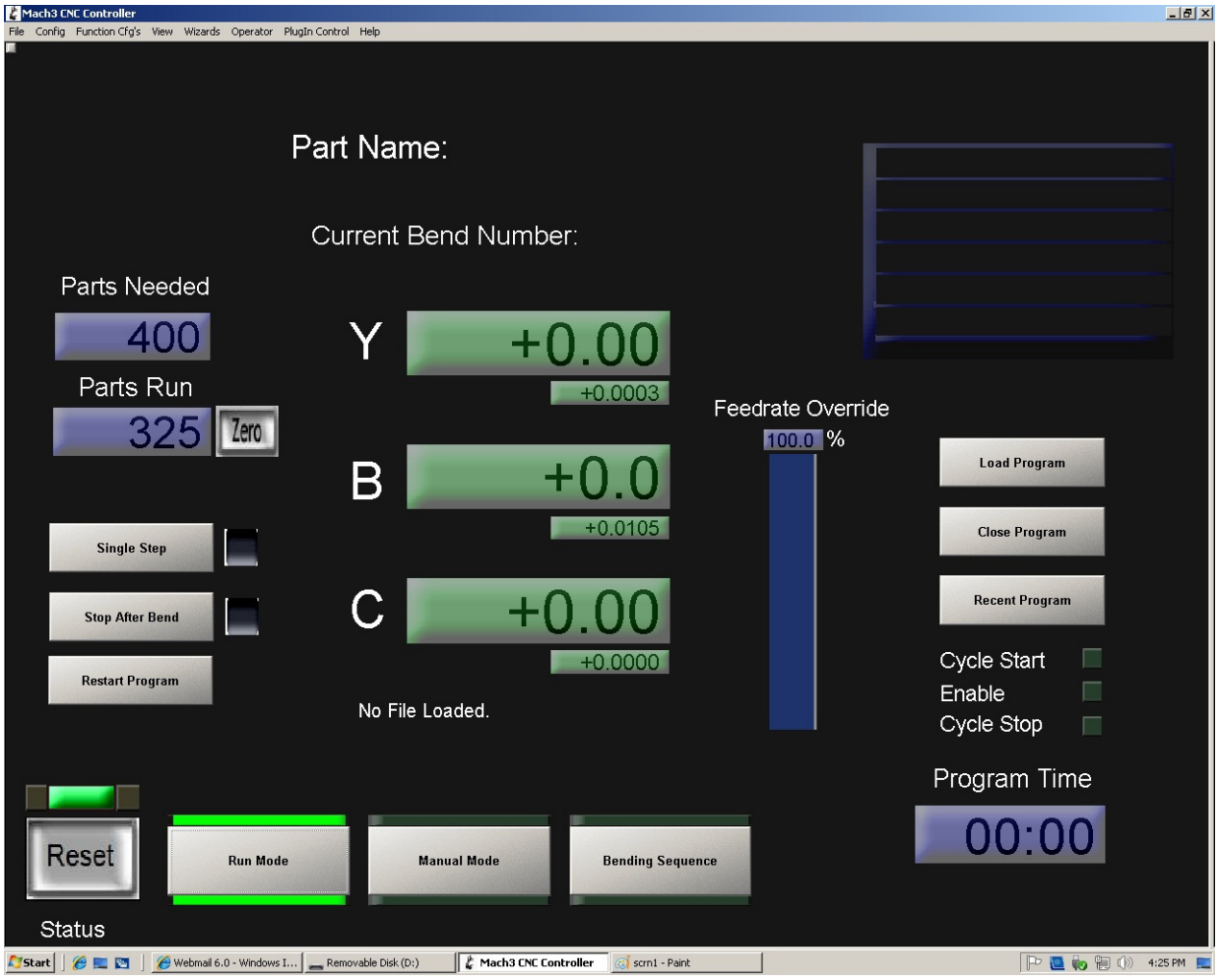

Figure 57 Run Mode

Open a Program

Old Program

To open an old program press **Load Program**.

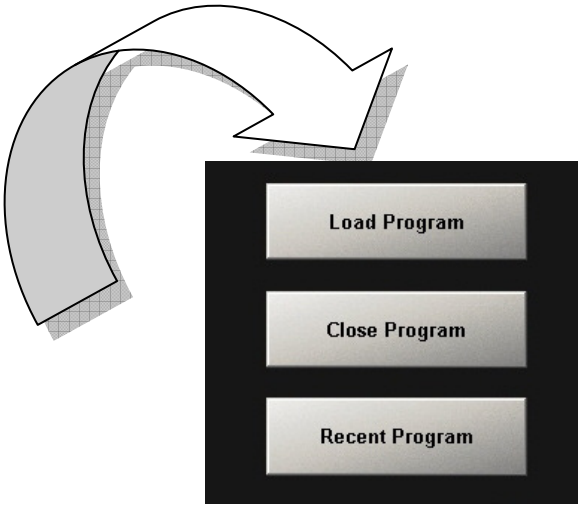

Figure 58 Load Program

An open dialog will open (Figure 59). To open a specific file, navigate to its folder. All programs are automatically stored in C:\Mach3\GCode. Change the type of file to (*.tap). Now you should see all your bend programs. See Figure 59 below.

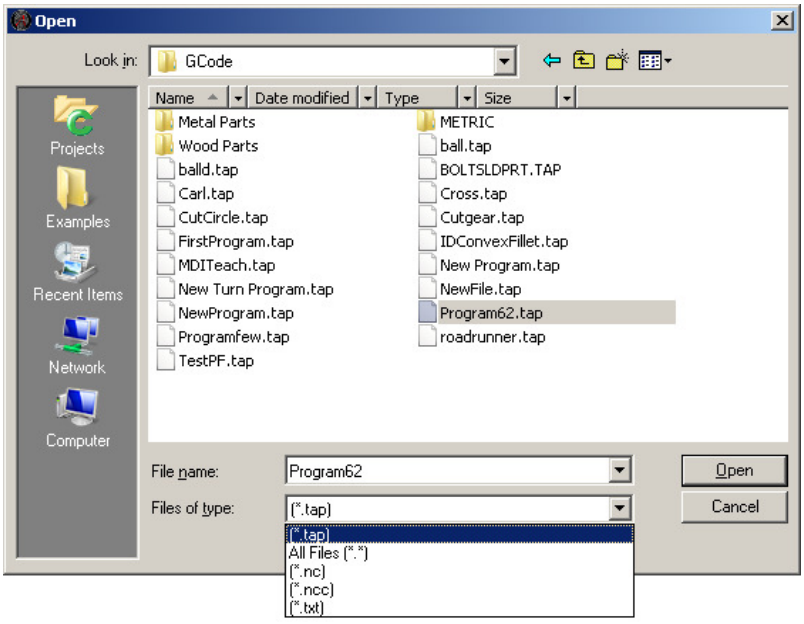

Figure 59 Open a File

Click on the correct program and press **Open**. Wait a moment as the program loads.

Recent Program

To open a recent file, click on the **Recent Program** button.

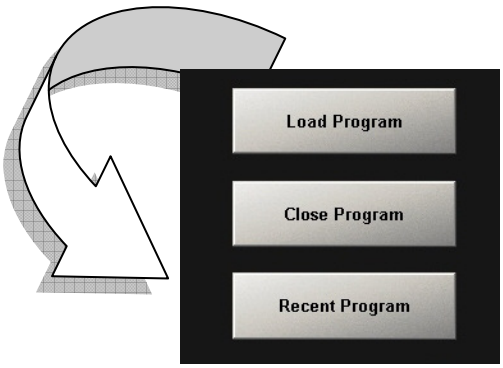

Figure 60 Recent Program

It will open a window with a list of up to ten of the most recent files. Select a program to load and press **OK**. Wait a moment as the program loads.

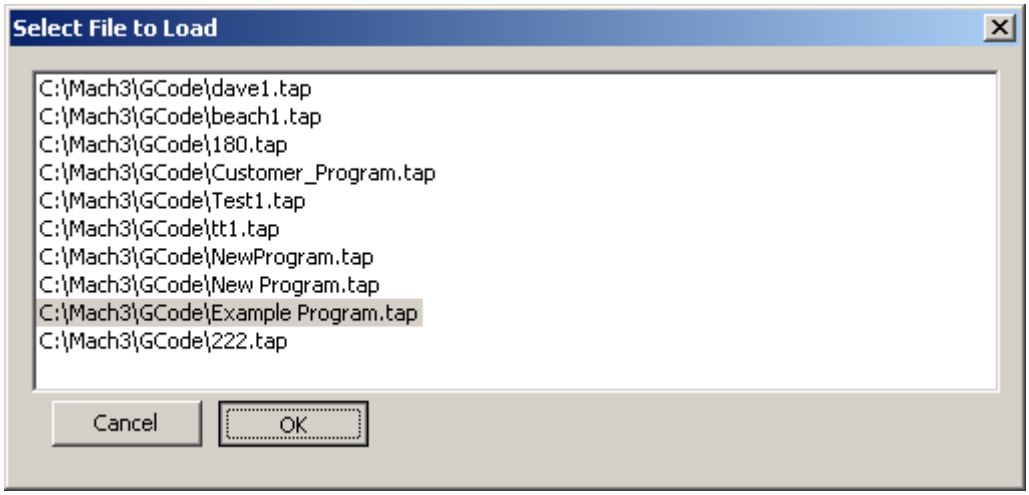

Figure 61 Select File to Load

Run a Program

Now with your program loaded, how do you start it? After starting a program you may need to pause or restart it. Also, if this is the first time this file has been run you might want the program to stop after every bend or after every line of code. If there is an emergency condition, you need to know how to stop the machine. In this section you will learn how to do each of these things.

Start a Program

To start a program, follow this procedure:

1. Press the **Load** button on the operator's panel (Figure 3 on page 8). The control will open the clamp and pressure die, move the carriage to load position and if not already home, will return the bend arm.

****

DANGER:

Stay clear of the machine. The C axis, pipe clamp, and pressure die will return and the carriage may move.

****

2. Place a pipe in the machine.

3. Press the **Collet** button on the side panel (right below the **Load** button). The collet will close.

4. Press the **Enable** button located on the left of the control console and at the same time press the **Cycle Start** button on the operator's panel. The file will begin to run.

****

DANGER:

Before pressing Cycle Start, move far away from the machine. Stay clear as long as the machine is running. Every function of the machine may operate.

****

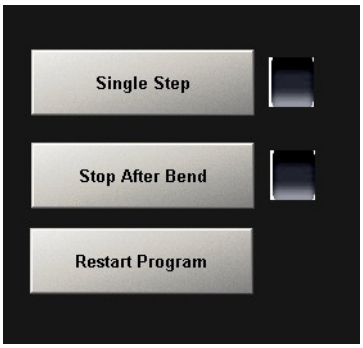

Figure 62 Control Buttons

Pause a Program

If for some reason you want to pause the machine, you can press the red **Feed Hold** button underneath the **Cycle Start** button on the operator's panel (Figure 3 on page 8). This allows the machine to slowly come to stop. If there is not an emergency condition, use the pause buttons. All hydraulic motion will stop, but the B and Y axes will complete their current moves. Pressing **Cycle Start** will continue the program from right where it left off.

If you decide *not* to start the program again, make sure to press **Reset**. If you try to operate the machine without pressing reset, the pressure will turn on but nothing else will happen. It is worth repeating. **ALWAYS** press reset if you paused the program and then decided not to continue running the machine from where you left off.

Stop a Program

To stop the program, click the **Reset** button on the screen. All motion including the hydraulics will stop on the machine. Any script or macro will be terminated. However, you cannot begin at the same place in the program. The program must be restarted before production can continue. DO NOT use the reset button for an emergency condition.

Restart a Program

To restart the program press the **Restart** button (Figure 63). The program will return to the very start.

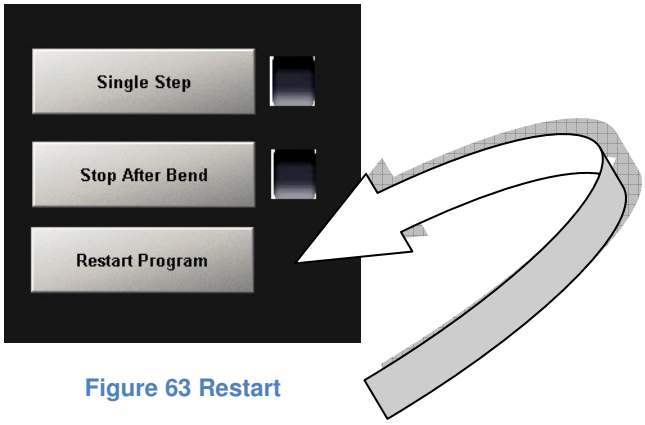

Figure 63 Restart

*Note: Pressing the **Load** button also restarts the program.*

Step through a Program

If you are running a file for the first time you may want to step through the program one line at a time. Press the **Single Step** button and the blue LED right next to it will begin to flash (Figure 64). Now every time you press cycle start, the control will only run one line of code.

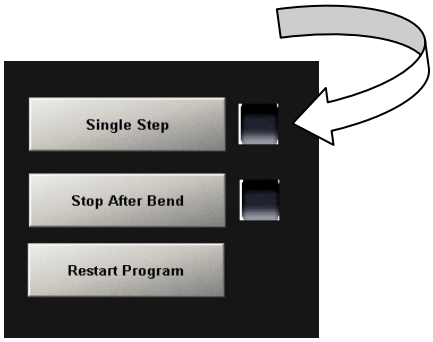

Figure 64 Single Step

Program Display

As a program is executed, you can view it on the top right hand corner of the screen (Figure 65).

Figure 65 Program Display

At the beginning of the program, information about your file is displayed. It shows you the part number, the pipe dimensions, the die information, functions that are turned on, the spring back values, and the operator's safety distance. Farther down in the program it has the information for the different bends. Notice that the first two lines of each bend contain a series of numbers. These values store information for the bend.

Run One Bend at a Time

When you are running a program for the first time, you may want to run more than one line at a time, but still you do not want to run the whole program at once. To run only one bend at a time, click on **Stop After Bend** (Figure 66). When the LED is on, only one bend will be run for every time cycle start is pressed.

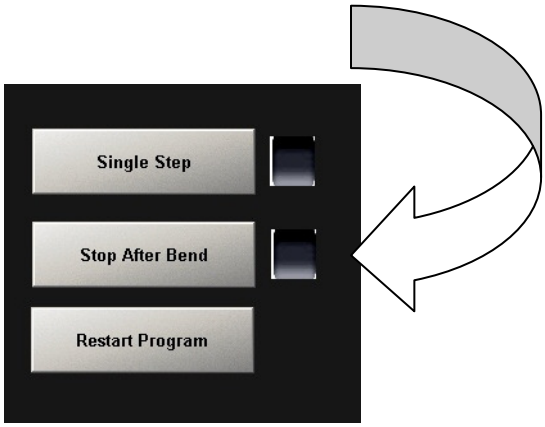

Figure 66 Stop After Bend

Emergency Stop

In case of an emergency, press the large red **EStop** button on the operator's panel (Figure 3 on page 8). DO NOT PRESS FEED HOLD OR CYCLE STOP! The EStop button shuts down power to everything but the control. All motion will stop immediately.

Note: Re-home the tube bender after an emergency condition.

Close a Program

To close a program click **Close Program.** See Figure 67 below.

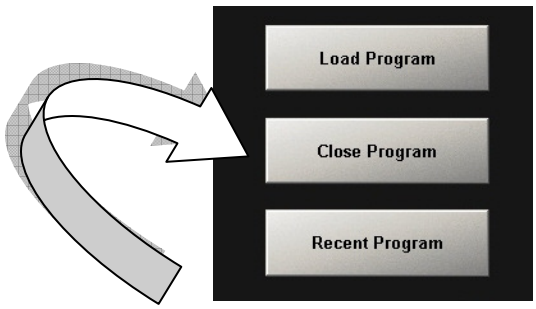

Figure 67 Close Program

Run Functions

Other functions available in Run Mode are detailed below.

Cycle Start, Enable and **Cycle Stop** LED's provide a visual feedback for the switches on the operator's console.

Program Time shows how long it has been since the last time cycle start was pressed (Figure 68 on page 48). This can give you an estimate of how long it will take to do a certain number of parts.

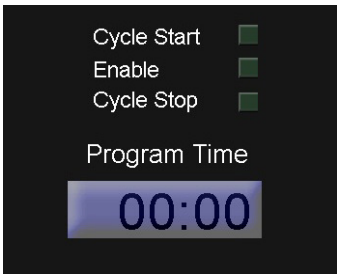

Figure 68 Program Time

Feedrate Override Is used to control the overall speed of the axis motions. Y, B and C axes are all controlled by the Feedrate Override slider.

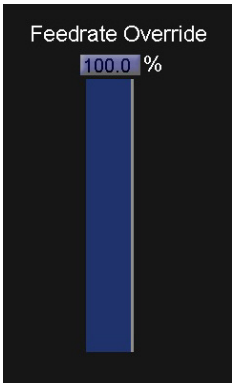

Figure 69 Feedrate Override

Parts Needed and **Parts Run** are fields used to keep track of how many parts are needed for a production run and how many have been produced.

Shutting Down the Control

To power down your control, follow the steps outlined below.

1. Shut down the tube bender control software by clicking the exit button at the top right of the control. A window will pop up asking you if you are sure you want to end the session.

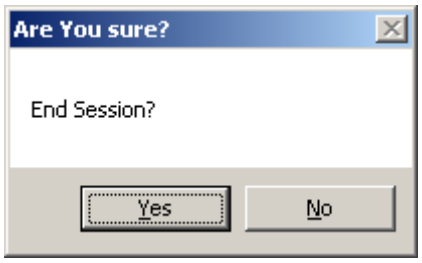

Figure 70 End Session

2. Click **Yes**. If another window pops up and asks you if you want to save the fixture, click **Yes**.

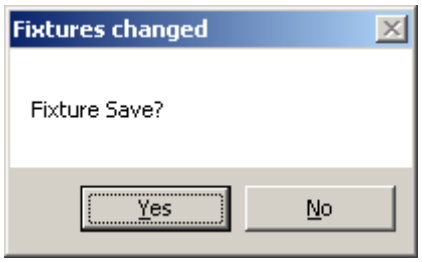

Figure 71 Fixture Save

3. Then click on the **Start** menu and then press **Shut Down**.
   The Mach Motion Tube Bender Control will turn off.

Note: Do not remove the power of the machine until the tube bender control is completely off.

Unit Conversion

You find out what units your machine is operating in by going to Manual Mode, then settings page. The current units will have a LED underneath the label. To convert the machine to inches from millimeters or from millimeters to inches, do the following:

1. On the menu bar click **Config**, then **Select Native Units.**
   A warning will come up.

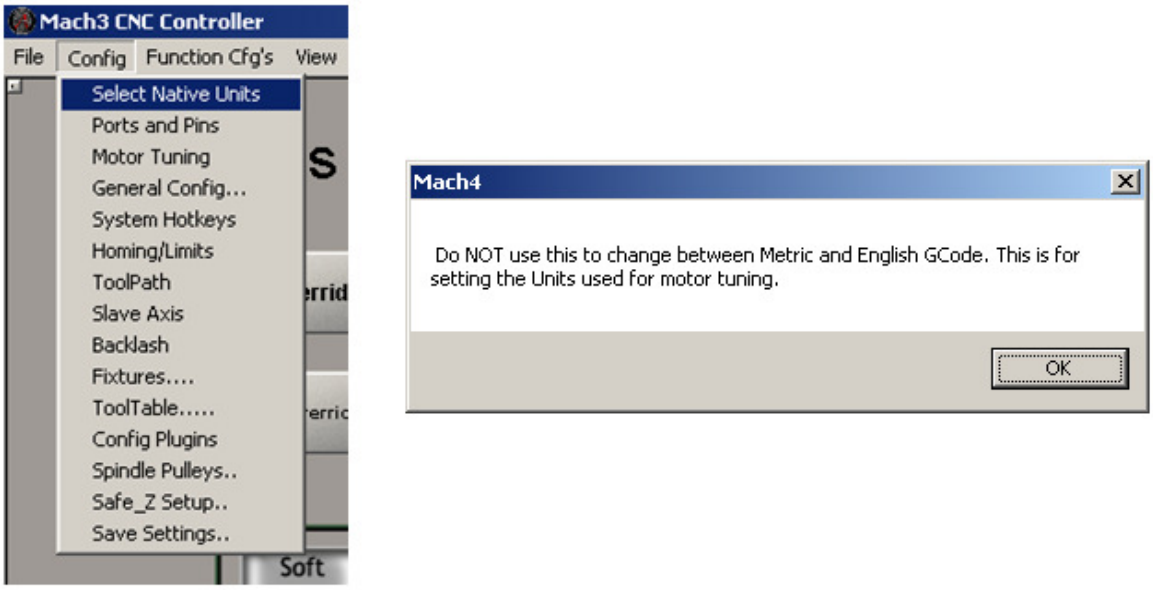

Figure 72 Select Native Units

2. Click **OK**.
   A window with the default units set up will pop up.

3. Change the units and press **OK**.

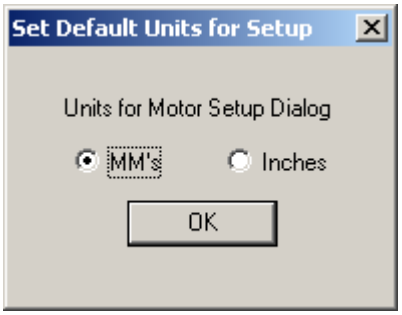

Figure 73 Default Units

4. Shut down the tube bender control software by clicking the exit button at the top right of the control. A window will pop up asking you if you are sure you want to end the session.

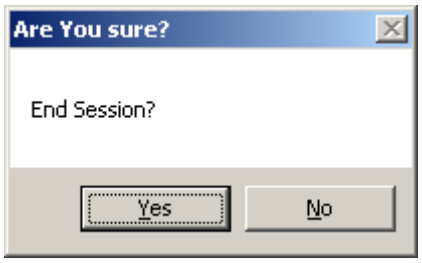

Figure 74 End Session

5. Click **Yes**. If another window pops up and asks you if you want to save the fixture, click **Yes**.

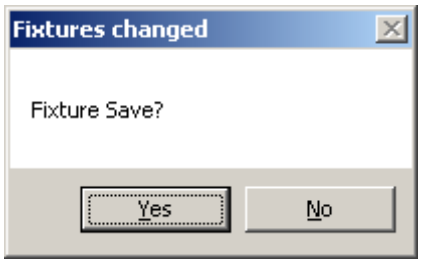

Figure 75 Fixture Save

6. Restart the tube bender control by double clicking on the icon on the desktop.

7. Click **Home Machine** (Figure 2 on page 7).

8. Click on the **Manual Mode** button and then click **Settings**. The LED next to the label of your desired unites should be on.

Figure 76 Convert Units

9. Click the **Convert Units** button ONLY ONCE (Figure 76)! More than once could mess up your machine. You will see a bunch of the values on the settings page change.

Your tube bender is now in the desired units.