



Designing the Fret Board Shape

By Eddie Ufford

Description of Activity

- ☛ In this lesson we are going to establish the shape and size of a fret board.
- ☛ This MLA is lesson #2 of 3 in the series. But also serves as a stand-alone MLA.
- ☛ One should use the CAD model they created from MLA lesson one. At the end of this lesson the student will have the basic design work completed for producing a custom fret board.
- ☛ The purpose of this MLA is to go from CADD to a useable design need for the Laser Cutter.
- ☛ One can also use this lesson without a laser cutter. Student can make full size prints and then use spray on adhesive or attach to their fret board designs to fret board material. Followed by manual cutting with various saws.
- ☛ This lesson is geared towards middle and high school computer aided design & drafting (CADD) students.

Learning Objectives:

(List measurable objectives)

1. Students will make vital measurements from an existing fret board for size and shape.
2. Students will use CADD design a tradition fret board, including the fret dot maker positions.
3. Students will use layers to define lines and their associated features.
4. Students will import their fret board spacing calculations onto their fret board shape.
5. Students will save and export their designs to a laser cutter/engraver.
6. Students will print off full sized drawings prior to using the laser cutter.
7. Students will calculate the volume or board feet needed for a fret board.
8. Students will calculate the cost of raw materials for the fret board.

Standards:

CSS.Math.Content.HSG.MG.A.3

CCSS.Math.Content.HSG.MG.A.2

CCSS.Math.Content.HSG.MG.A.1

CCSS.Math.Content.HSN.VM.B.4.a

CTE.ED.C.C5.2 Know the various object-altering techniques.

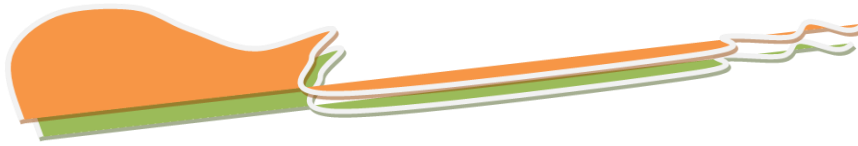
CTE.ED.C.C3.1 Know how the various measurement systems are used in engineering drawings.

CTE.ED.C.C5.1 Understand the commands and concepts necessary for editing engineering drawings.

CTE.ED.C.C3.2 Understand the degree of accuracy necessary for engineering design.

CTE.ED.C.C5.3 Know the CADD components and the operational functions of CADD systems.

CTE.ED.C.C5.4 Apply two-dimensional and three-dimensional CADD operations in creating working and pictorial drawings, notes, and notations.



Materials Required:

- ☛ A computer with CAD software such as Rhino, Fusion 360, AutoCAD, Solidworks, etc...
- ☛ Digital Calibers
- ☛ Printer and Spray on Adhesive
- ☛ Laser Cutter/Engraver (optional)
- ☛ Wooden Fret Board blank for laser cutter.

Safety:

- ☛ Review safe handling of equipment and tools if needed.

References:

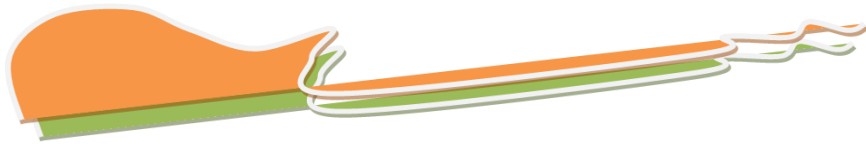
- ☛ Scale Length Explained by STEWMAC https://www.stewmac.com/How-To/Online_Resources/Learn_About_Guitar_and_Instrument_Fretting_and_Fretw/Scale_Length_Explained.html

Activities:

- ☛ The student will design a fret board from scratch.
- ☛ The student will use computer aided design and drafting (CADD) software to create an accurate, full-sized fret board drawing. The drawing will need to be printed out full size 1:1.
- ☛ The student will calculate area, volume and cost for fret boards material.
- ☛ In addition, the student will upload his or her CADD file into the laser-cutter. From which he or she will use the laser-cutter to mark the fret lines, dot maker position and then cut-out the basic fret board shape.

Pre-CADD Actives:

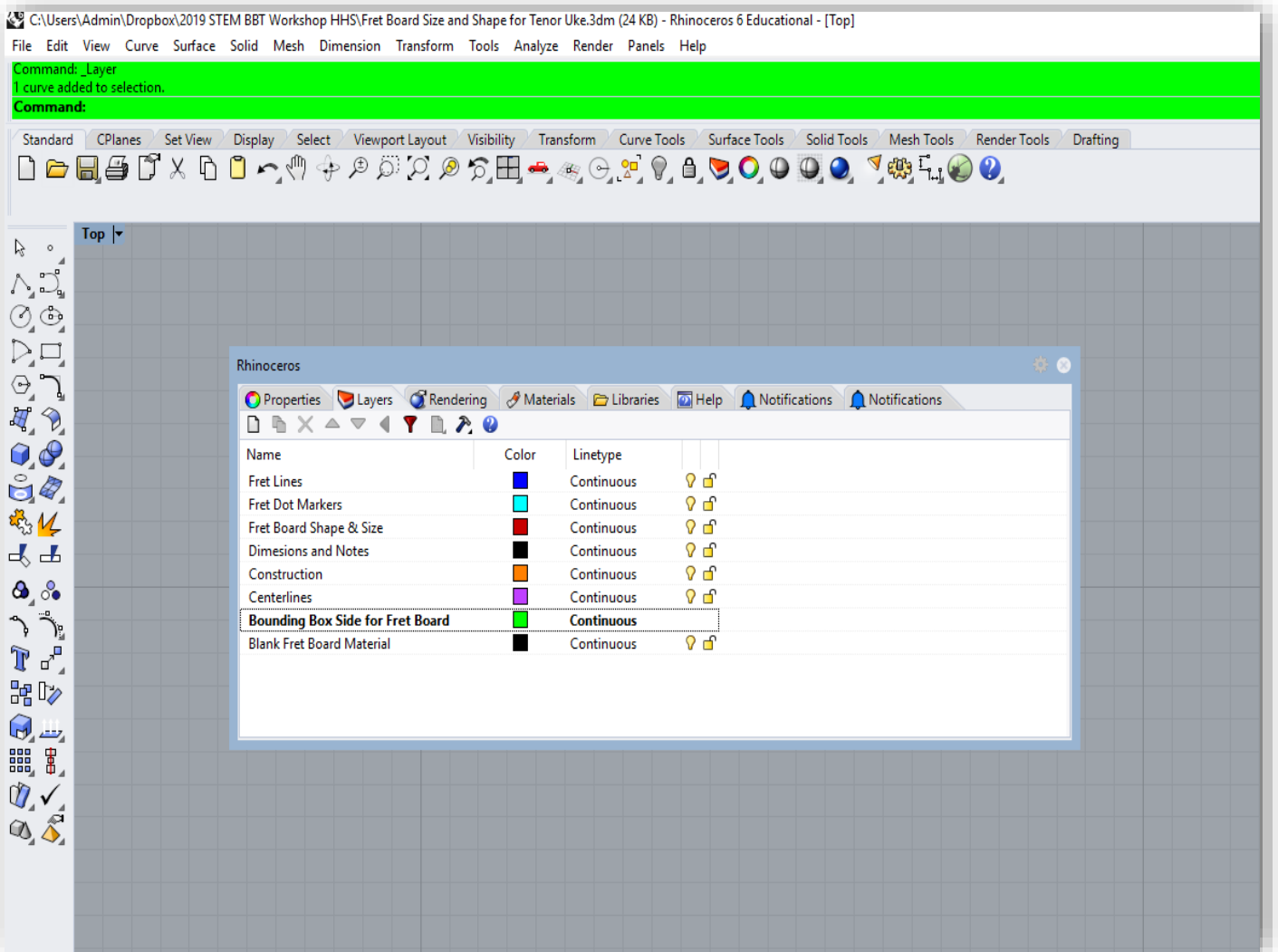
- ☛ Before one actually starts drawing, one needs measurement tools such as digital calipers and a bench rule to gather information from an existing fret board. One will need the overall length and width, in addition to the exact width at the nut/fret Zero and another fret such as Fret 18. For our example it only has 18 frets. It is advised that you take the measurements from the two farthest apart frets lines. This will yield the most accurate double taper.
- ☛ The width of the fret board starts off as a blank rectangle but is then transformed into a double-tapered trapezoidal shape with lines to indicate where the fret wires are placed.
 - ☛ Overall Length _____
 - ☛ Overall Width _____
 - ☛ Width at Nut/Fret Zero _____
 - ☛ Width at _____ Fret _____
 - ☛ *Optional – kerf width of laser beam _____

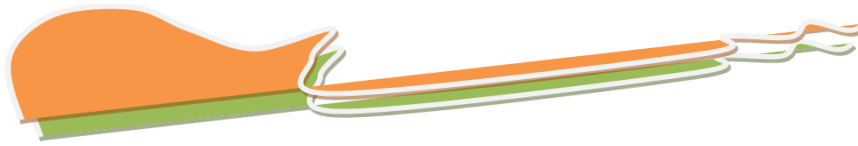


CADD Activities:

1) CADD Step 1 (Drawing Setup)

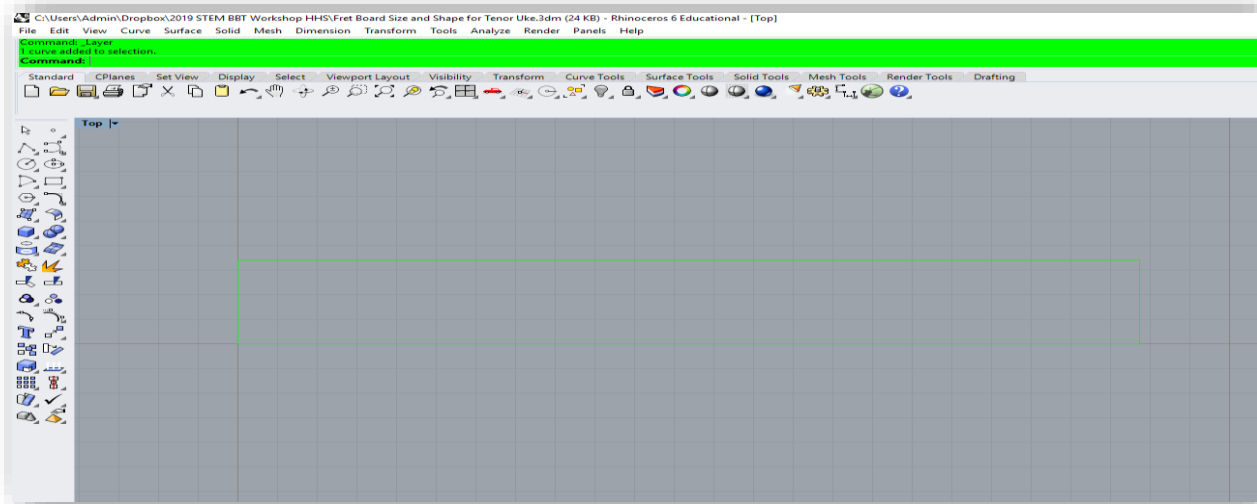
- Start a new CADD drawing. Set the units to inches and accuracy to five decimal places, 0.00001. Depending on your CADD software, you will want to be working in the TOP viewport. Setup the following layers see image below:
- I realize not everyone uses the same software or command sets. You may have to adapt this document to match your software. The process should be very similar and I attempted to keep it as generic as possible so all can follow along no matter what software they are using.
- The end goal for everyone is to be able to accurately model out the fret board shape and size. Then import the fret wire positions from the Tangent Line Method; which is the 1st MLA in this series. If you don't have that, then one could use STEW Mac's fret calculator to derive the fret positions. But then again, you will miss out on all the geometry fun and learning something new!



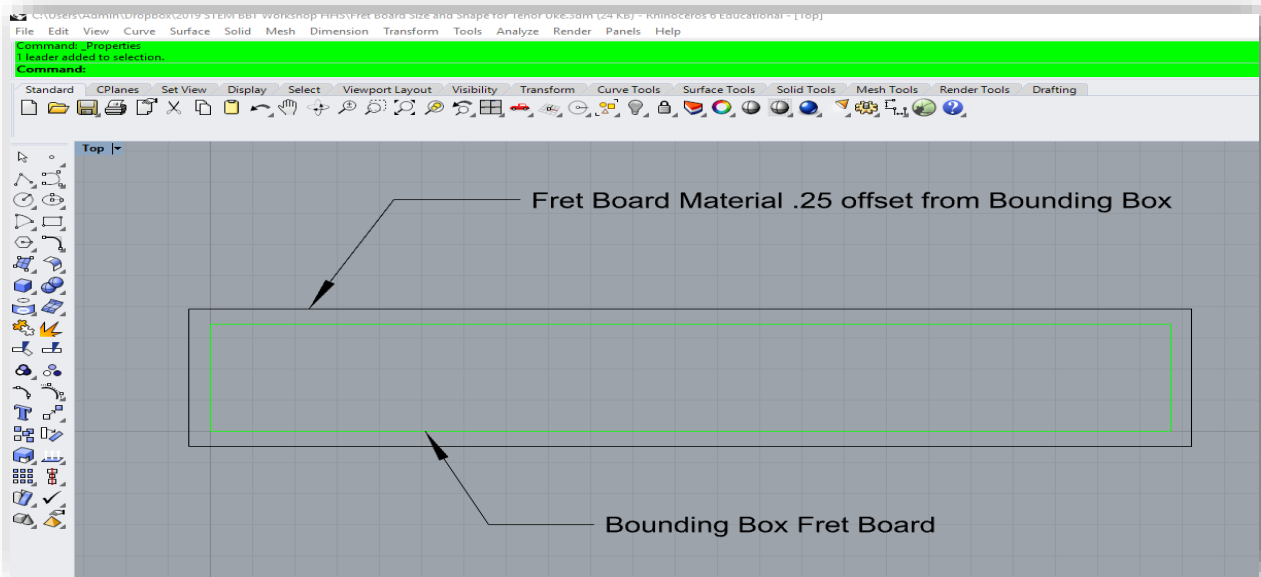


2) CADD Step 2 (Rectangle Fret Board Shape plus Offset)

- Start by drawing a **green** bounding box rectangle using the overall width and length measurements. As shown below. This is the minimal rectangular size that is needed to contain the fret board. The extreme left-hand size will eventually become fret zero.

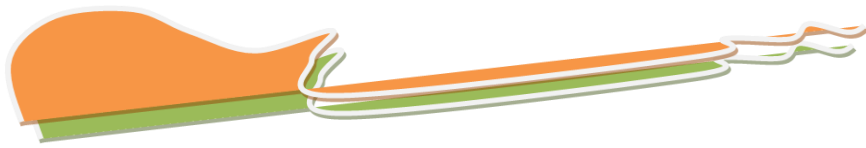


- Use the **OFFSET** command and create a 2nd rectangle 0.25" to the outside. This outer rectangle is the "working size" or blank fret board material. The line should be **black**.



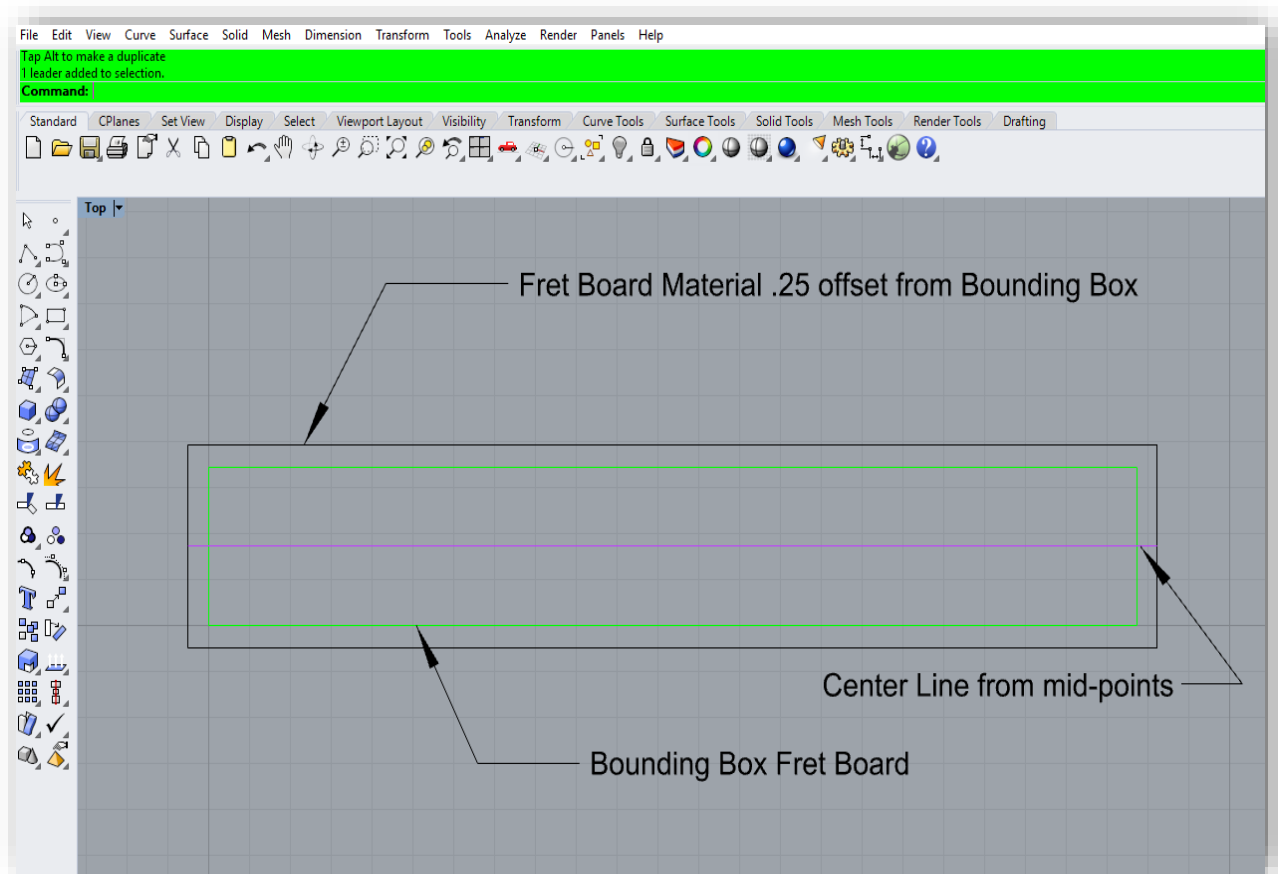
Questions:

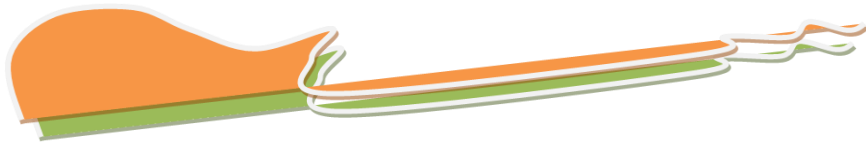
- What is the overall working size you drew? X .
- What is the formula area?
- Calculate the area of the Fret Board Material above?
- What is the formula for board feet?
- If the fret board thickness is .25" thick, then what is the volume needed in board feet?
- Figured Maple cost \$5.00 per board foot. How much will it cost for this fret board? \$
- Ebony cost \$95.00 per board foot. How much will it cost for this fret board? \$



3) CADD Step 3 (Centerline for Symmetrical Double Taper)

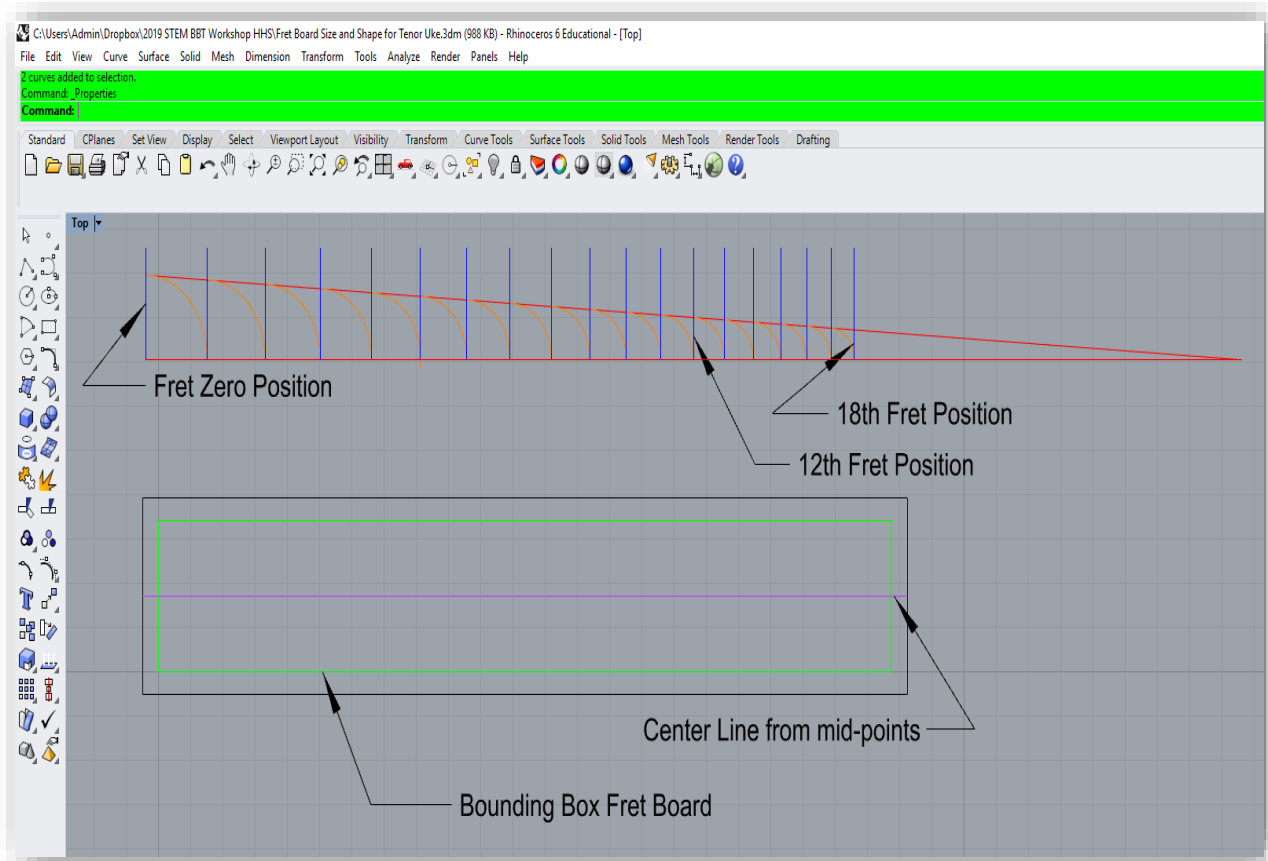
- Draw the **purple** centerline from end of the rectangle to the other end. This centerline must divide the rectangle into two imagery and equal halves. This center line will also be used to help locate the fret dot marker locations later in this tutorial.
- Centerlines are used for symmetric objects, and also for the center of circles and holes. Technically, the purple center line shown below is no properly displayed. In drafting and design centerlines show up as a series of chained dashes and spaces (----- - -----). For this tutorial purpose the **purple** line represents the true center of our work.





4) CADD Step 4 (Import Fret Board Spacing)

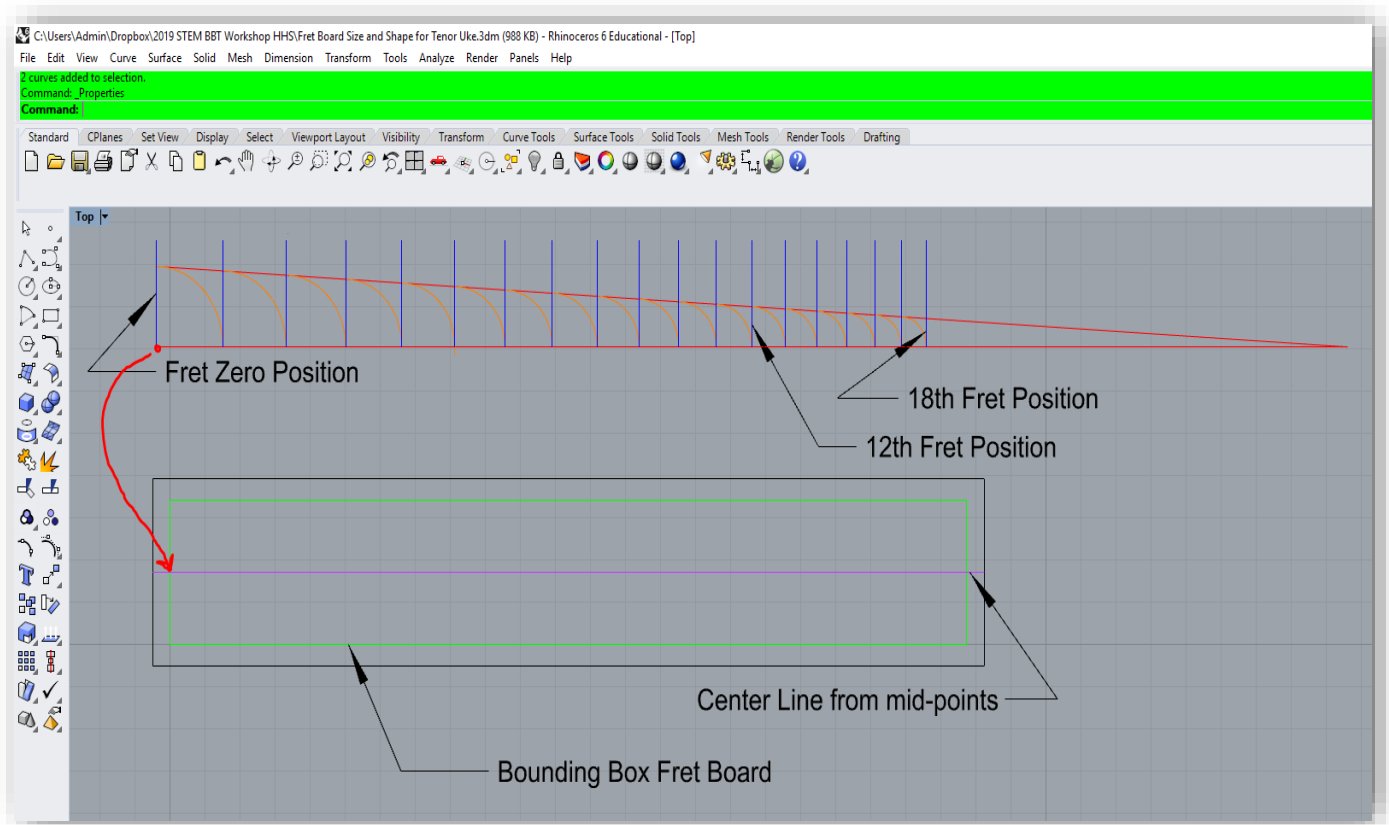
- ☛ Import your Fret Board Spacing CADD file from the first MLA.
- ☛ Next group those imported entities, and set them on the **Fret Line** layer. Be extremely careful not to lose the position of any lines. They all should be grouped together and moved as one entity.
- ☛ Remember these are only lines that indicate where the fret wire lines need to be marked. They may or may not match your fret board shape yet. Later on, you will extend or trim these to match your fret board shape and size.

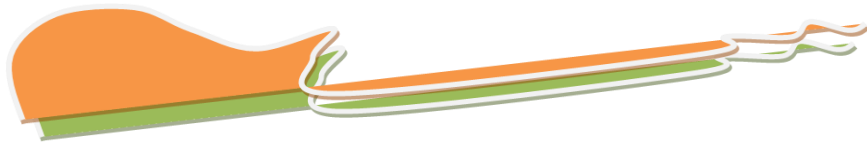




5) CADD Step 5 (Superimpose Fret Spacing to Board Material)

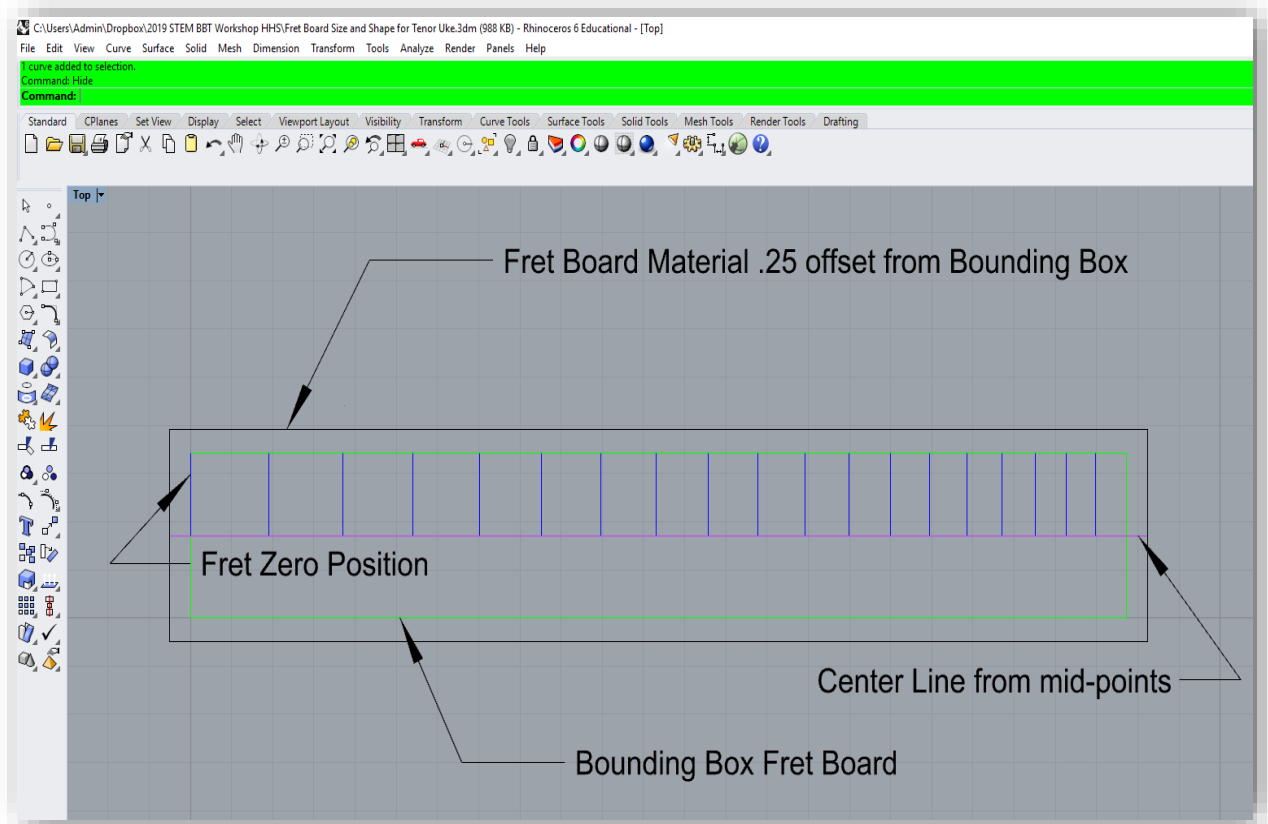
- ☛ If you haven't done so yet, it is recommended one group all 18 blue fret wires as one single entity. Next, move the fret wires from precise end of fret zero down to the left-handed intersection of the **purple** center line and **green** Bound Box Fret Board rectangle as shown.
- ☛ One is superimposing their fret board spacing onto the board blank and aligning it from the center line.

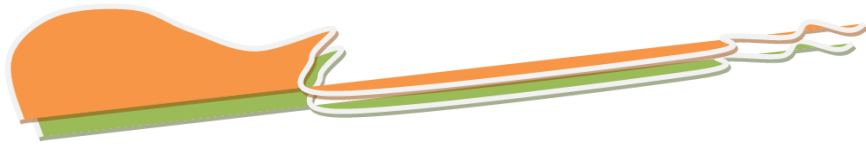




6) CADD Step 6 (Trim/Extend Fret Lines)

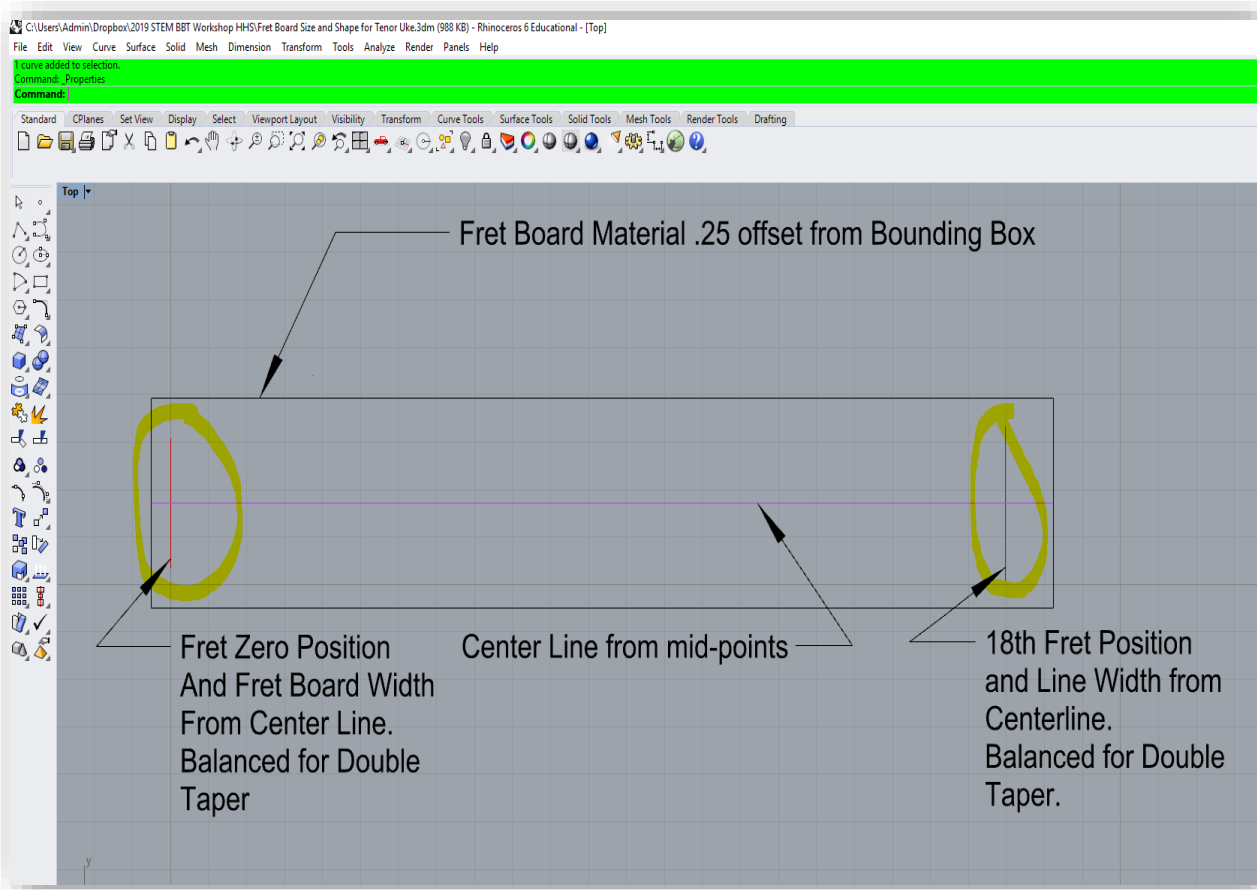
- ☛ Extend, trim, cut hide, etc....all 18 frets lines to the outer edges of the **green** Bounding Box Fret Board rectangle as shown.
- ☛ Hide your layout arcs if you haven't done so already.
- ☛ One needs to see just the fret position lines, the center line, Bounding Box Fret Board and Fret Board Material. See example below.
- ☛ At this point you may want to use the **mirror** command or extend all the **blue** fret wires to the lower half of the **green** Bound Box Fret Board. If not now, we will do that in Step #9.

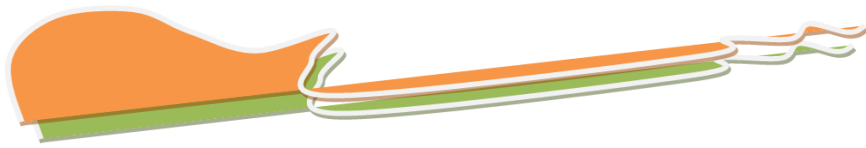




7) CADD Step 7 (Draw parallel ends to the trapezoid, aka the fret board shape)

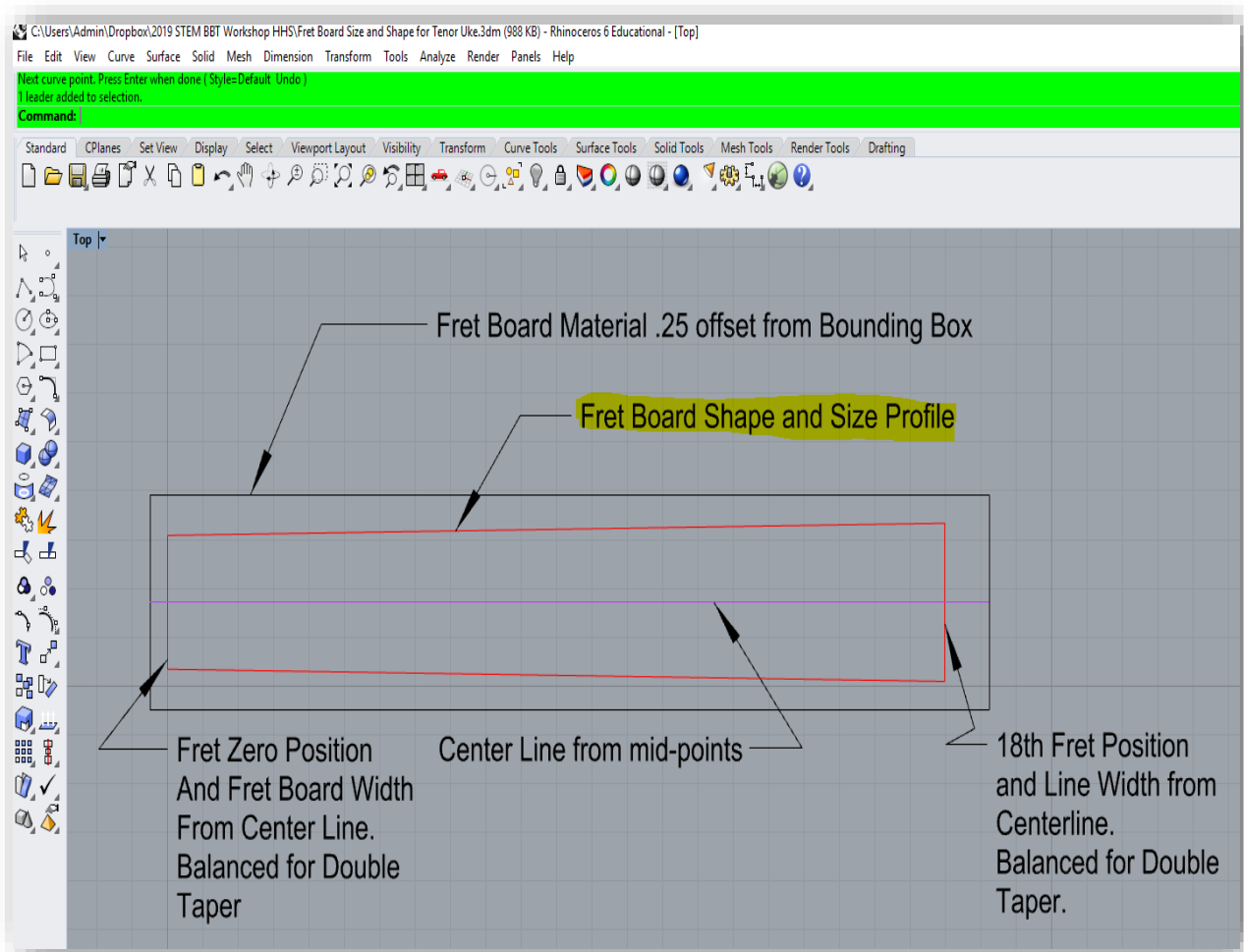
- For clarity, it is recommended that one use the layer command to hide all the fret lines as shown below.
- After hiding all fret wire lines. Draw the two parallel ends of the trapezoidal shaped fret board. Begin by locating **fret 0** and laying out the exact length of that fret line. Use the measurements you recorded in the Pre-CADD activity. Caution: the centerline is the exact half-way point for these lengths. This is critical for making the symmetrical, double tapered, fret board shaped trapezoid. For example, if the fret wire length is 1.500", then 0.750" must be on the center line.
- Next, locate 18th fret line position then layout the exact line length that is needed to create double taper. See example below. Remember the half way point must match up with the center line.

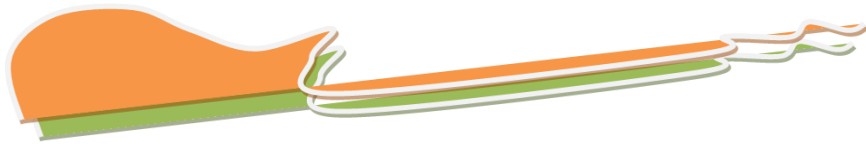




8) CADD Step 8 (Connect the Ends to complete the symmetrical double tapered shape)

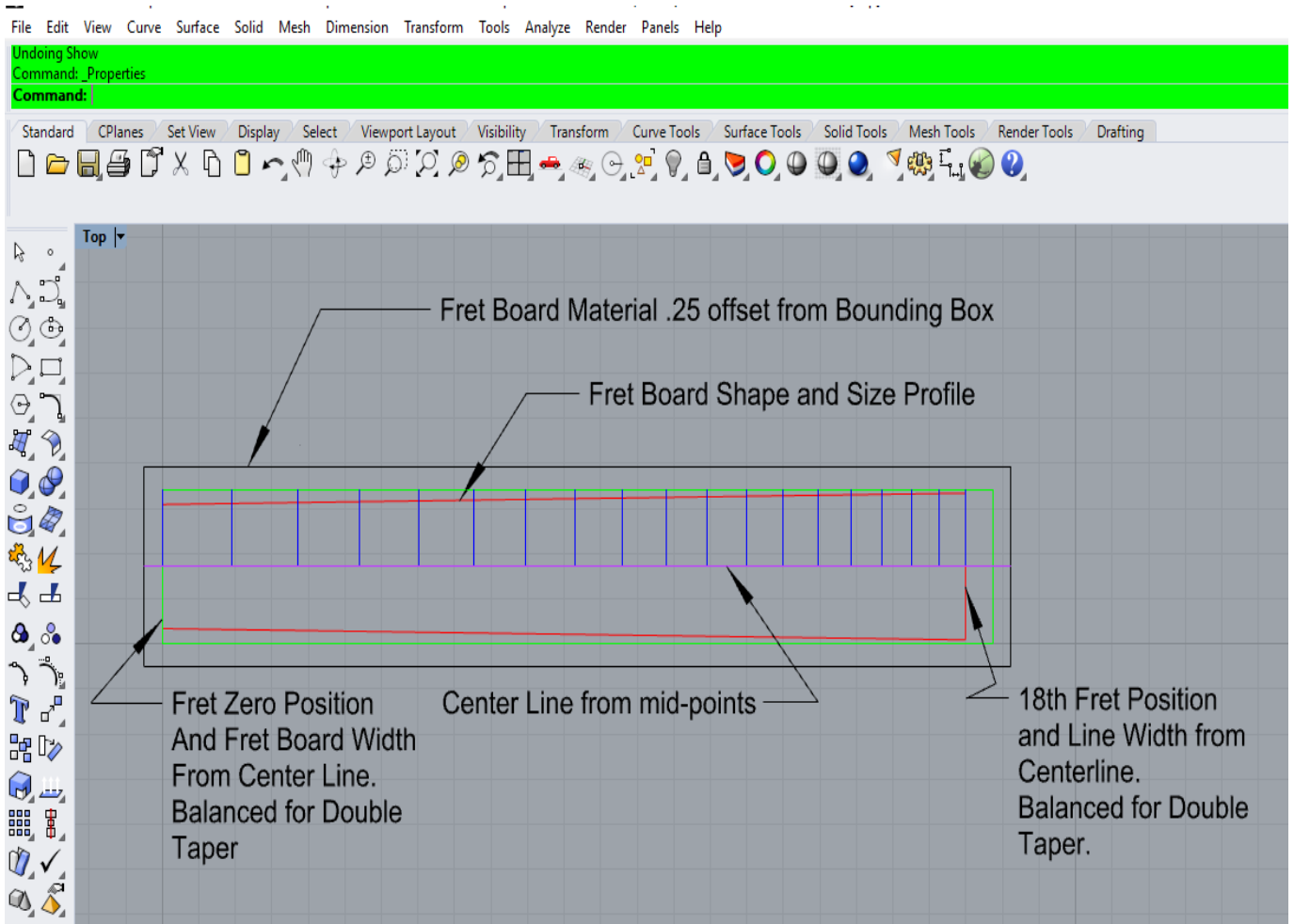
- Next, connect the end points of fret zero and the 18th fret with the lines as shown below. Do this for both halves. Congratulations, you have just created a symmetrical double tapered fret board shape.
- Use your dimensioning tools to verify all dimensions are accurate.





9) CADD Step 9 (What lines to show).

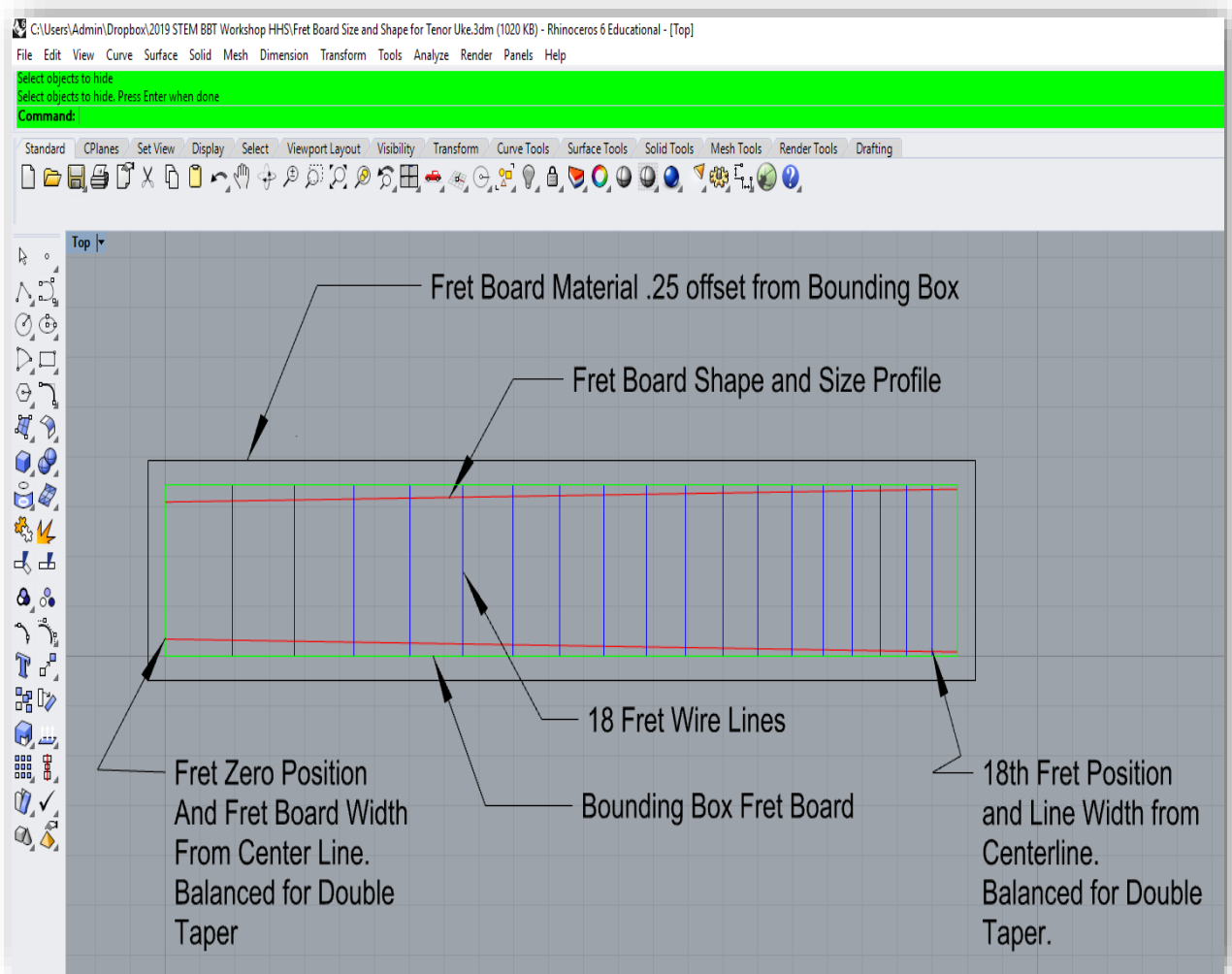
- ☛ Unhide or turn back on the **blue** fret wire layer.
- ☛ Extend all fret lines to **green** Bounding Box Fret Board rectangle.
- ☛ To recap one should now have:
 - a **green** rectangle that representing your fret board bounding box.
 - A **black** rectangle that represents the 0.25" offset fret board material.
 - A **red** trapezoid the fret board shape and size profile, 18 fret wire lines.
 - A **purple** line the represent the imaginary center of the fret board.
 - 18 **blue** fret wire lines

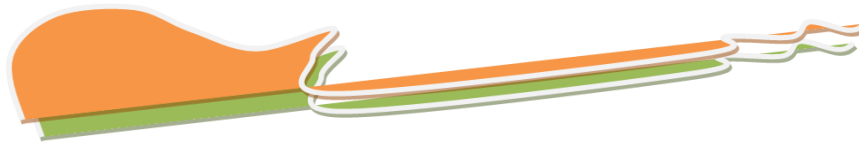




10) CADD Step 10 (Extend the double taper)

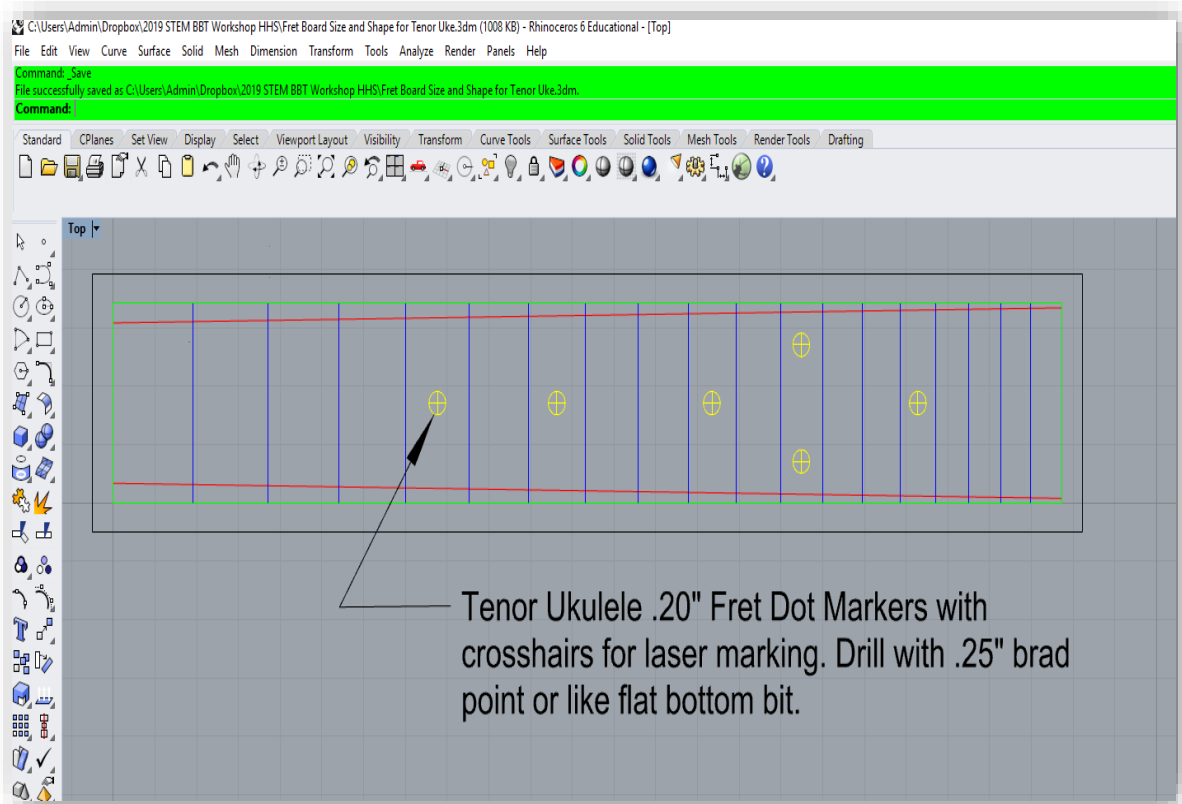
- Examine the far-right side of the fret board. If we laser cut that as is, we will only get 17 fret wires positions as the 18th will be cut through by the laser. One needs to extend both **red** tapered lines so that then intersect with the far edge of the **green** bounding box fret board.
- Material must be left beyond the last fret wire position. For this, we just extended the double tapered line to their lineal intersections.





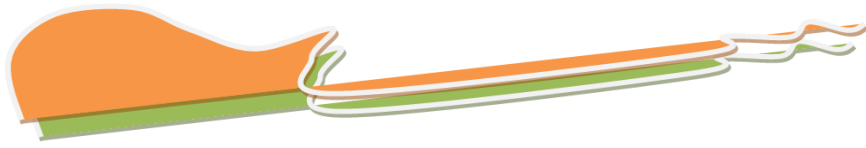
11) CADD Step 11 (Add the Fret Maker Dots)

- Typically, our fret boards use a $\frac{1}{4}$ " dots place along the center line at various spaces. Using double dots for the 12th fret. Locate yours accordingly.
- For this exercise one will draw in these circular dots so that our laser can all mark them. Make sure you include a center mark "+" as the intersecting lines will mark the true center for the $\frac{1}{4}$ " brad point or forstner drill bit.
- The circles are not absolutely necessary, but provide a good visual reference. If you do add the lasered circles, then it is recommended that you make them a bit undersized. The laser beam has a kerf diameter that must be calculated into your circle diameters. As stated about, we will make the circles a little smaller and let the drill bit cut then precisely.



12) CADD Step 12 (Save and Export)

- Congratulations, you now have the fret board design ready for the laser!
- For now, save your work and make backup copies.
- Export you fret board design work as a .DXF file type. No DXF means no laser work for you!
- Inspect you drawing for accuracy by printing off a full-sized 1:1 drawing.
- Your drawing must include a title box and border.
- Submit for a grade.



13) CADD Step 13 (Next Up)

- ☛ In the next MLA activity, we will prepare your CADD design file for the laser cutter by grouping like lines and vectors.
- ☛ We will cut out a test sample and make any compensations for laser beam kerf width.
- ☛ In addition, we will walk one through how to set the power and laser speed and review safety.

Quiz:

Circle the Best Answer

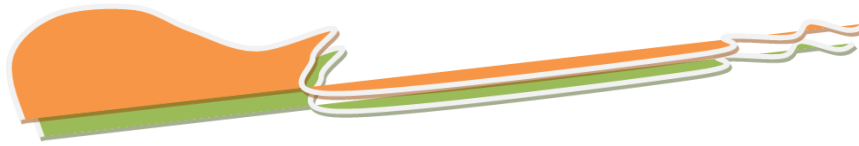
1. How much larger should your blank fret board material be compared to the actual model?
 - Approximately $\frac{1}{4}$ " all the way around
 - Approximately $\frac{3}{4}$ " all the way around
 - Approximately 1" all the way around
 - Not larger. Needs to be the same size.
2. What file type does our laser cutter need export from your CADD designs?
 - .DWG
 - .RHL
 - .DXF
 - .STL
3. What CADD command makes placing parallel lines at a set distance accurate and easy?
 - Offset
 - Copy
 - Parallel
 - Mirror
4. Why is it recommended that one use crosshairs at the center of all laser marked circles that will be later drilled?
 - Because watching the laser in action is cool.
 - To mark the true center point of a circles that will be drill out later.
 - To practice drawing lines.
 - Both A and C.
5. What is the purpose of the centerline?
 - To mark the true center of a given object.
 - To show hidden features.
 - To show the placement of text, notes and dimensions.
 - Both B and C
6. Why are drawing layers important?



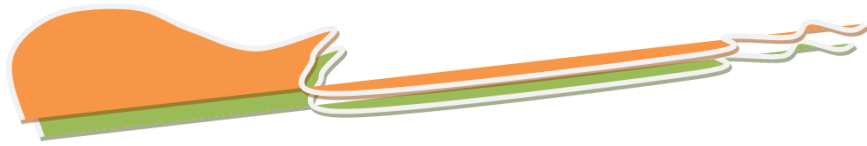
- It is easier for one to understand the drawing by separating features to individual layers.
 - To organize lines and features into individual manageable pieces based on their function.
 - It gives the user greater control as one is able to show, hide, lock, unlock, color change various lines and features.
 - All the above.
7. What type of taper to fret boards have?
- Single
 - Double
 - Asymmetrical
 - MT#2
8. When figuring out the symmetrical double taper at what two fret lines should one collect the necessary dimensions?
- Fret 1 and Fret 12
 - Fret 0 and Fret 13
 - Fret 1 and 14
 - The two frets farthest apart
9. What command is used in open a drawing within another drawing?
- Open
 - Import
 - Insert
 - Exit
10. If one can't measure an existing fret board for size and shape dimensions, how can they find the needed information?
- Google it.
 - Guess
 - Ask a friend
 - Ask your teacher

Answer Key

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9. What command is used in open a drawing within another drawing?
 - Open
 - Import
 - Insert
 - Exit
10. If one lacks a given or existing fret board to measure for the size and shape dimensions. How can one find the needed information?
 - Google it. Research guitar building website to harvest the needed information.
 - Guess, being off a few 1/16ths of an inch is no big deal.
 - Ask a friend
 - Ask a band member



Reviewing Faculty Cohort Members:

Allen Androkites

Alex Moll

Matt Peitzman