Build Your Own Dynagraph

In this activity you'll construct your own *dynagraph.** A dynagraph consists of a pair of horizontal axes in which the top axis is the input axis and the bottom axis is the output axis. A marker on the input axis can be dragged to set the input value, and a marker on the output axis moves accordingly to show the output value.

CONSTRUCT PARALLEL AXES

1. In a new sketch, define a coordinate system by using **Graph | Define Coordinate System.** The horizontal axis of this coordinate system will be the input axis.

To construct the output axis, define a second coordinate system aligned with the first.

2. Construct the origin point of the second coordinate system by putting a point on the negative *y*-axis.
3. To make the scales of the two coordinate systems match, you need to measure the unit distance (the scale) of the first system. Measure the distance from the origin to the unit point on the horizontal axis.
4. Hide the vertical axis, the grid, and the unit point.
5. To create the second coordinate system, select both the desired origin (the point you constructed in step 2) and the desired unit distance (the distance you measured in step 3). Then choose **Graph | Define Unit Distance.** You will see a warning about creating a second coordinate system: Click Yes to create the new system.
6. Hide the vertical axis and the grid of the new coordinate system.

ADD THE INPUT VARIABLE AND OUTPUT VARIABLE

7. Construct an input variable by using the **Point** tool on the input axis. Label the point *x*.
8. Construct a function to connect the input and output by choosing **Graph | New Function.** Define the function in any way you choose.

To construct the output value, you first need to calculate the value of the function given the current input value.

9. Measure the abscissa of the input value, x_x.
10. Calculate the value of the function for this input value, $f(x_x)$.

*The term *dynagraph* was coined by Paul Goldenberg, Philip Lewis, and James O'Keefe in their study "Dynamic Representation and the Development of a Process Understanding of Functions," published by Education Development Center, Inc., and supported in part by a grant from the National Science Foundation.

To construct the output point, you need to plot $(f(x_x), 0)$ on the output axis. For this purpose you need a parameter with a value of zero.

11. Construct a new parameter by choosing **Graph | New Parameter.** Make the parameter's label *zero* and make its value zero.
12. Plot the output point by selecting in order the calculated output value $f(x_x)$ and parameter *zero,* and then choosing **Graph | Plot As (x, y).**
13. Connect the input and output points with a segment.
14. Drag the input point to make sure the dynagraph functions correctly.
15. Hide the various measurements and calculations. You may want to hide the function, or you may want to create a Hide/Show button for it.

DECORATE THE DYNAGRAPH

16. Give important objects clear labels. Change the abscissa measurement's label to *x.* Show the labels of the axes. Label the top axis *input* and the bottom one *output.*

You can create a marker above the input point to make it easier to see and drag.

17. Change the sketch's distance unit to pixels by choosing **Edit | Preferences | Units** and changing the distance unit setting.
18. Construct two translated images of the input point, one by 10 pixels at 45° and one by 10 pixels at 135°.
19. Translate each of these images by 20 pixels at 90°.
20. Construct a pentagon from the input point and all four translated images by selecting them in order and choosing **Construct | Pentagon Interior.** Hide the four translated image points.
21. Drag the pentagon to make sure it controls the input value correctly.

You can also create a marker below the output point to make it easier to see. Decide on a shape, and then use translations based on the output point to construct your shape.

When you're finished, choose appropriate colors and line widths for the various parts of your dynagraph.

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Activity Notes

Objective: Students or teachers create their own dynagraphs similar to the dynagraphs used in several algebra activities.

Student Audience: Algebra 1/Algebra 2/Precalculus

Prerequisites: None

Sketchpad Level: Challenging. The student or teacher constructs the entire dynagraph starting from a blank sketch.

Activity Time: 30–40 minutes

Setting: Paired/Individual Activity (no sketch needed)

This is an interesting and enjoyable enrichment activity for students who have used any of the dynagraph activities and have been curious about how they were created.