DIWIRE Bender Workflow
Computation + Construction Lab | Iowa State University
DIWIRE Bender
Hardware

After using these tools please make sure to return them to the grey container labeled DIWIRE CNC Wire Bender.

DIWIRE

POWER CORD
AC Wall Adaptor - 24 Volts / 2.5 Amps

USB CORD
The USB allows the DIWire to communicate with your computer.

BEND HEAD + FEED WHEELS
The DIWire is assembled with 1/8” Bend Head and Feed Wheels. 1/16” versions are provided in the little black pouch. Keep these somewhere safe!

T15 TORX SCREWDRIVER
+ 5/32 HEX SCREWDRIVER
Used to change out Bend Head and Feed Wheels and Tension Adjust.

WIRE
We’ve given you a sample of some of our favorite wire to use with the Tutorials. Visit www.PensaLabs.com to buy more.
DIWIRE Overview

BEND PINS
Bends wire against the Bend Head.

BEND HEAD
Holds wire in place as it is bent. Interchangeable to accommodate a range of material diameters.

RESET BUTTON
The button to reset the DIWire.

FEED WHEELS
Pushes material forward and reverse.

WIRE GUIDES
Guides to feed material through.

POWER SWITCH
The on/off switch for the DIWire.

USB-B PORT
The external serial bus interface for connecting the DIWire to a computer.

POWER JACK
A DC connector that is the electrical connector for supplying direct current power.
Plugging in the DIWIRE
Loading Wire

Important!
Loading wire past the start point will cause the Bend Pins to hit the wire during the homing sequence.

START POINT
The indent on the Bend Head is the start point for the wire. The indent allows for wire to be marked with a Sharpie.
Design Setup

- Rhino
- AutoCAD
- A range of software can be used to setup an vector based files, .DXF or .SVG

USB A to USB B Cable

Hook the DIWIRE to a computer using a USB A to USB B cable.

Pensa Labs’ Wireware

- This software can be found on the CCL #1 desktop located next to the DIWIRE Bender.
Switching Bend Head + Feed Wheels

Similar to a drill needing different drill bits for different types of screws, the DiWire Bend Head and Feed Wheels must be changed to accommodate different wire dimensions.

The Bend Head and Feed Wheels need to be changed to ensure the wire remains centered while bending. As the wire diameter gets larger, the groove in the Bend Head gets larger and the Feed Wheels get smaller.
Adjusting Tension

If the Feed Wheels are slipping, meaning they are not effectively pulling wire through, the Tension Adjust needs to be modified.

Going against convention, turn left to tighten and turn right to loosen. You will notice a variation in how tightly the bearings pull towards the Feed Wheels. This is something you will get a feel for over time.
Material Profiles

All wires have a little spring to them - bend them a little and they spring right back (known as “spring-back”). Wires of different materials and/or diameters have different spring-back characteristics. Since each wire has a unique spring-back, the DIWIRE needs to know how much to over-bend a given wire material in order to compensate for its spring-back.

Because of this, each wire will need its own calibrated Material Profile saved.
For new wire materials you will need to create and calibrate a new material profile.

EDIT > Material Profiles

Choose a Material Profile to edit or create a new one

MATERIAL PROFILES LIST
Select an existing material to edit, duplicate or delete.

Select “Create” while “Create a New Profile” is selected to make a new material.
Creating New Profiles

After selecting CREATE to initiate creating a new Material Profile there will be multiple options to select for this material before starting calibration.

**PROFILE NAME**
Type in the name of the new material.

**MATERIAL**
Describe the material and size.

**ACCURACY**
Choose the level of accuracy for the calibration process. High Accuracy is the most thorough, but also takes the longest amount of time and uses the most wire. Quick Accuracy uses the fewest amount of spring-back points but that may be enough for certain projects.

**BEND HEAD & FEED WHEELS**
Choose the Bend Head & Feed Wheels that will be used with the material being calibrated. 1/8” and 1/16” are included with the DiWire.

**START CALIBRATION**
Once the upper section is filled out, press this to begin the calibration process for a new material.
Once START CALIBRATION is pressed, a table will appear in the main window. The column titled “Attempted” will populate. These are the angles to which the DIWIRE will attempt to bend the wire.

Load wire through the feed wheels and bend head so that the end of the wire is flush with the end of the Bend Head. Do NOT extend past the Bend Head. Press BEGIN.
Creating New Profiles (Continued)

Now that you’ve hit BEGIN, you will need to calibrate the A (Clockwise) and B (Counter-Clockwise) Bend Pins:

Clockwise (A Bend Pin)
The first angle to set is “0”. Use the keyboard right arrow key to move the A Bend Pin to just touch the wire on the Left side and press OK. The DIWIRE will then attempt to bend the first angle. After each attempt use the right arrow to move the A Bend Pin to touch the wire and press OK. The column titled “Actual” will populate with the actual angles to which the wire has been bent.

WARNING- At some point the curved wire may begin to snag on the bend head. Redirect the wire over the top of the head so that it doesn’t get caught behind the head and effect the calibration readings.

Counter Clockwise (B Bend Pin)
The wire will feed forward once the Clockwise side is finished so that the Counter Clockwise side can be started. Repeat the same process as above starting with touching the B pin to “0”. Remember that now the left arrow key is being used to move the B Bend Pin to touch the wire on the Right side.
1. Options to EDIT or DELETE a Material Profile
2. After selecting EDIT, choose to update settings, or edit calibration for Material Profile.
Edit Existing Profile

Once EDIT CALIBRATION is pressed, a table will appear in the main window. It will be populated with the values saved to this Material Profile from the previous Calibration process. There are 2 ways to edit the Profile Calibration.

- RE-CALIBRATE
  By pressing this button the calibration will start from scratch and go through the entire calibration process as described previously in Creating New Profile.

- REFINES RANGE
  Refine a certain range of angles that have proven to be problematic in bending.

  Enter the LO to HI angle range in the boxes below as well as the number of STEPS between them. For example a range could be between 60 degrees and 80 degrees, with 10 calibration steps (2 degree increments) between them.

  Press REFINES RANGE to begin the calibration process for this range. This is the same process as described in Creating New Profile only for the angle range chosen.
Launch Screen

Wireware opens to the Launch Screen. From here you have the option to “Open” or drag and drop a file into the Preview Window, or access Material Profiles or Manual Mode.
MODE > EDIT

In Edit, Wireware opens a vector-based file, such as .SVG or .DXF, and creates a series of Bend Points that form a Bend Path. In Edit, the Bend Path can be manipulated in a variety of ways that are covered in this section.

When a file is dragged and dropped into Wireware Edit Mode is automatically opened.
Main Window Legend

PREVIEW WINDOW
Displays the Bend Paths.

TOOLS
- Select
- Zoom In
- Zoom Out
- Zoom To Fit Screen
- Pan

STATUS BAR
Displays if the DIWire is connected and if the file is bendable. When bendable, the Status Bar is green. When the Status Bar is red, it means there are Warnings, such as “Bend Points too close together” or “Bends are too sharp.”

BEND BUTTON
Button to press to start bending.

OUTPUT INFORMATION
- Curve Length
  Total amount of wire needed to bend the file.
- # of Bend Points
  Bend Points in the file.
- # of Paths
  Paths in the file

Bend Point Warning
Warms how many Bend Points are too close together.
Sharp Angle Warning
Warms how many bends are too sharp.
Bend Paths

When a file is brought into the Preview screen it forms a Bend Path.

Multiple bend paths can be imported at once to Preview Screen. These paths can be edited independently however some Setting changes, such as scale will apply to all Paths in the Preview Window.

Be sure to have the correct path selected to bend before hitting the BEND button. Use the keyboard arrow keys to select between the paths. The number of paths on the Preview Screen can be found the lower corner of the screen.
Editing Bend Points

Once you have opened a file in Wireware you have the ability to move, add and delete bend points to make the file suitable for bending.

SELECTING A BEND POINT
Using the Select Tool click and hold the point to move it. To constrain the movement hold the Shift key.

ADDING A BEND POINT
Right mouse click on part of the bend path to create a bend point.

SELECTING MULTIPLE BEND POINTS
Using the Select Tool draw a selection box around the desired points to move. Hold the Control key to move these together.

DELETING A BEND POINT
Using the Select Tool, select the point to delete and then hit the keyboard Delete key.
Color Codes

When creating or editing a shape in Wireware it is important to understand that the DIWIRE has constraints to work within. These include how many bend points can exist along a length of wire, how close together these bend points can be, and how short the length between the points can be.

Lucily Wireware lets you know where you stand by flagging any length or angle issues with red. You can edit these right in Wireware by moving the points or adding/deleting them.

Below is guide for the colors you will see in the Preview Window.

**BEND POINT COLORS**

*Location where the DIWire will bend an angle. These will change color to reflect several different conditions:*

- **BLACK**
  - The bend points are far enough apart. Safe to bend!

- **YELLOW**
  - When a point is selected with the Select tool, it will turn Yellow.

- **GREEN**
  - The blue point designates the first point that will be bent after the first line segment.

- **RED**
  - If points are too close together they will turn Red. They will need to be moved apart further, or the entire file will need to be scaled up.

**LINE SEGMENT COLORS**

*The line segments between Bend Points. These will change color to reflect several different conditions:*

- **GRAY**
  - This is the original imported line. This will remain on screen unless “HIDE ORIGINAL FILE” is checked.

- **GREEN**
  - The line segment angles are large enough. Safe to bend!

- **BLUE**
  - During the bending process, the blue line segment designates the segment that has just been bent.

- **RED**
  - If the angle created by two line segments coming together is too sharp the line segments will turn Red. This can be fixed by:

  - **ADDING A BEND POINT**
  - **INCREASING THE ANGLE**
**MATERIAL PROFILE**
Select the type of wire that will be bent on the DIWire. (See Material Profiles for more on this)

**UNITS**
Select metric or imperial measurement system to be used in Wireware.

**WIRE LENGTH**
Enter Wire Length in the text box to modify the amount of wire to use. As Wire Length is adjusted, Scale will reflect how much the file is being scaled up or down.

**SCALE**
Scale the Bend Path by moving the slider or typing directly in the text box. As scale is adjusted, Wire Length will reflect how much wire is needed.

**RESOLUTION**
Adjust level of bend points along a bend path.

**PATH TYPE**
- **Adaptive**
  Creates a higher resolution along curves, less along straighter zones.
- **Line Segments**
  Breaks the bend path down into simple straight lengths with no extra points.
- **Whole Curve**
  Creates equidistant points that can be tweaked with the Resolution setting.
Planning your Drawing

The following notes are principles to keep in mind while creating a drawing to import into Wireware.

**THE CONSTRAINTS**
The DIWire creates a bent shape through the use of line segments and bends. The DIWire has certain inherent constraints for the minimum distance between bend points (12mm) and the tightest angle (135 degrees). Knowing this ahead of time will help avoid a lot of tweaking once the imported file is in Wireware. For example, some angles will need to be made up of multiple bends.

MAXIMUM Angle & Line Segments:

**WIREWARE WILL TRANSLATE YOUR FILE INTO POINTS**
Wireware is set up to take exported .svg lines and curves from vector drawing and CAD programs and translate them into a Bend Path with an array of Bend Points to edit using Wireware. Files can be set up with this in mind ahead of time, or Wireware can translate.

**CURVES**
The DIWire bends a curve by bending many small segments that make up that curve. Therefore, the smaller the curve the more noticeable these segments will be. On larger curves, the small segments are almost undetectable.

**DO NOT ADD RADII TO CORNERS**
You will notice on your bent wire that the bend will have a radius to it. This is a natural product of using the DIWire. You do NOT need to add these to your .svg file as it would result in 2 bend points at every corner that would likely be flagged as errors.
Loading .DXF Files

OPEN .DXF FILE
Using Open or dragging and dropping onto the Preview Screen

CHOOSE FILTER
Choose which line Wireware should use for importing. These are options for filtering out the “extra” lines that can come with DXF files.

GAP THRESHOLD
.DXF’s are imported as unconnected curves. The software will automatically stitch as many of the curves together as it can, but sometimes gaps between the curves are not closed. If this is the case, set the Gap Threshold to a low number, such as between 5-10. If more gaps need to be closed, raise the threshold. Setting the threshold too high may cause unintended gaps to be filled.

CLOSE GAPS
When the Gap Threshold is chosen, press Close Gaps.
Launch Screen

Wireware opens to the Launch Screen. From here you have the option to “Open” or drag and drop a file into the Preview Window, or access Material Profiles or Manual Mode.
In Manual, the feed and the bend pins are controlled through actions in this mode. This can be by simply holding the arrows corresponding to Feed and Bend actions or through using “Inputs” to enter exact values for these actions.

Troubleshooting Jammed Wire
While this ideally won’t happen, there are times when the wire will get jammed in the bend head. This could happen because the wire was loaded too far forward before hitting BEND. The best way to work this out is to open MANUAL mode and use the arrows to move the bend pins away from the wire, and then use the feed forward button to move the wire out so that it can be cut.