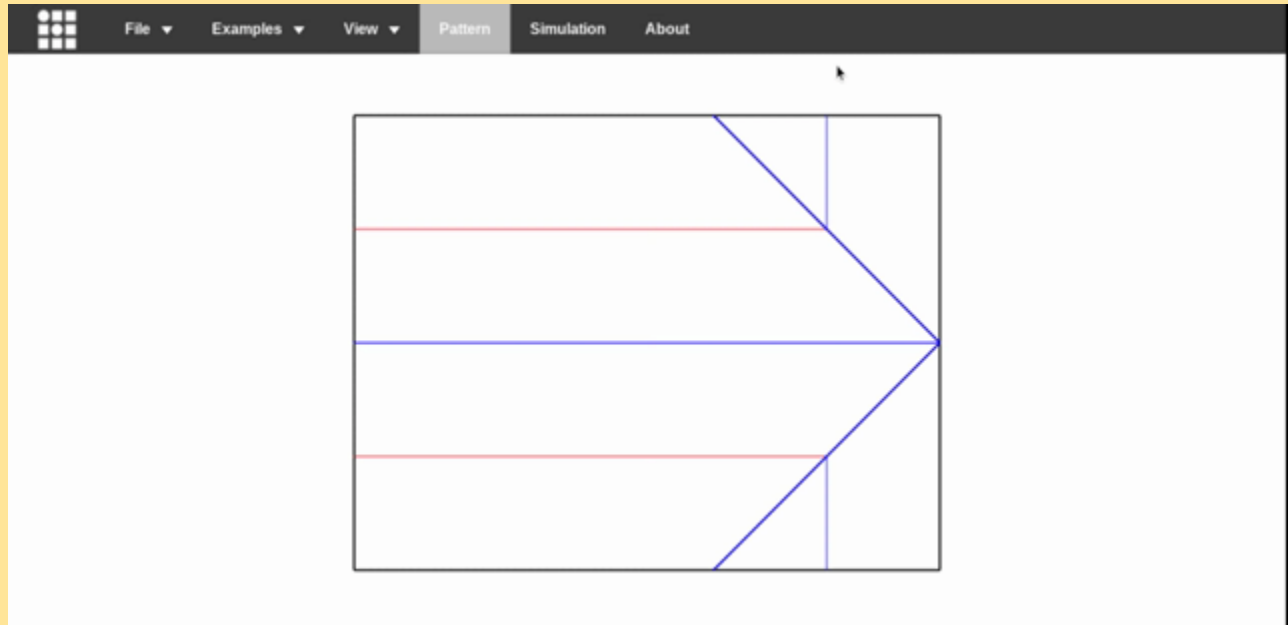


# Overview

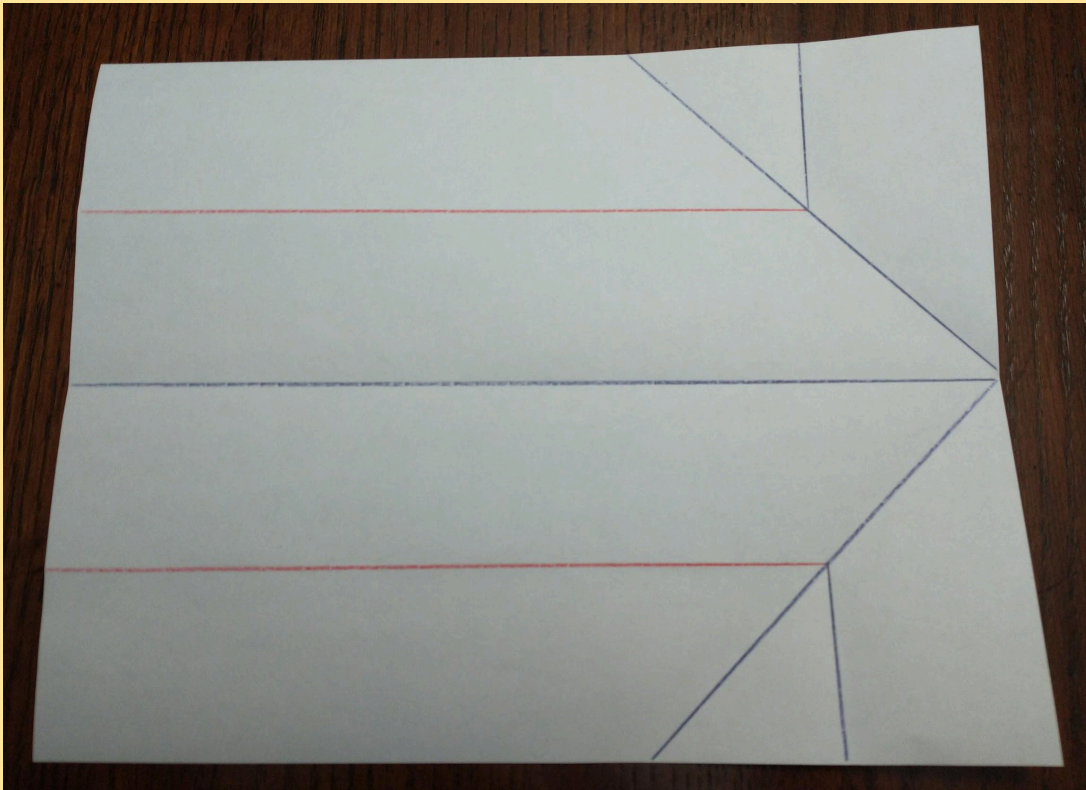
*Folding paper airplanes has been a favorite activity among people for many generations. All it takes is some paper and a few folds, and you've created a fun flying model. This tutorial will walk you through the steps on how to transform your analog paper airplane into a digital simulation.*



# Analog

Supplies:

- US Letter Paper (8.5" x 11")
  - Ruler
  - Colored Pencils or crayons (Red & Blue)
1. Visit <https://www.foldnfly.com/0.html#The-Basic>
  2. Follow the instructions and fold the plane.
  3. Unfold the paper and draw the folds. Mountain folds should be red, valley folds should be blue.



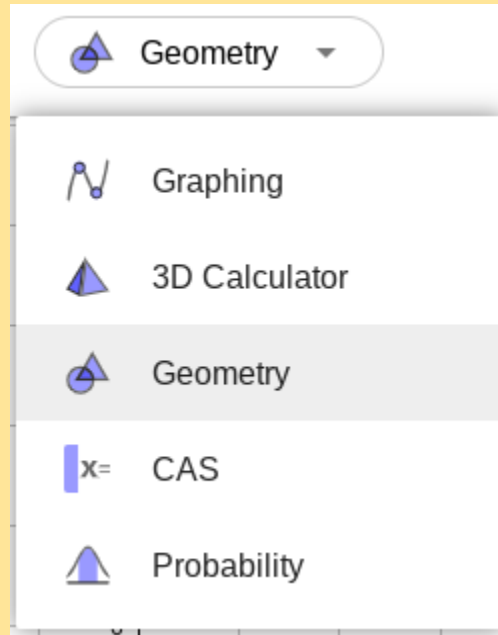
4. This is your analog crease pattern for the airplane. Now, let's make it digital!

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# Digital Crease Pattern Construction










1. Go to <https://www.geogebra.org/calculator>
2. In the dropdown at the top of the screen, select Geometry

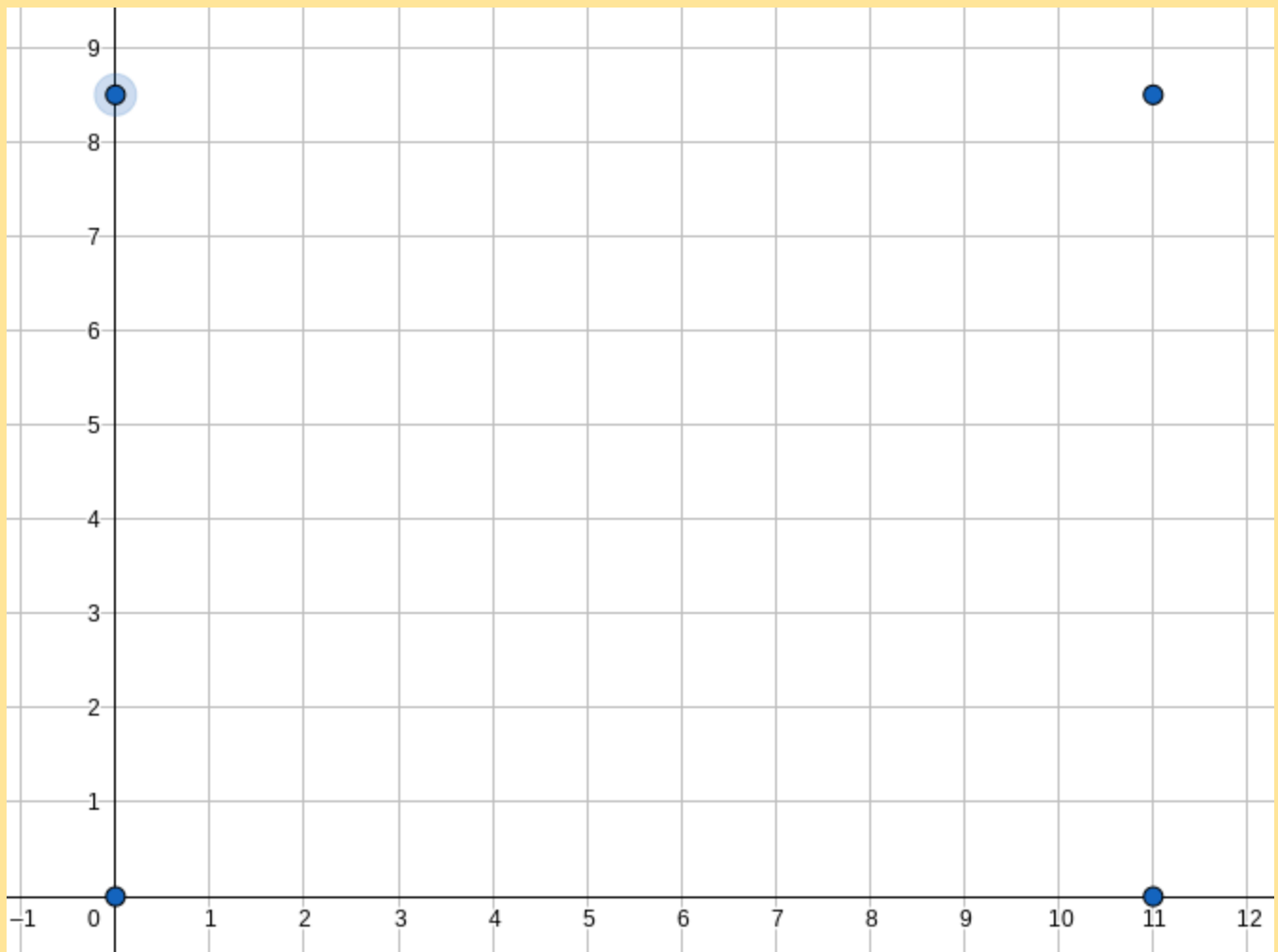


3. We need to turn off the labeling before we begin constructing:



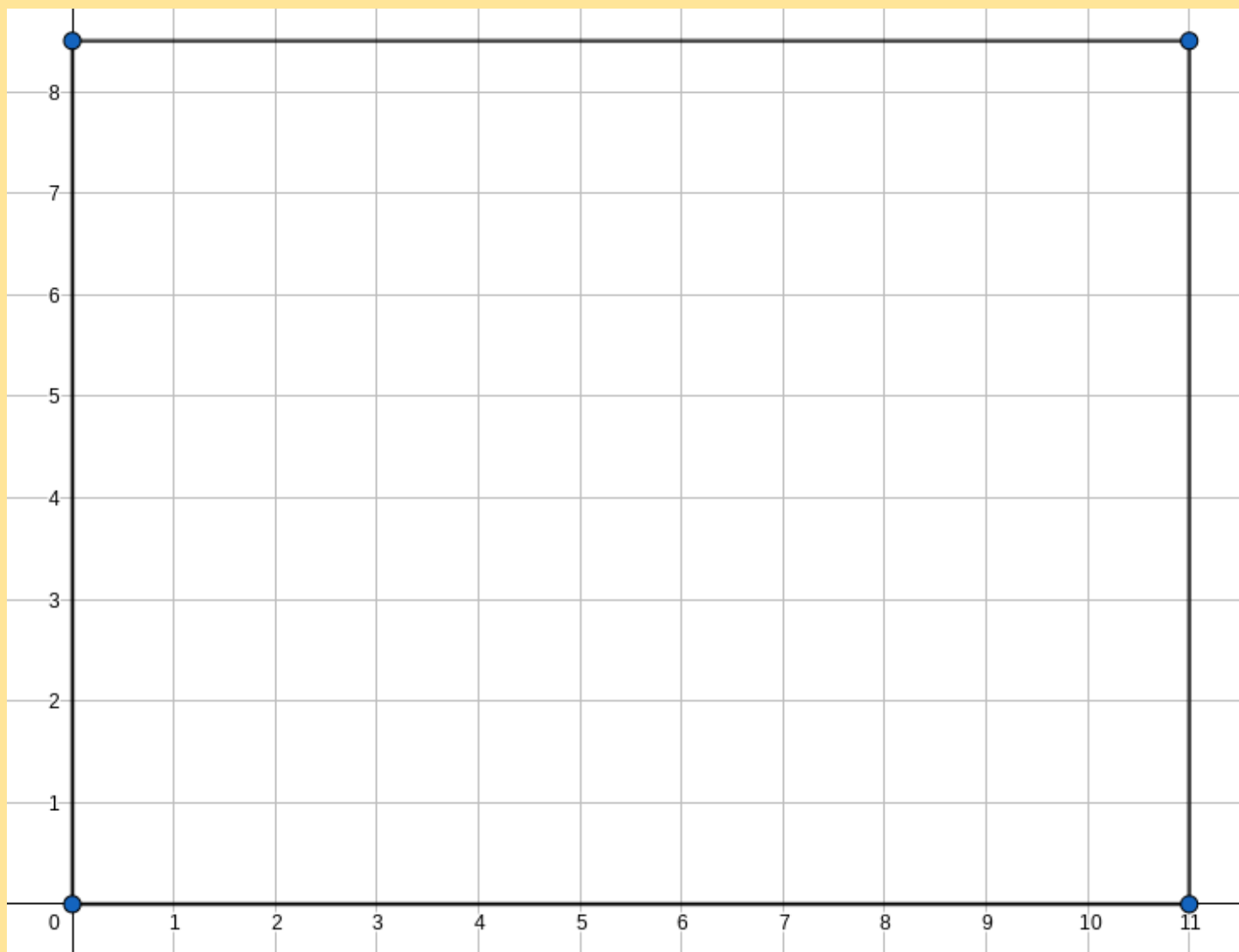
4. First, create the vertices for the rectangular piece of paper, by plotting points at (0,0), (11,0), (11,8.5), and (0,8.5). You can do this by clicking on the Algebra button on the left, and then entering in the coordinates in the sidebar.

 Algebra		A = (0, 0)	
		B = (11, 0)	
		C = (11, 8.5)	
		D = (0, 8.5)	

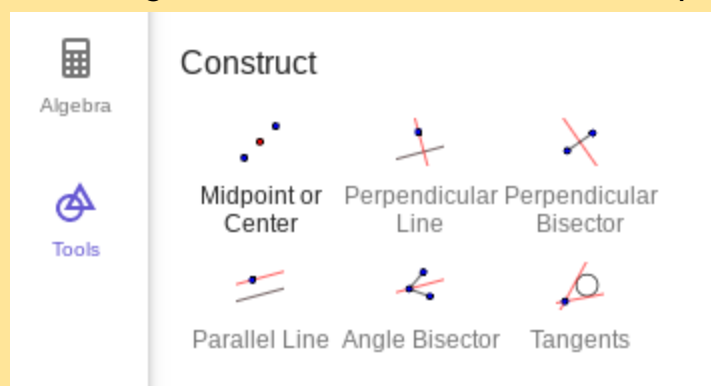


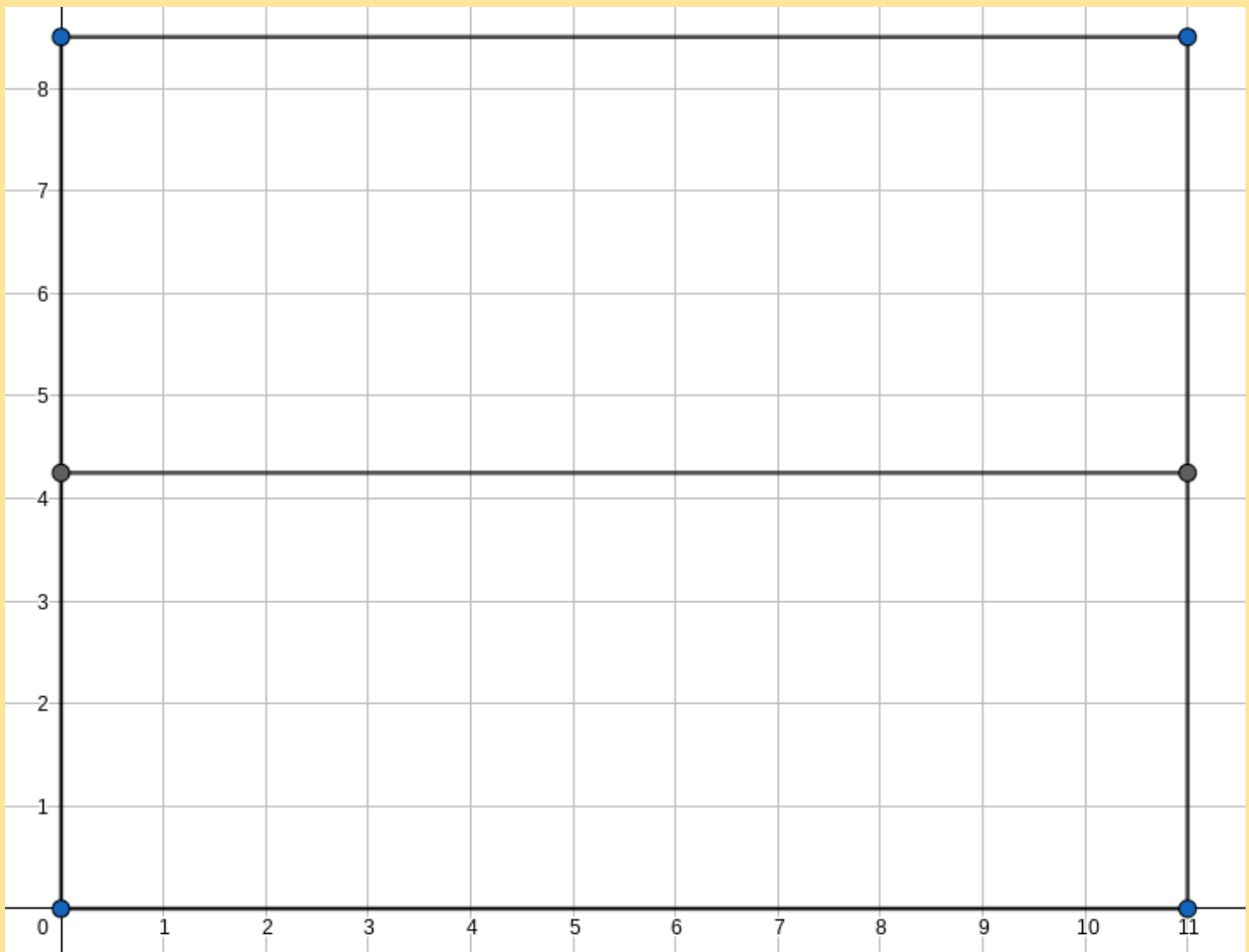
5. Next form the rectangle using the segment tool.



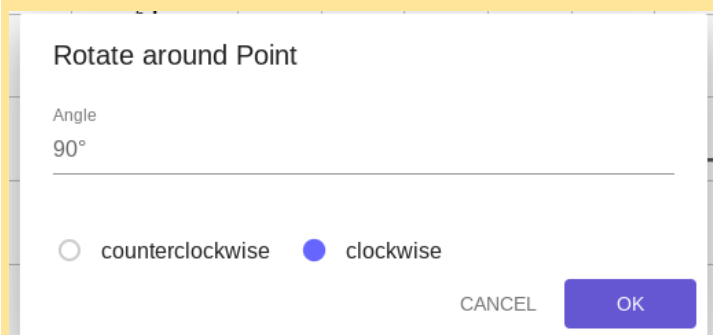
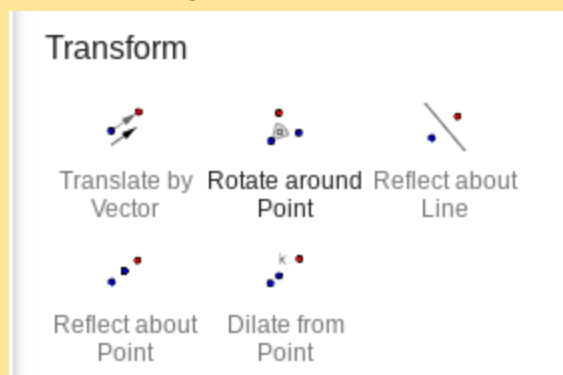


6. Now let's form the folds, in the same order as when you folded the paper. To make the centerfold, use the midpoint tool to find the midpoint of the left and right sides of the rectangle. Then use the segment tool to connect the two midpoints.



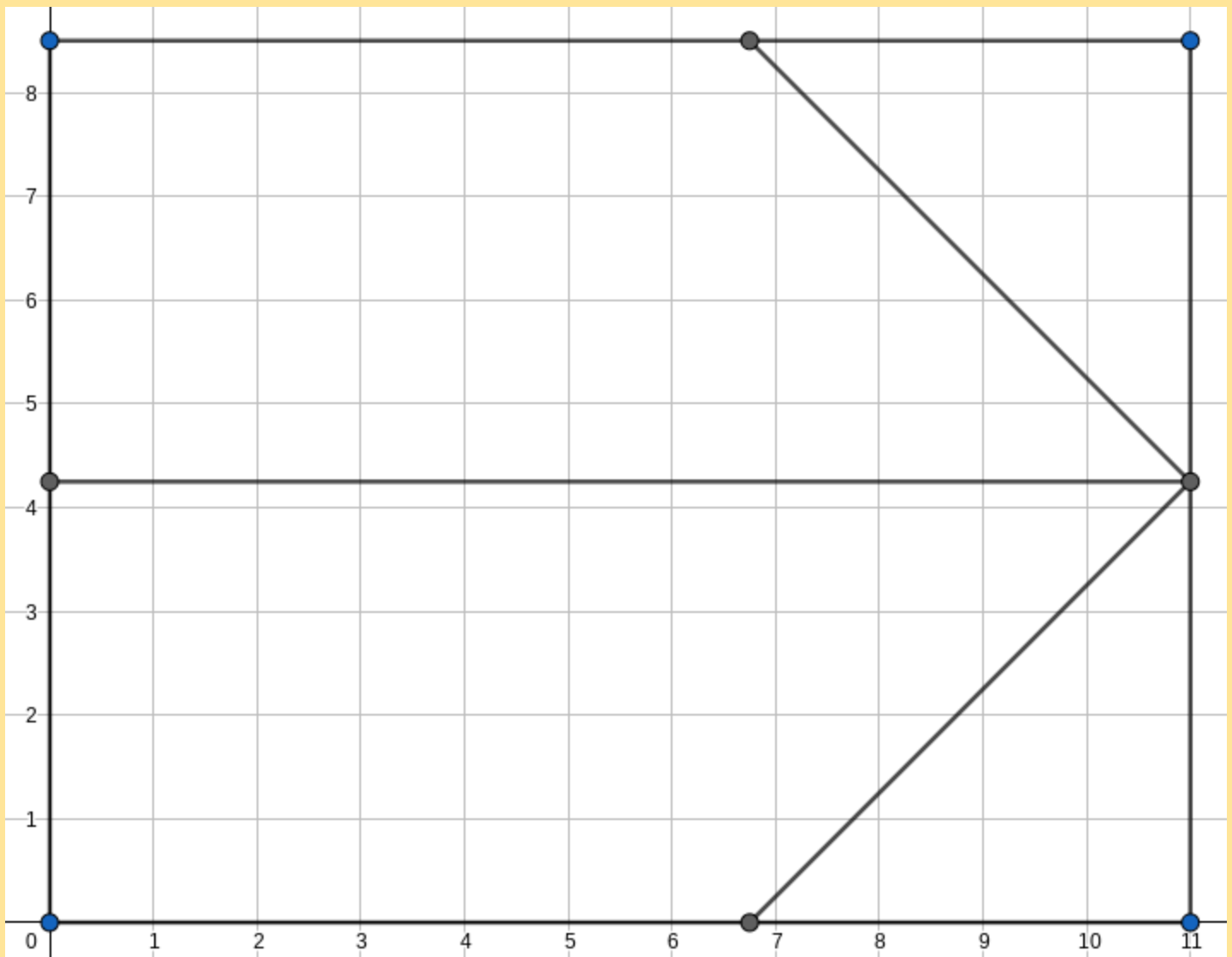


7. Now to construct the two corner folds, we will use the Rotate around Point tool. Rotate the midpoint of the right side of the rectangle  $90^\circ$  clockwise around the upper right corner of the rectangle. Repeat this process to rotate the midpoint of the right side of the rectangle  $90^\circ$  counterclockwise around the lower right corner of the rectangle.



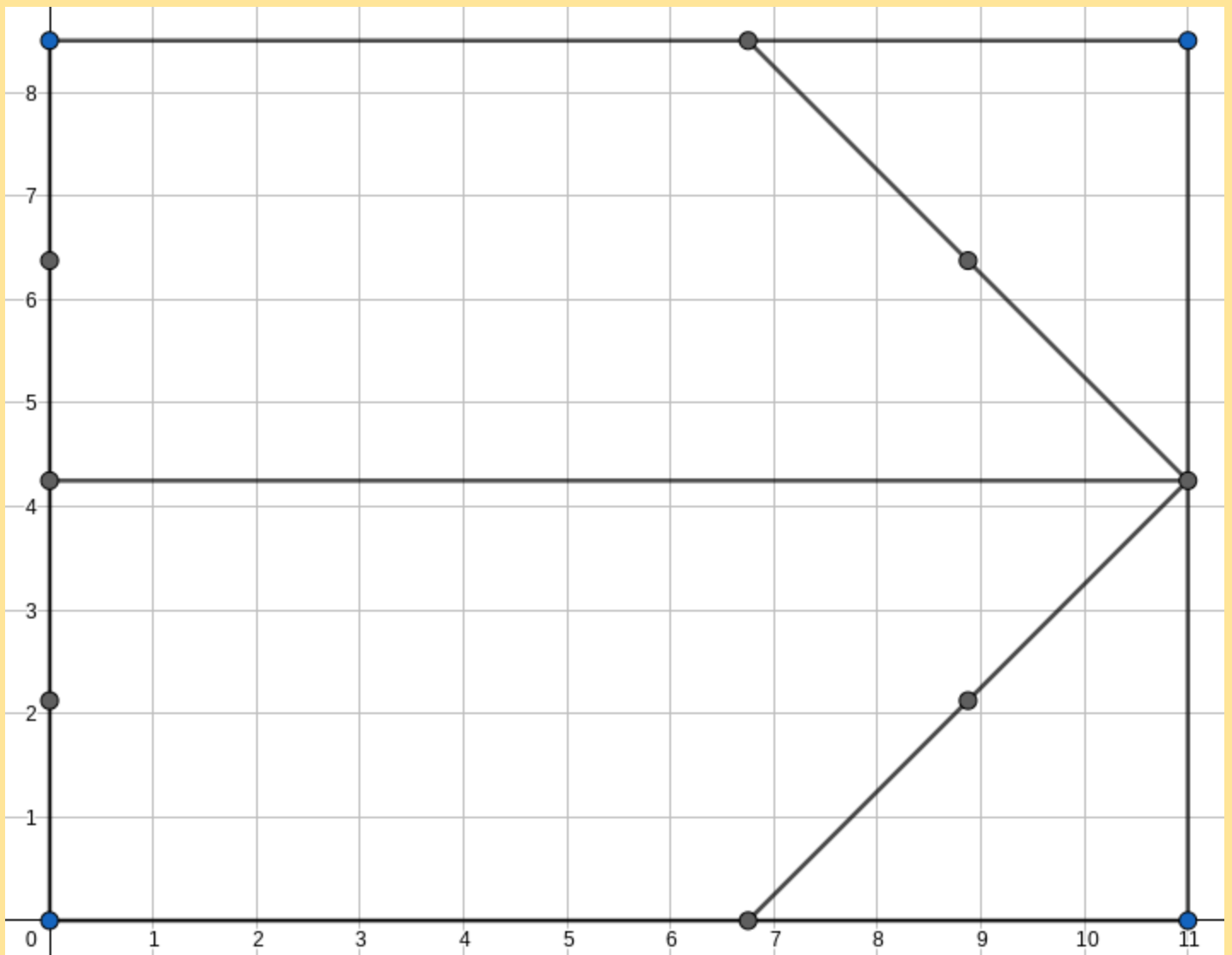


8. Then use the segment tool to connect the two rotated points to the right side midpoint.

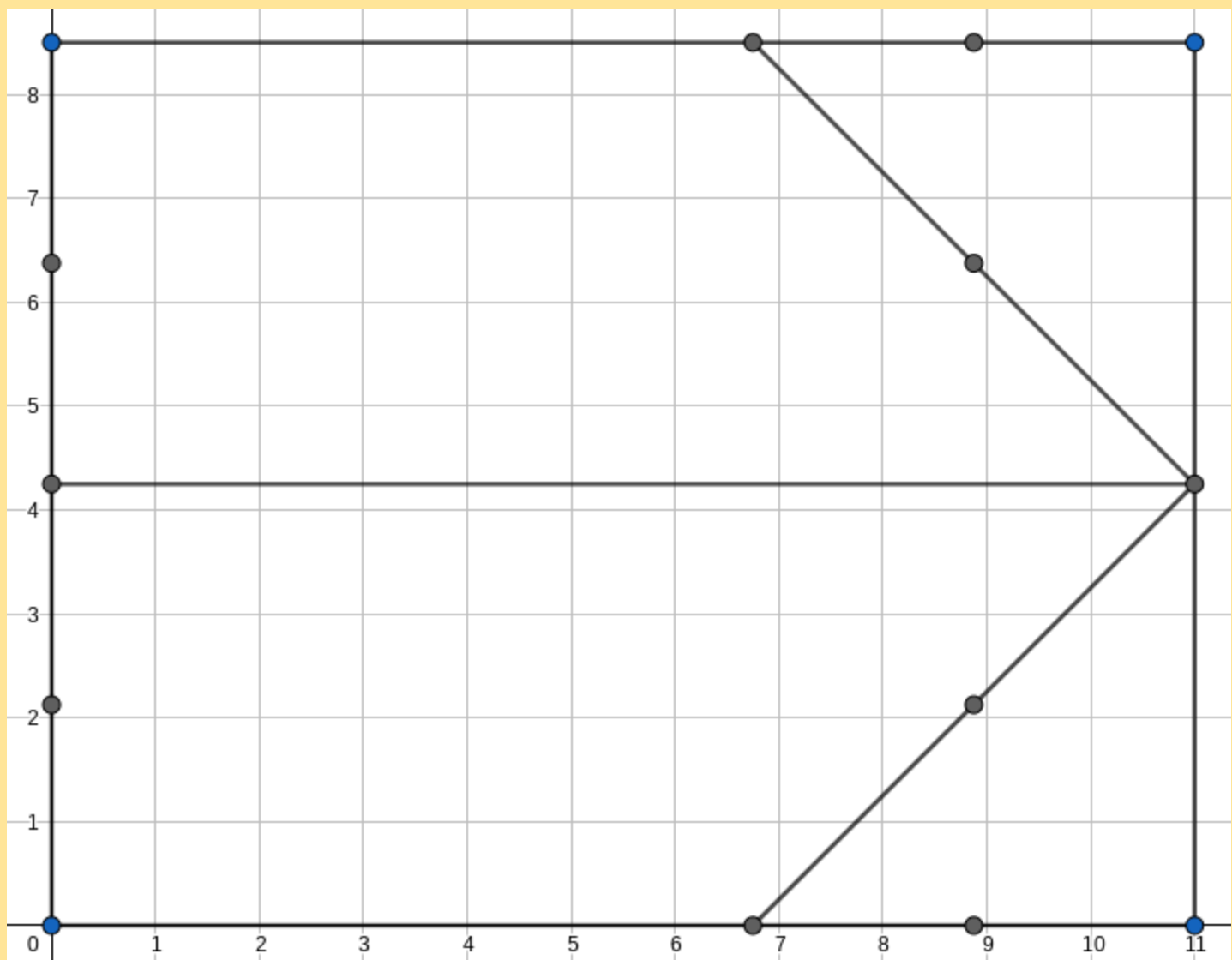


9. To create the edge folds, use the midpoint tool again to find the midpoint of the two corner folds. Also find the midpoint of the bottom half and the upper half of the left edge of the rectangle.

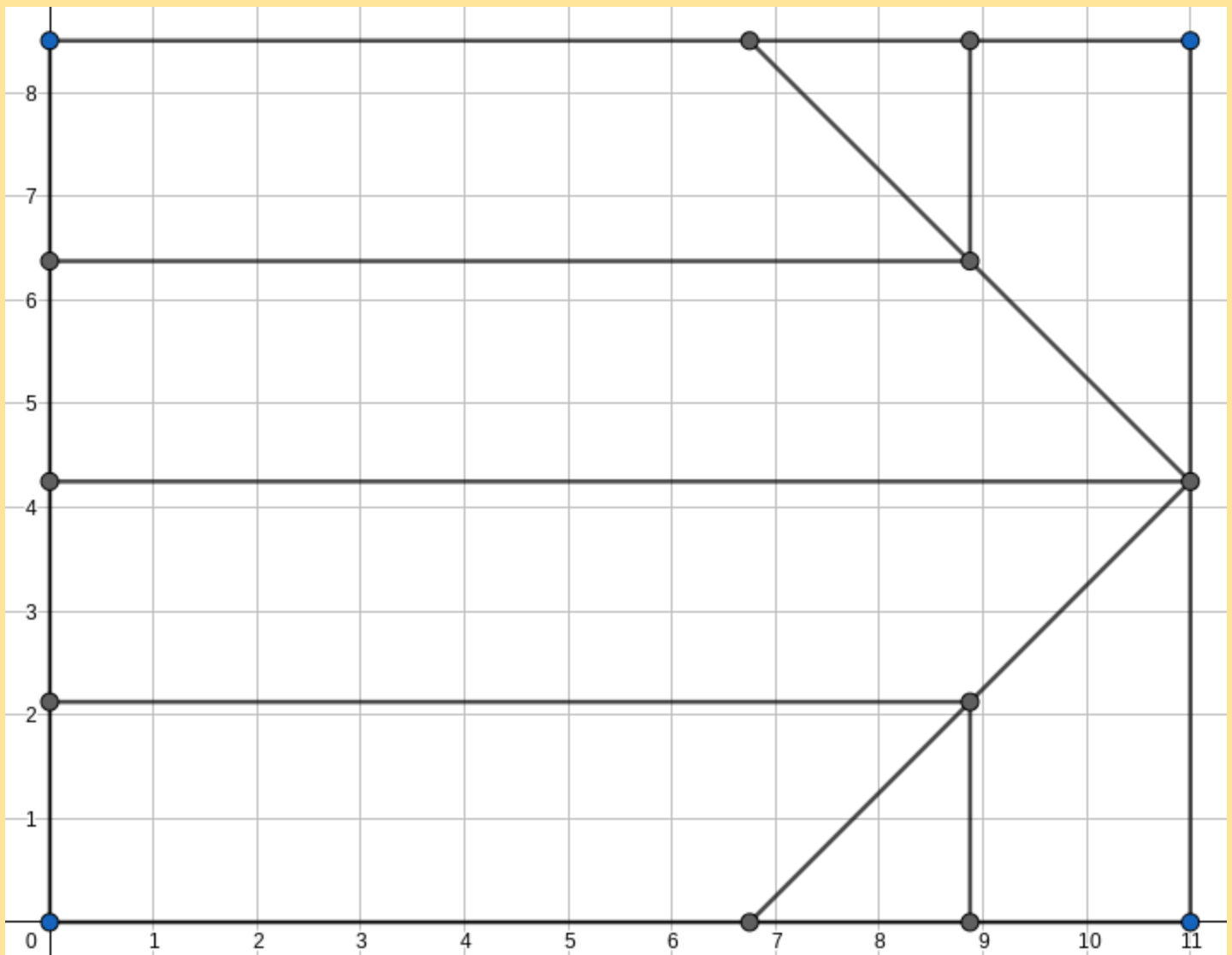




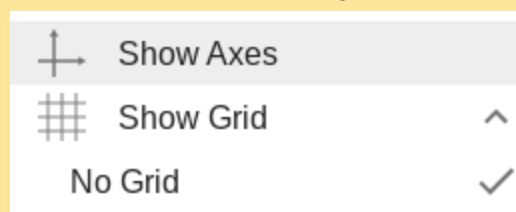
10. Then find the midpoint of the lower right and upper right of the bottom and top edges of the rectangle.



11. Then use the segment tool to construct the folds.



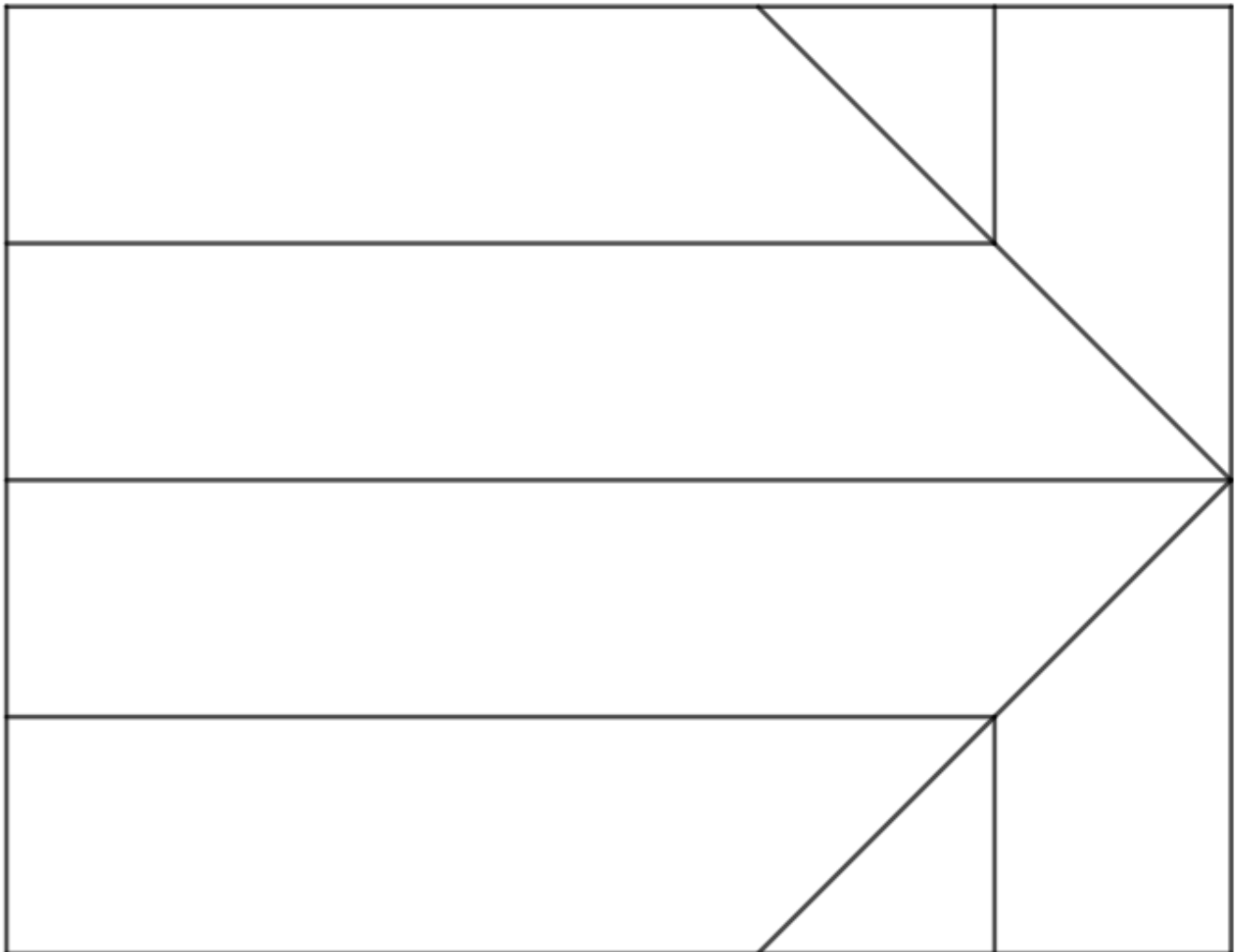
12. Now the crease pattern is constructed. Next, let's prepare it for the Origami Simulator.
13. First, turn off the grid and axes. Click on the gear in the upper right corner to do this.



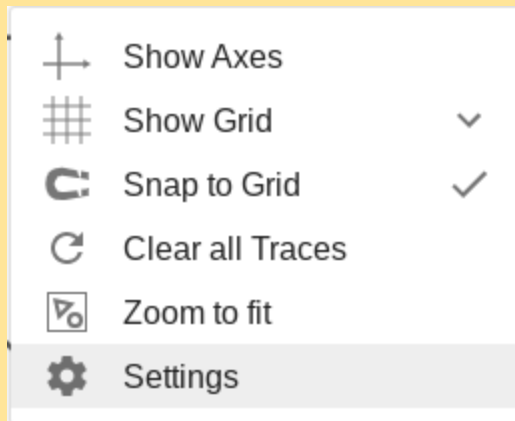
14. Next, turn off all of the points. Click on the Algebra button on the far left. Then click on the circles for the points, in the sidebar. Note: Points will be named using capital letters.

<input checked="" type="radio"/>	$A = (0, 0)$	⋮
<input type="radio"/>	$B = (11, 0)$	⋮
<input type="radio"/>	$C = (11, 8.5)$	⋮
<input type="radio"/>	$D = (0, 8.5)$	⋮

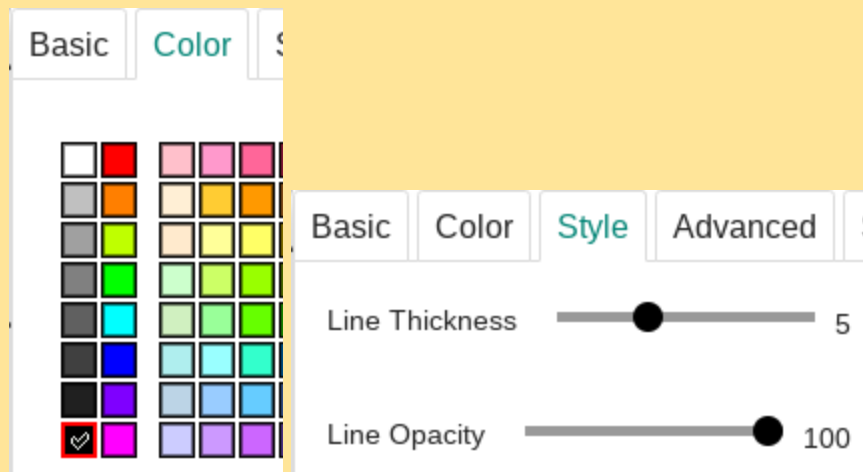
<input type="radio"/>	$E = \text{Midpoint}(i)$ $\rightarrow (0, 4.3)$	⋮
<input type="radio"/>	$F = \text{Midpoint}(g)$ $\rightarrow (11, 4.3)$	⋮



15. Now we need to set the colors for the segments. Click on the gear in the upper right, and select Settings.

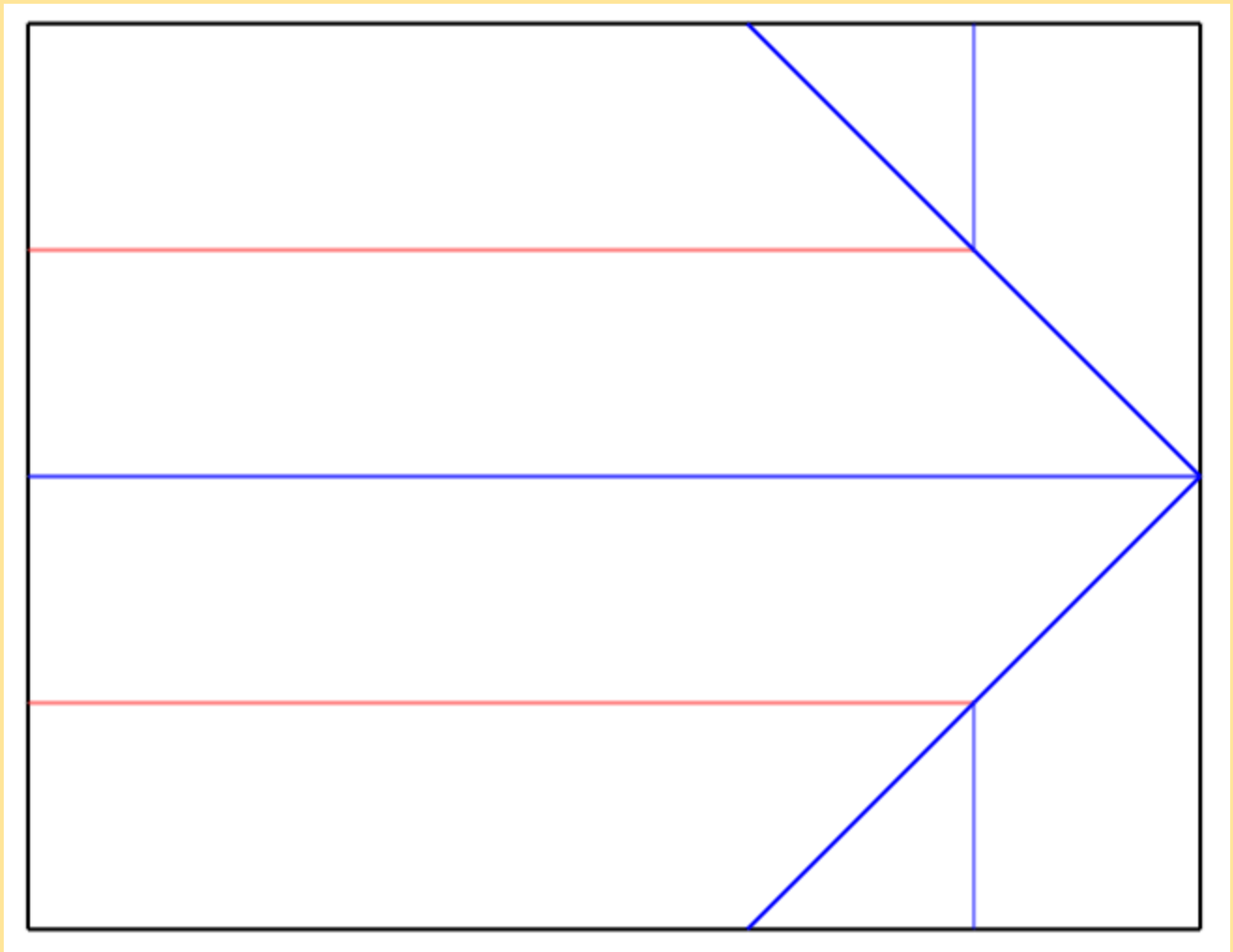


16. The rectangle sides should all be black and the opacity should be 100%. Click on a segment and set the color and opacity (found under the Style tab).



17. Repeat these steps for the other segments. Refer to your analog crease pattern to determine which segments should be red and which are blue. Also because the two edge folds (step 4 from the Fold 'N Fly instructions) form 90° angles with the body of the plane, these folds should have an opacity of 50%. All the other creases are folded completely flat, and should have an opacity of 100%. You can experiment with the opacity of the centerfold.

18. Your crease pattern should now be all ready for exporting!



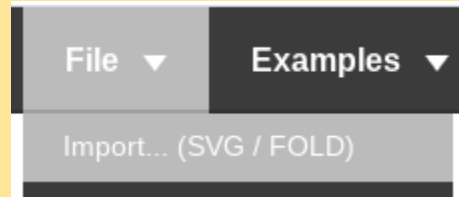
19. Click on the three bars in the upper left corner. Select Download as -> SVG image (.svg)

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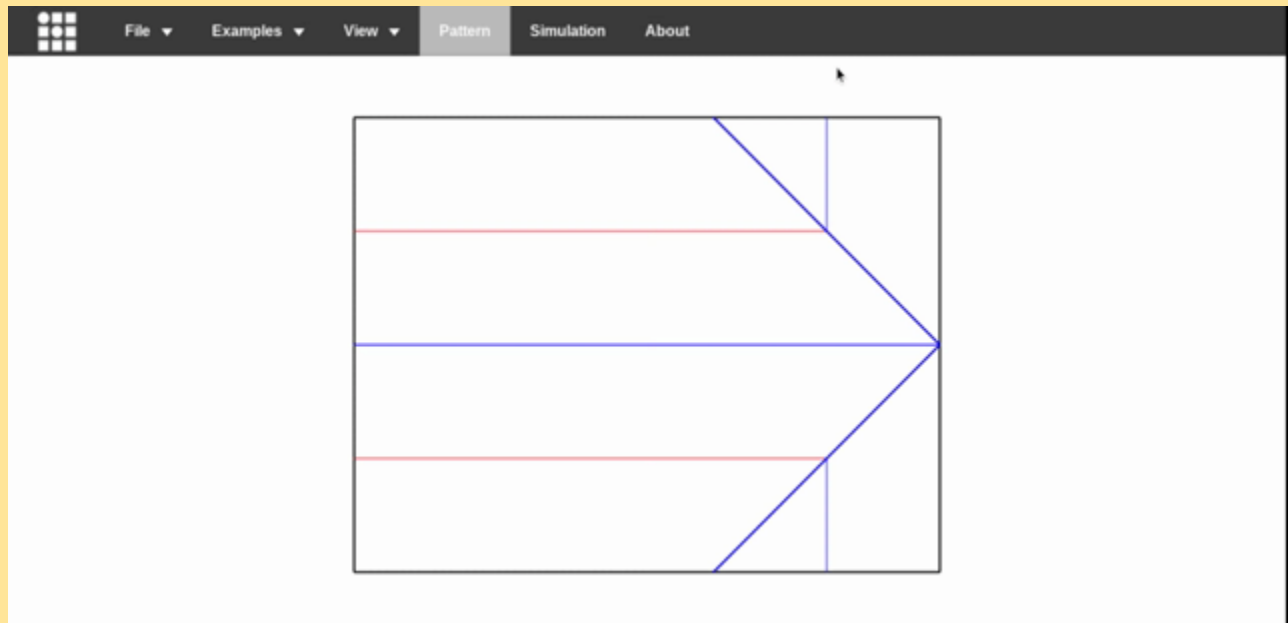
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# Origami Simulation

1. While most would not consider folding a paper airplane as origami, we will use an Origami Simulator to create a digital version of our airplane.
2. Visit <https://origamisimulator.org/>
3. In the upper left, click on File -> Import... (SVG/FOLD)



4. Import your downloaded SVG file from GeoGebra.
5. Use the controls at the bottom of the screen to play with your Paper Airplane Fold Simulation!

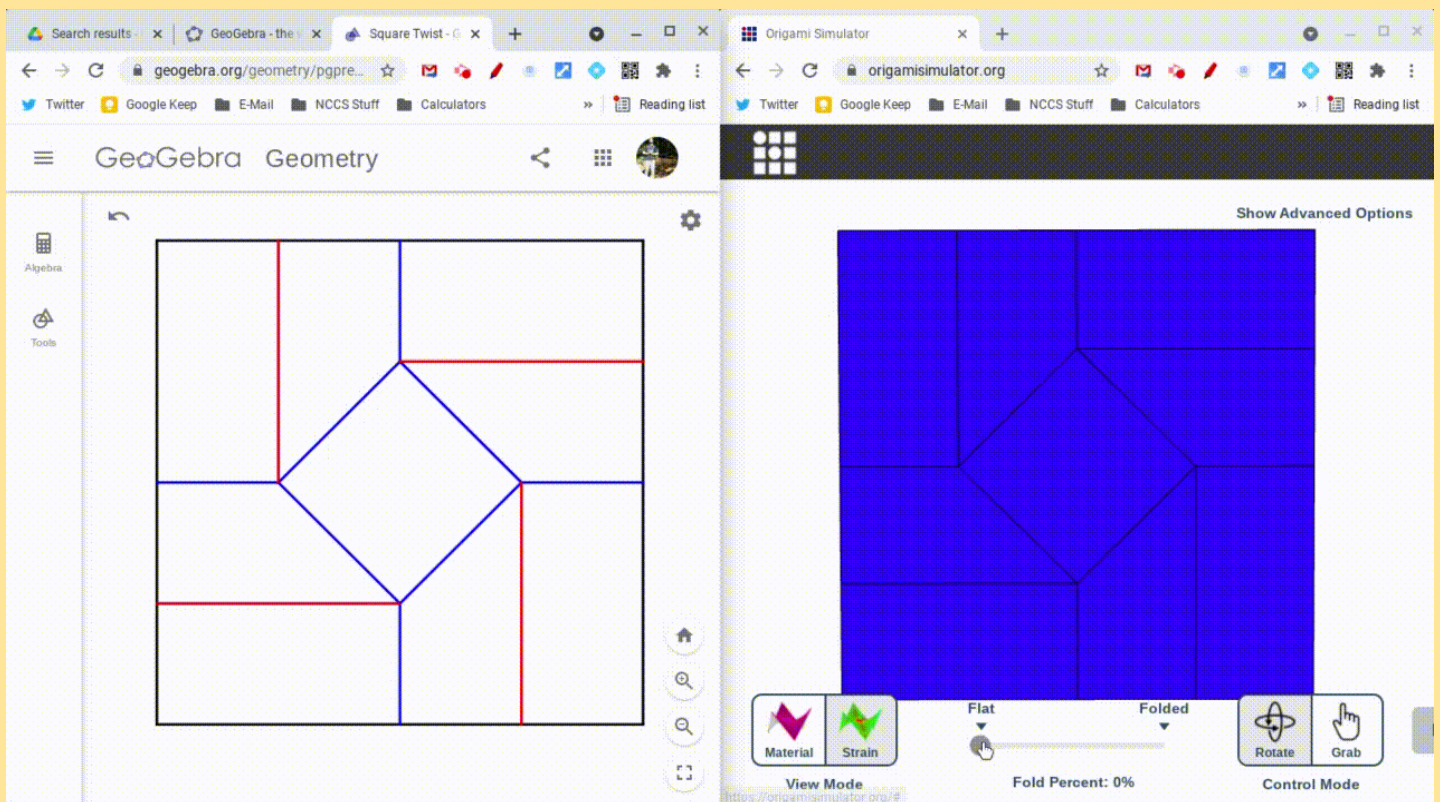
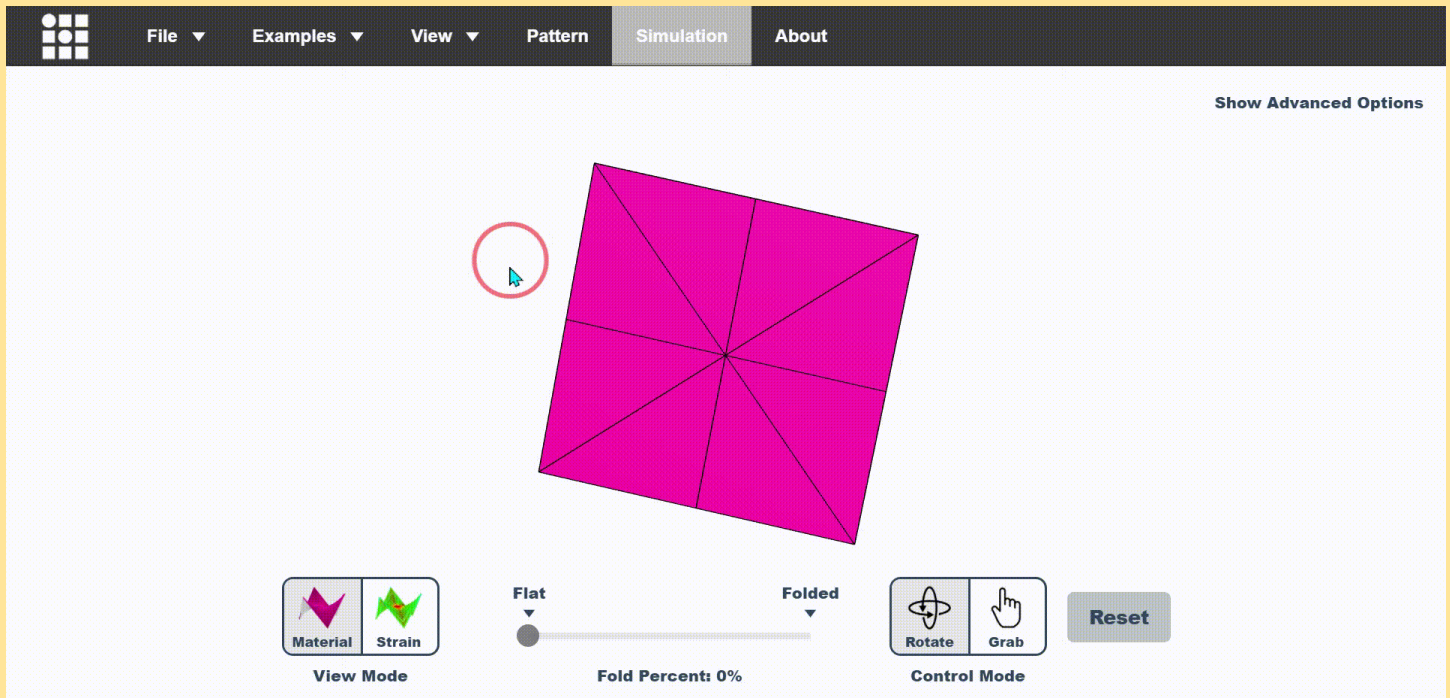


6. Try using the “Show Advanced Options”, found in the upper right corner.
  7. Also try this same tutorial for other airplane and origami designs!
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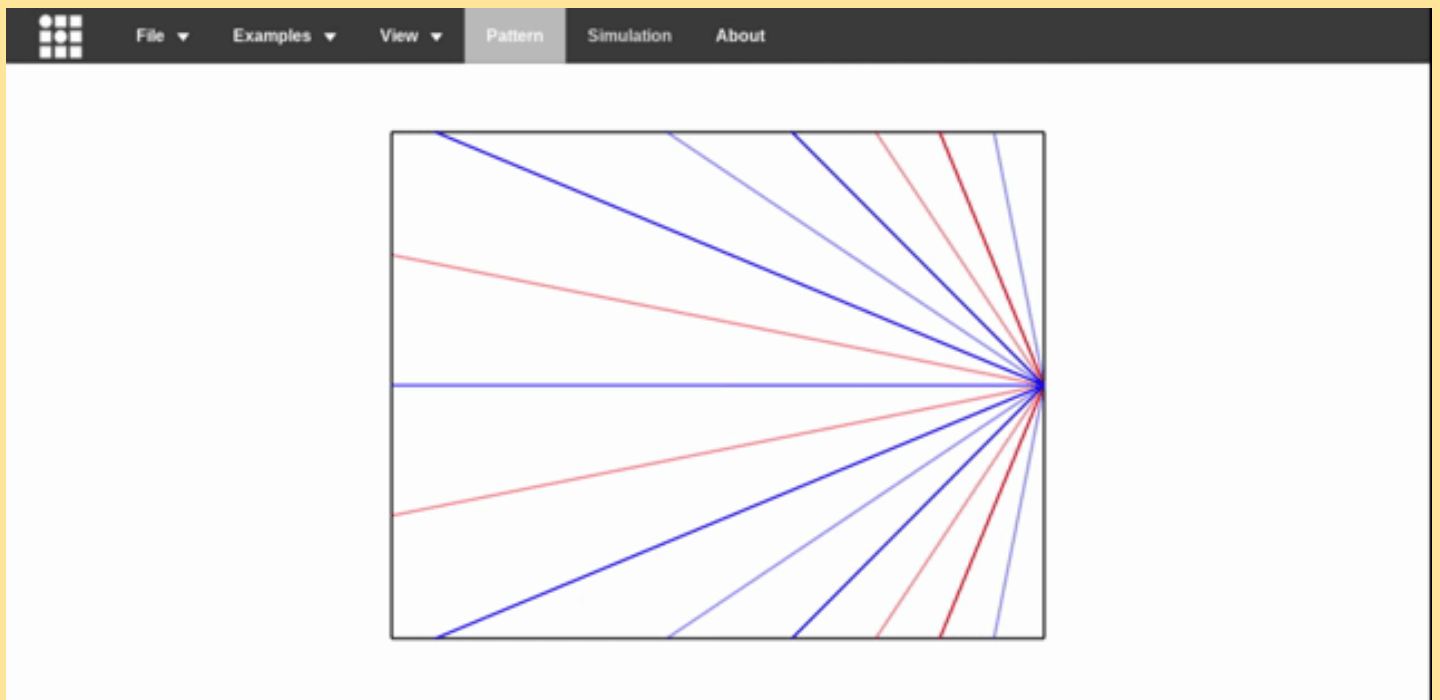
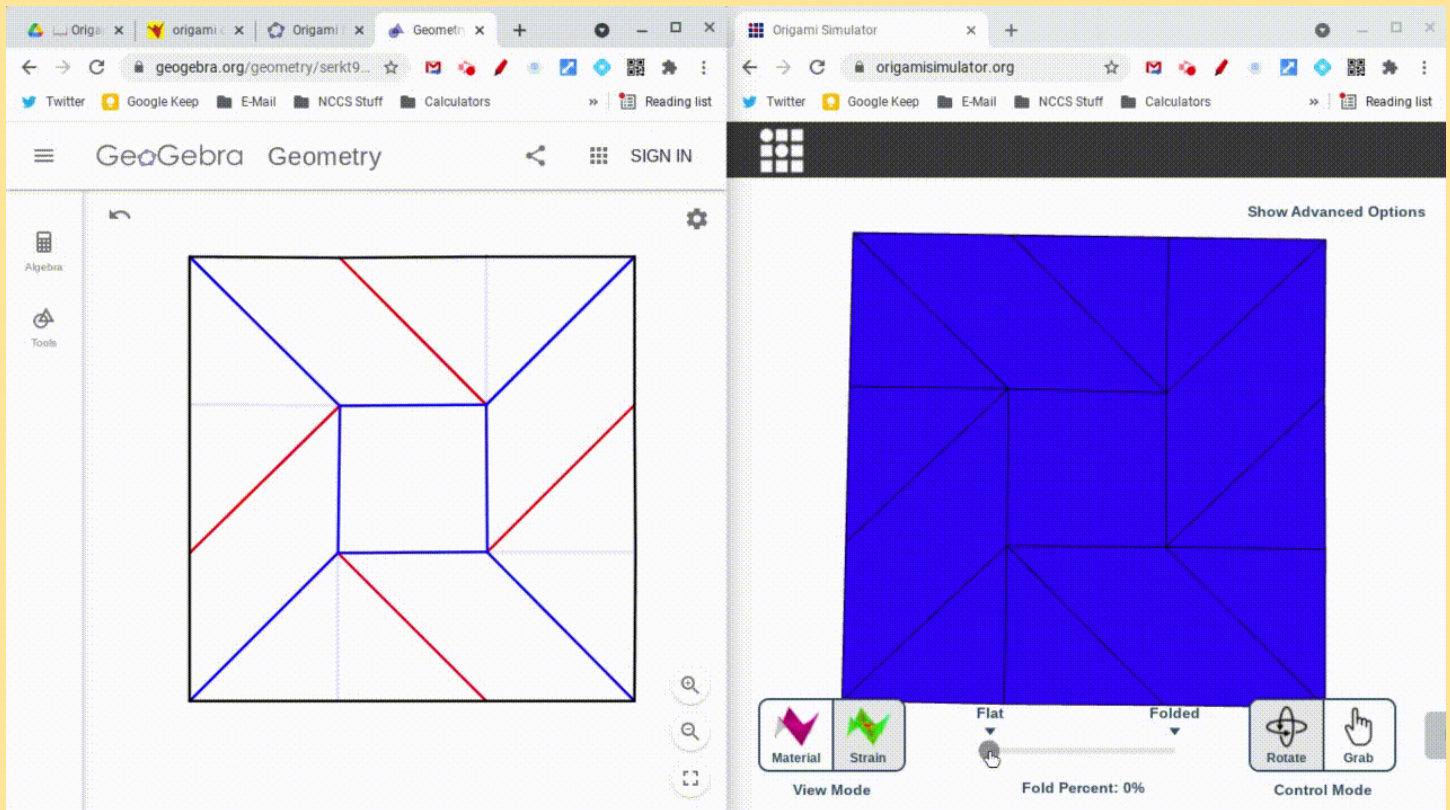
# Final Thoughts

*In addition to using this method to simulate the folding of paper airplanes, these steps can also be followed for origami models. Here are three origami models (waterbomb base, square twist & star twist), and another more complicated paper airplane.*

*This is an activity that seeks to combine analog and digital modeling. This activity is also filled with rich opportunities for geometric applications.*







Questions/Feedback?

Contact Mark Kaercher ([mark.kaercher@nccsk12.org](mailto:mark.kaercher@nccsk12.org))