Real-time Double Reed Shaper 3D Modeling

CurvaSURE Shaper Generator User Manual v1.0.0

Welcome to CurvaSURE! This application empowers you to design and generate precise 3D printable straight shaper forms for various double reed instruments. It offers a balance of pre-defined presets for quick starts and extensive customisation options for unique designs.

1. Getting Started

Upon launching the application, you'll see a main window divided into two sections:

- **Left Panel (Control Panel):** Contains all the input fields, parameters, and action buttons. This is where you define your shaper.
- **Right Panel (Preview Area):** Displays a real-time 2D visual representation of your shaper as you adjust parameters.

2. Main Sections

2.1. Shaper Parameters

This section allows you to define the fundamental dimensions of your shaper.

- **Preset:**
    - **Select a Preset:** This dropdown menu provides a comprehensive list of pre-defined shaper profiles categorised by instrument (e.g., Bassoon, Baroque Bassoon, Contrabassoon, Contraforte). Selecting a preset will automatically populate all relevant parameters and shape points, giving you a great starting point.
    - **Online Presets:** The application automatically checks for and downloads new or updated presets from an online repository. You can also manually trigger a check using the "Check for Updated Presets Now" button in the Preset menu.

- **Export Custom Preset:** Once you've designed a custom shaper you're happy with, use this feature to save all its parameters and shape points to a **.json file**. This allows you to easily recall your custom design later or share it with others. ***Important:*** *No custom presets are stored in the program memory, only locally on your hard drive.*

- **Load Custom Preset:** Use this to load a previously saved .json preset file.

- **Download/Update Presets (Online):** Selecting this checks the online repository for any un-downloaded presets or updates to the presets that may have been published. The program will automatically check every time it opens, this is simply a way to manually engage that check.

- **Load Backup Database (Offline):** In the event that the program is unable to access the online repository, an offline backup can be loaded through this interface. Please get in contact if this is needed.

- **Clear Preset Cache:** This removes all the plugins cached on your computer. If you are having an issue with a preset or if you know a preset has been updated but doesn't seem to be showing, click 'Clear Preset Cache' and then 'Check for Updated Presets Now'. This will download the newest versions of the presets into the program. (*This will not affect the presets you have exported and saved elsewhere.)*

- **Total Length (mm):** Defines the overall length of the cane for which the shaper is designed.

- **Original Gouge (mm):** This is the gouge that matches the shaper from which the measurements were taken. If you are creating a custom shape, by default, the Original Gouge will match the Gouge Diameter you pick.

- **Gouge Diameter (mm):** Specifies the diameter of the gouge to embed in the shaper. If a measurement was taken from a shaper, then this field will default to the same gouge as the original shaper. If, however, you gouge your cane with a different diameter blade, you can select it from the dropdown menu.

    - To be as precise as possible and to prevent your cane from being unnecessarily bent, it is generally recommended to select the correct gouge you use.

    - **Gouge Compensation:** If the gouge happens to be different from the Original Gouge, the program will automatically calculate the shaper measurement differences needed to give you the exact same shape once you fold. Don't be alarmed if the numbers change, this is just compensation for the change in geometry due to gouge differences. The Folded Tip Width should stay exactly the same.

- **Bolt Hole Diameter (mm):** Sets the diameter for the mounting holes on the shaper. The default value is **M4 Hex (4mm)**, but there are more options for both metric and imperial bolt measurements. There is an inbuilt **0.2mm** addition to this diameter to make threaded bolts slide through easier and to compensate for printing layers. This would make a 4mm hole actually 4.2mm.

    - **Hex Bolts:** In general, hex bolts are recommended as there will be an indent created in the bottom of the shaper to nest it. This helps with tightening and doesn't require additional adhesion.

    - **Spring Indent:** As a default, there is a slightly larger sunken area around the hole on the inside of the shaper halves. This is for spring placement, if you would like to make the shaper halves easier to use. **0.6 x 8 x 12mm** compression springs are what this indent is configured for. If springs are not used, these indents will not affect functionality.

- **Generate Guide Indents (Recommended):** This checkbox controls whether small physical indents are included at the tip, narrowest point, and butt of the shaper. These indents serve as visual and tactile guides for accurate cane placement and shaping. It is recommended to keep this enabled.

- **Generate Alignment Posts (Recommended):** This checkbox controls whether alignment posts are embedded in the shaper to assist with cane placement. It is recommended this stay ticked as it will assist in both shaper alignment and strength. This is recommended to stay on, unless perhaps you print vertically.

- **Engrave Shaper Name (Recommended):** This checkbox controls whether the name of the preset is engraved on the bottom of the shaper. It is recommended to keep this enabled so as to easily identify the shaper after printing.

- **Shaper Name (Editable):** This box allows for customisation of the engraved shaper name, assuming *Engrave Shaper Name* is ticked. The box will auto-populate with the name of the loaded preset but it can be changed to whatever is desired. It is recommended to keep the character count, including spaces, to around 12 to maintain readability.

2.2. Advanced Features

- **Offset Shape Start:** This slider allows the start of the shape to be pushed back a specified amount from the tip, with retaining the proportions of the original shape.

    - ***Example:*** If you wanted to retain the tip width of the shape after clipping 2mm off the tip, you would offset the shape start by 2mm.

    - This setting *will* be saved if you export a preset.

2.3. Shape Points (Customisation Hub)

This is where the true flexibility and power of CurvaSURE shines, allowing you to define highly custom shaper profiles. The shaper's profile is determined by a series of (Distance from Tip, Width) points.

- **"0 (Tip - Required)":** This is the starting point of your shaper profile, representing the width at the very tip of the cane.

- **Intermediate Points:** These are user-defined points along the length of the shaper.

    - **Add Point:** Click this button to add a new intermediate point row. You'll enter a "Distance from Tip (mm)" and a "Width (mm)". To insert a row at a specific point, click in the field above where you want to insert a point, then click ‘Add Point’.

    - **Remove Point:** To remove an intermediate point, first **click on either the "Distance from Tip" or "Width" field** of the specific intermediate point you wish to remove. Once selected (the field will have focus), click the "Remove Point" button. You cannot remove the "Tip" or "Butt" required points.

    - **Distance from Tip (mm):** This value specifies how far along the shaper's length (from the tip) the point is located.

        - **Accepted Range:** Values must be between **0mm and 90mm**.

    - **Width (mm):** This value defines the width of the cane at the specified distance from the tip of the reed.

        - **Accepted Range:** Values must be greater than **0mm and up to 30mm**.

- **"(Butt - Required)":** This is the final point of your shaper profile, representing the width at the butt end of the cane. Its "Distance from Tip" is automatically calculated as half of the "Total Length (mm)". This point cannot be removed.

- **Input Validation:** The application performs real-time validation of your input values. If a value is outside the accepted range or in an invalid format, the input field will turn red, and an error message will appear in the preview area or via a pop-up.

2.4. Curve Options

This section controls how the application interpolates between your defined shape points.

- **Smooth Curve (Recommended):** This option uses a cubic spline interpolation method to create a smooth, continuous curve between your defined points. This is generally recommended for most shaper designs as it produces a more organic and flowing profile. To get the benefit of the curve, multiple points are needed. Generally speaking, the more points you have the better your shape will turn out.

    - As you’re inputting points, you may notice that the Smooth Curve option creates some bizarre shapes. This is only the mathematics trying to make sense of the overall shape of the points currently available. As you work your way down the shaper, the wildness of the curves will be tamed - you simply need more data points.

- **Straight Lines:** This option connects your defined points with straight line segments. This can be useful for creating more angular or segmented shaper profiles, particularly with fewer Shape Points. This is also useful for experimenting with ‘rough’ or ‘experimental’ shapes prior to engaging the smooth curve, as you can input fewer points and still have a workable result.

- If you have enough points listed, the differences in the Smooth Curve and Straight Line settings become very small to negligible.

2.5. Preview Controls

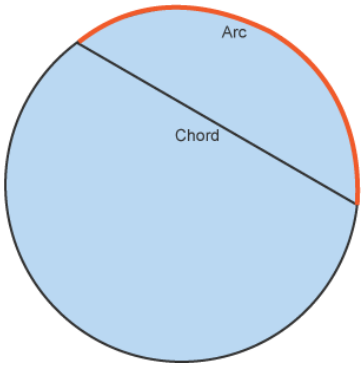
The right panel provides a visual preview of your shaper.

- **Show Preview:** Toggles the visibility of the 2D shaper preview.
- **Show Guide Marks:** Toggles the display of helpful visual guides on the preview:
    - **Red Dashed Line:** Represents the centre line of the shaper.
    - **Green Dashed Line:** Mark the butt end of the shaper.
    - **Orange Dashed Line:** Indicate the narrowest point of the shape.
    - **Purple Dashed Line:** If Offset Shape Start is engaged, this indicates the place to where the tip measurement is offset.
- **Auto-update:** When enabled, the preview will automatically regenerate in real-time as you modify parameters or shape points.
- **Generate Preview:** If "Auto-update" is disabled, click this button to manually refresh the preview.

2.6. Action Buttons

- **Generate Files (STL / DXF):** This is the core function for exporting your shaper design.
    - Clicking this button will prompt you to choose a save location.
    - The application will generate two files:
        - **STL (.stl):** A 3D model file suitable for 3D printing. The generated STL will include two mirrored shaper halves and a connecting base, ready for printing.
        - **DXF (.dxf):** A 2D CAD file representing the outline of your shaper, useful for laser cutting or further CAD work.
    - **Error Handling:** The application will validate all parameters before generation. If any required parameters are missing or values are invalid, an error message will be displayed.
- **Help:** Links back to this very manual!
- **Shaper Measurement Converter:** This is a computational tool that will convert measurements between straight shapers and fold-over shapers or flat reed measurements. Straight shapers maintain the gouge radius while you shape the cane whereas fold-over shapers force the cane at the tip flat (or almost flat). This tool accounts for the differences in curvature of the cane, so if you wanted to input

the measurements of a fold-over shaper, you would get the correct straight shaper values.



Example: Let's say you wanted to convert a Rieger 1A shaper tip to a straight shaper. On the Rieger website (and confirmed by measuring the actual shaper tip) the tip width is **15.5mm**. If you shape a piece of cane using this tip, the resultant tip will be 15.5mm as the fold-over shaper more or less resembles the folded state of the reed.

However, if you were to apply those measurements to a straight shaper with no adjustment, then the resulting measurement of the folded tip would be an incorrect width of **16.18mm** (using a 32mm gouge).

This is because the **chord length** (the width measurement of a piece of cane measured from above) was used instead of **arc length** (the total length of the flattened out tip).

We want a consistent tip measurement regardless of our gouge settings, therefore the **arc length** *must* stay the same and the gouge will be the same. This only leaves the **chord length** variable, so to achieve an accurate shape transfer it is this value that needs to be adjusted.

Therefore, if you have a shaper tip you would like to convert into a straight shaper, take measurement values at the tip and every 5-10mm, plug those values into the fields provided along with the desired straight shaper gouge, and press **Calculate**. Add these values to the Shape Points field and voilà, you have a straight shaper copy!

- If there is a slight curvature at the back of the shaper tip, you can choose to take that as a flat-measurement and accept the slight resulting width difference (often less than 0.1mm) or you can take a radius gauge measurement at various increments and plug different values in. For example, if the back of a shaper tip has a very slight bend (i.e. 40mm radius), then plug in 40mm as the gouge and take the overhead measurement and enter that value into the Straight Shaper field. Convert and get the Flat Measurement. Next, erase the Straight Shaper value and change the Gouge value to match your desired shaper (while keeping the Flat Measurement you had) then generate the new Straight Shaper value. It's a roundabout process to do it this way, but you're guaranteed to convert your shaper correctly!

3. Tips for Best Results

- **Validate Inputs:** Always ensure your numerical inputs are within the accepted ranges. Invalid inputs can lead to unexpected or unprintable shapes.

- **Preview Regularly:** Even with auto-update, occasionally review the preview to ensure the shape is developing as intended.
- **Understand Your Cane:** The ideal shaper profile depends heavily on the specific cane you are using (its thickness, density, and natural curve). Experimentation and iterative design are key.
- **3D Printing Considerations:** When generating STL files, remember that the final print quality will depend on your 3D printer's capabilities and slicer settings. Ensure you use appropriate materials and print resolutions.

4. Troubleshooting

- **"Input Error" / "Plotting Error":** Check the values you've entered in the "Shaper Parameters" and "Shape Points" sections. Look for red-highlighted fields.
- **"Cannot Remove Point":** Remember you can only remove intermediate points, not the "Tip" or "Butt" required points. Ensure you've clicked on an intermediate point's field to select it before attempting to remove.
- **"Failed to generate files":** This usually indicates missing or invalid parameters. Review all fields, especially those related to "Total Length", "Gouge Diameter", and "Screw Hole" dimensions.
- **No Logo/Icon:** If the logo or icon doesn't appear, it simply means the image files are not found in the expected location. The application will still function normally.
- **"Connection Error" / "Data Error" for Presets:** This indicates an issue connecting to the online preset server or a problem with the downloaded data. Check your internet connection.

5. Materials, 3D Printing Tips, Assembly and Shaping

5.1. What You Will Need

Below you will find the materials needed for fully assembling the straight shaper.

- **3D Printer:** Any sort of 3D printer will do, as long as the printing bed is large enough to be able to print the Total Length parameter.
- **Filament:** In testing 3D printed shapers out, the best performing filaments of the group were **PLA**, **PLA+**, and **PETG**.
    - **PETG:** PETG is my preferred option for printing. This is a filament with much higher flexibility than PLA/PLA+ and it is much more resistant to knife scraping. Due to the strength it possesses, it is often used for manufacturing parts that go through wear and tear. Depending on the infill percentage you

end up using, you may find that if you can twist it ever so slightly but this is not an issue when the other half is attached and tightened.

- **PLA/PLA+:** PLA is a very commonly used filament praised for the high tensile strength it provides and evenness of printing surface. PLA+ is a modified version of this meant to be slightly stronger and more flexible. Printing with PLA/PLA+ is a great choice to start off with, but be aware that it can flake if you dig a knife into it. Care needs to be taken when shaping to prevent digging into the filament surface. Sandpaper is a useful tool to smooth areas out you can't reach with a knife.

Any of these are good options, so it is worth experimenting to find out which you prefer.

- **Bolt and nut (at least 40mm in length)**: For clamping the two halves together, a bolt and nut are needed. The appropriate length for this is a minimum of 40mm as it will reach though the shaper giving just enough threading on the other side for the nut to close around. The bolt size needs to match the Bolt Hole Diameter option that you chose when generating the shaper.

    - ***Recommended:*** Print a Hex Nut Grip which can house the nut meant to screw the bolt in. This is much easier to tighten and handle than using the nut on its own. Please click **here** to download the recommended STL files. After printing two of them, insert the nut into the bottom of the print and screw into the bolt.

- **Compression Spring 0.6 x 7 (or 8) x 15mm (optional)**: For additional ease of keeping the shaper open, a compression spring may be used. The shaper has embedded indents around the bolt hole where these springs may be placed. The diameter of the indent is 8mm, therefore any spring with that diameter will fit. However, the recommended height of the spring is 15mm. This will allow the spring to compress fully when closed without too much effort and have enough force to push the two halves apart when the bolts are loosened. Any spring thicker than 0.6mm will also be difficult to push closed.

5.2. 3D Printing Tips

As straight shapers are fairly complex geometrical shapes, the question may arise how to get the best result printing them. Luckily there are only two options and both of them have their own merits. Experimentation to find out which works best for you is the way to go, but pros and cons of both options will be listed below based on experience.

- **Print Settings**: The following print settings are recommended for the best result.

    - ***20% infill, Gyroid or Grid*** - Gyroid is suggested as it won't cross over itself while printing.

    - ***Wall thickness*** - 4 layers at 0.4mm (1.6mm thickness in total)

    - ***Avoid crossing walls*** - If your printer has this function, then it is highly recommended that you engage it so as to prevent and filament build-up and

inconsistencies in the print if the nozzle catches on a wall. This is especially important if you print vertically, as the shapers can easily topple.

- **Printing Horizontally (Default / Preferred)**: When you export the STL/DFX files from CurvaSURE, the default printing layout is horizontal. This means the longest part of the shaper is printed on the bed.
    - This is an easy and consistent way of reliably printing. There is inherent stability in that the base is long and the print isn't too high.
    - One draw back is that the curvature of the inside will be slightly 'bumpy'. If you hold up the concave half of the shaper you might find that you can see small 'steps' as the curve goes up and down. This is simply due to the way 3D printers layer the filament. This can be lessened by creating thinner layers but it will always exist to a certain extent when printing in this orientation.
    - If possible, in your 3D printing slicer, engage an Adaptive Layer setting which will make the top curved surfaces much thinner and thus much smoother.
    - **Tip:** To counteract this 'step' appearance, a bit of sandpaper along the edges will help, both with the halves open and closed together. If it has any effect on the shape, it is negligible - however, it does make shaping easier.
- **Printing Vertically**: An alternatively to printing horizontally is to print vertically. This means the ends of the shaper are on the bed. To achieve this, ***rotate the exported print 90° along the horizontal axis***. While this helps remove the steps mentioned previously, there is inherent instability in the printing process.
    - Due to the shape being taller than it is long by a significant amount, this method can lead to the print tipping over. To counteract this, it is essential to add a **brim** while printing. The recommended amount is at least **15mm**.
    - Another recommendation would be to slow down the overall print speed and possibly print one half at a time. As the printer will be printing layer by layer, it will keep switching back and forth between each shaper half. As the shapes get taller, there is a higher likelihood of a blob of filament forming and catching on the printer nozzle as it moves, causing the shape to topple. If the printer has a setting to avoid crossing walls, this is also recommended.
    - If the shaper is printed in this orientation, you will find the curves to be much smoother.
    - It is recommended that you disengage the **Generate Alignment Posts** feature if printing vertically, as the posts would be floating. It might be possible to generate support trees for them, but be careful in removing the supports after - the post holes only have a 0.2mm tolerance.
    - A potential drawback is that you will now be scraping perpendicular to the filament layering. This could lead to more filament flaking compared to a horizontal print.

- **Tip:** It is worth smoothing the print along the cutting line with high grit sandpaper (~1000 grit) to ensure an easier shaping process.

5.3. Assembly

Once you have all your materials and printed halves, it is time to assemble the shaper.

- **Step 1**: Determine which way you would like to orient the shaper. The shaper can 'smile' or 'frown', referencing the way the gouge is pointing based on the end of the shaper. As there are no threads embedded into the shaper bolt holes, you may choose which direction you prefer - however, it is recommended the shaper 'smile' (concave side on the bottom and convex side on the top) as it is much easier to rest the cane in when positioning. If you choose this orientation, the engraved shaper name should be facing up.

- **Step 2**: Take your bolts and insert them through the bolt holes from the bottom up through the top. The head of the bolt should be on the bottom of the shaper and the threaded ends should be sticking up through the top.

    - If you selected Hex Bolts in the program, there will be a hexagonal indent printed on the bottom of the shaper which allows for the bolt to fit within the shaper and not need additional fastening when opening or closing.

    - If you do *not* have a Hex Bolt and have a rounded top, then dab a bit of super glue around the top of the bolt, underneath the head, and then press and hold into the bottom shaper half until fastened. This is useful if you don't want the bolt to spin around while you are tightening the shaper.

    - If you choose not to glue it, when you tighten the nut on top place your thumb on the bolt head to prevent it from turning.

- **Step 3 (optional)**: If using springs, take the top half of the shaper off and drop a spring around each one of the threaded bolts sticking upwards. The springs should fit neatly into the indents on the inside of the shaper. Place the top half back on, being careful to line up the springs with the indents on that half.

- **Step 4**: Tighten a nut around each one of the upwards facing bolt threads, making sure that the shapers can close all the way.

- **Step 5**: If printing horizontally, it is recommended to rub sandpaper along the point where the two shaper halves meet when closed. This will smooth out the connection between the two halves and ensure nothing is sticking up to impede the shaping process.

    - Any change to the shape will be negligible, as you are only removing excess material that might be sticking up from the printing process. Be gentle and not heavy-handed.

5.4. Shaping

Due to the nature of 3D printing filament, there may be some concern over what using an abrasive, such as a knife or sandpaper, might do to the final shape. Based on testing, there hasn't been change to the overall dimensions of the shaper even after repeated uses.

This comes down to a few things:

- Using PETG filament, which seems to be more resistant to abrasion than PLA/PLA+
- A shallow angle when cutting along the shaper (5-10 degrees above the shape)
- Using high grit sandpaper to gently smooth the print prior to cutting

If you take care while shaping to keep that small angle, especially when printing with PETG, then you will find it won’t catch on the shaper.

6. Support

Any support inquiries can be address directly via this form.