

Maria Hernández The NC School of Science and Mathematics

We would like to explore the motion of a train traveling along a circular track. The train is traveling in a counterclockwise direction as indicated in the picture on the right. **Watch the video of the train and generate some questions related to the train's position over time.**

We can collect data from the video by inserting the video into LoggerPro. Then we will collect data that corresponds to the train's position.

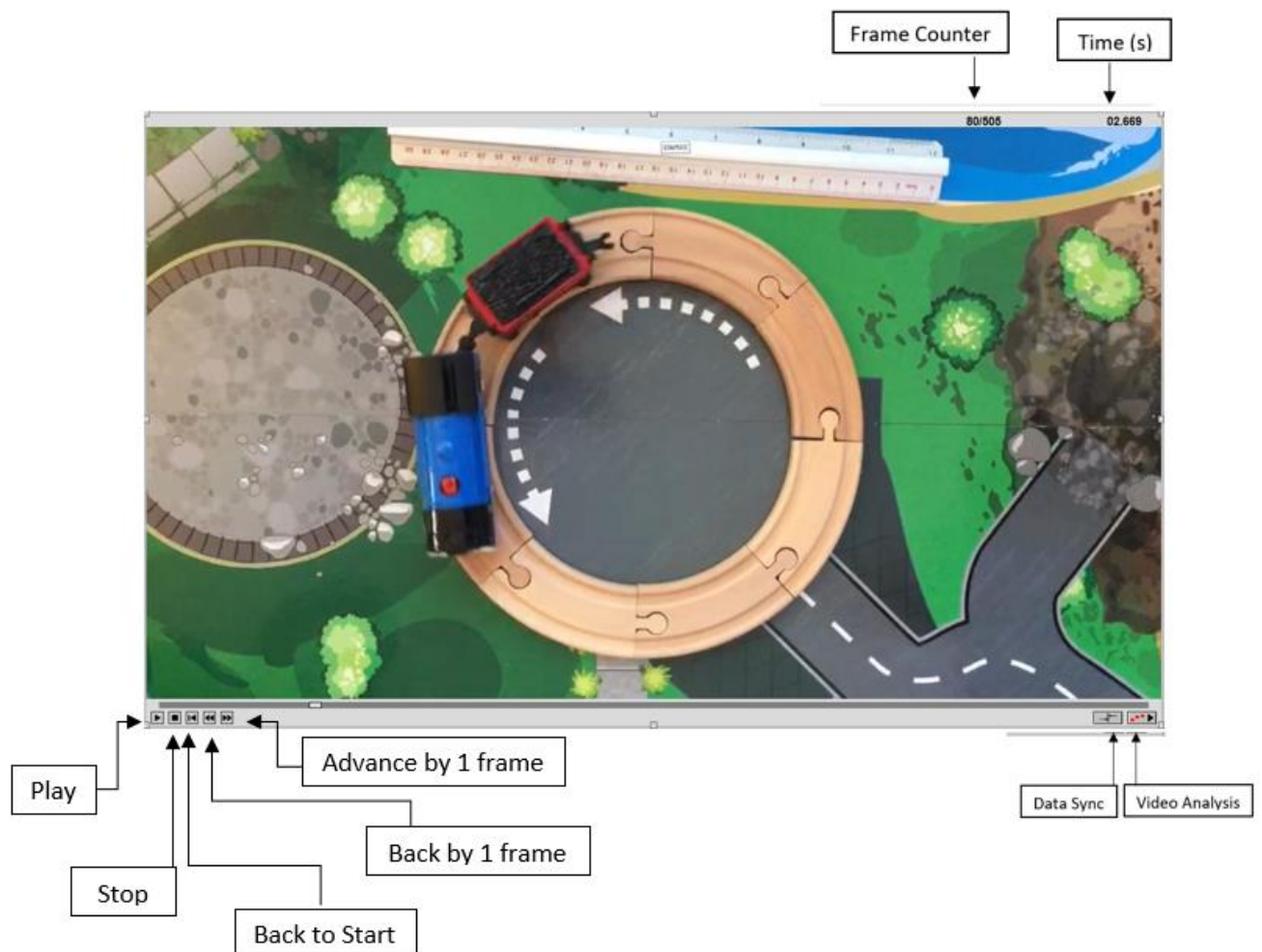
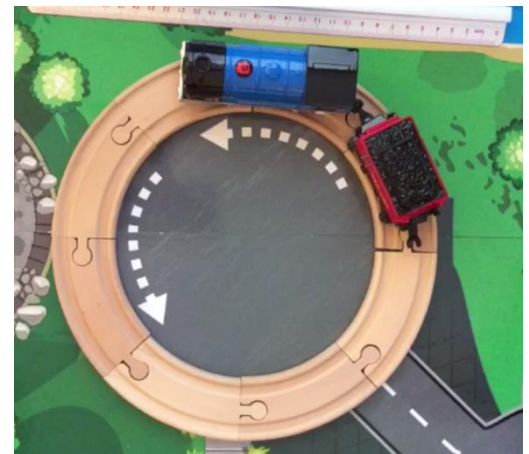
## Part I – Importing a Movie Clip

### 1. Opening the Movie Clip in Logger Pro

Open the Logger Pro software on your computer. Under [Insert], select [Movie]. Select the movie file. The movie should open in a resizable box showing the first frame. Save your LoggerPro file in the same folder that contains your movie file.

### 2. Viewing the Movie Clip

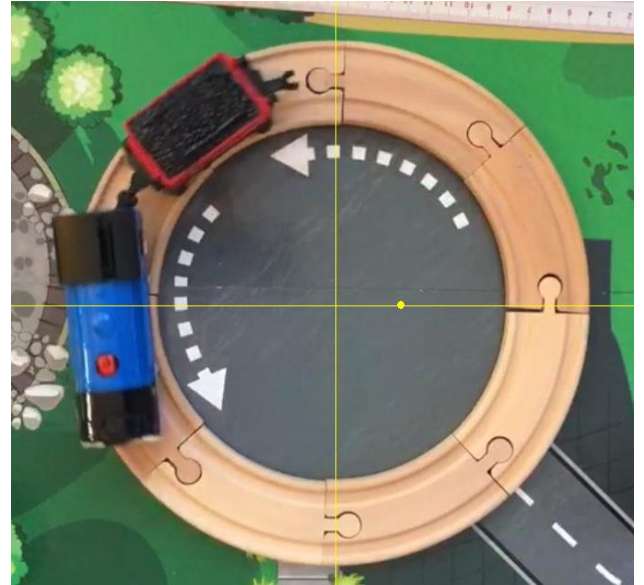
You can play the movie by pushing the play button on the bottom left corner of the movie window. There is not a pause button, but the stop button acts similarly. You can fast forward and rewind by dragging the slider at the bottom of the window. You can also advance the movie forwards or backwards by a single frame by clicking the double arrows. There is an indicator that displays how many seconds into the clip you are, as well as how many frames into the movie you are, located in the top right of the movie box.



## Part II Sketching Graphs of the Horizontal and Vertical Position of the Train

1. Watch the movie clip again from start to finish. Think about the position of the train on the track over time and consider the questions you posed previously. In this part of the activity, we will break down the motion of one of the train in to the vertical and horizontal positions. You will make some conjectures about what those graphs look like and then we'll collect data from the video that corresponds to those graphs. These graphs could be useful in answering some of the questions you posed at the beginning of the activity.
2. Suppose we superimpose a set of axes so that the vertical axis is down the middle of the train track and the horizontal axis is along the middle of the train track. (See the diagram to the right.)

Suppose we would like to sketch a graph the train's position over time. We will need to consider the horizontal position and the vertical position separately.

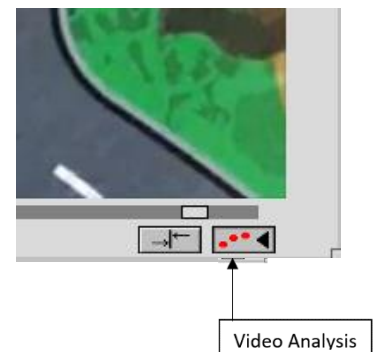
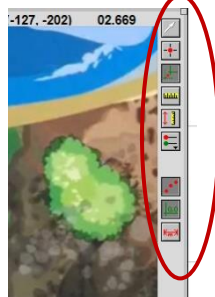


## Part III – Collecting the Data

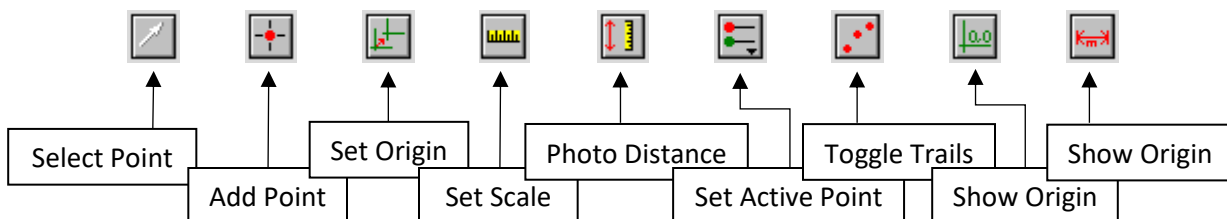
### 3. Measuring Position on the Graph

You will now analyze the clip by marking positions of the train in several frames of the video.

- Enlarge the video so it takes up as much screen space as possible by clicking and dragging a corner of the movie window. This will allow for more accurate data collection.
- Click on the Video Analysis button on the bottom right corner of the video window to open a new toolbar that will appear down the right edge of the video window. The toolbar is shown below.



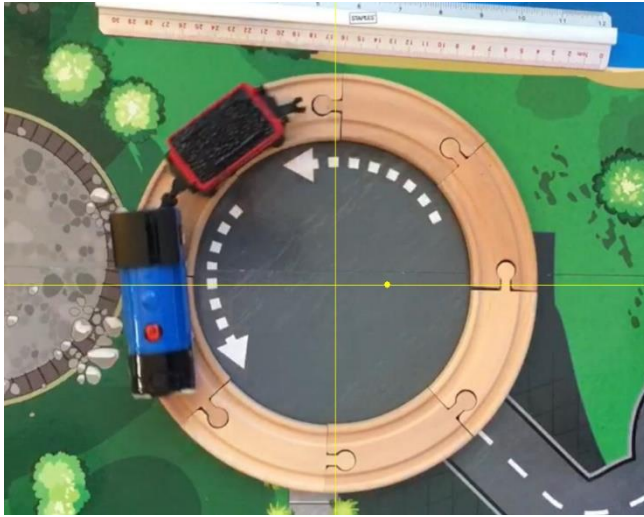
Below is an explanation of each icon on that toolbar.



## Part IV – Setting a Scale

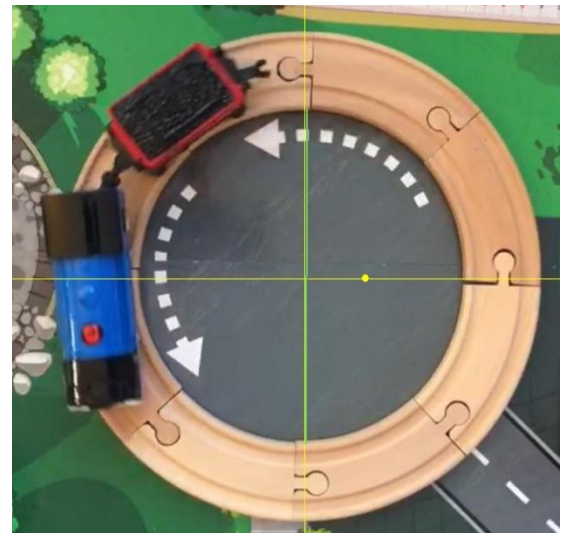
### 4. Marking the Origin

Select the “Set Origin” tool and click on the movie clip to set the origin of your graph. The origin should be placed at the center of the soccer field. This will create an x-y axis where the units are pixels of the movie clip.



### 5. Creating a Scale

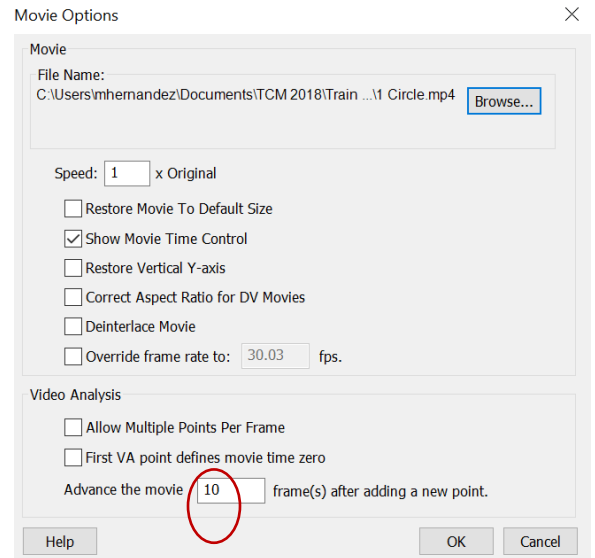
Scale your graph by selecting the “Set Scale” tool (ruler icon). Click and drag your mouse to create a green line that spans across the inside diameter of the circle (shown to the right). LoggerPro will then open a dialog box so that you can input the actual size of the length of the **18 cm**. Input the dimension to set the scale to the correct length. This will convert your x-y axis to have a scale in meters



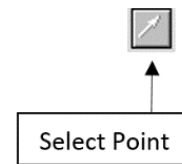
### 6. Marking Points on the Movie

Select the “Add Point” tool from the toolbar. (Red Dot)

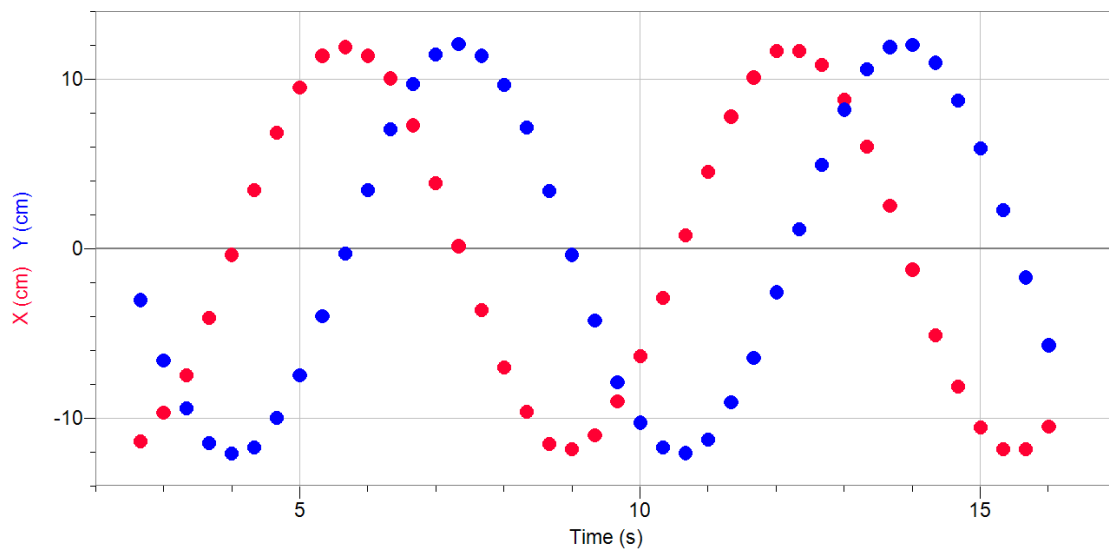
Advance through the clip either by pressing play or going frame by frame. As the train advances around the track, mark points by clicking **on part of the train**. For example you can click on the red dot on top of the engine or on the front middle part of the coal car. You can set the frame advancement so that the video advances 10 frames each time you add a point. To do this, right click on the video window and choose "Movie Options". You should see the window shown to the right. Type 10 in the Advance the movie \_\_\_\_\_ frame(s) after adding a new point as shown to the right.



Should you need to delete a point, choose the "Select Point" tool, click a point to select it, and press the delete key on your keyboard.



The graphs shown to the right represent the train's horizontal and vertical position (in meters) over time (in seconds)

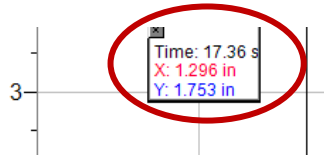
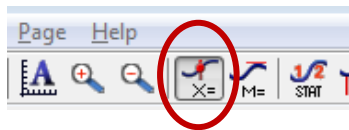


## Part V – Data Analysis

### 7. Viewing the Data

You may have noticed that as you were marking data points, they were being plotted in the background behind the video clip. Resize the video clip so you can see this graph. The data table is shown on the left of your screen. Browsing through the data table, you should see time values (in seconds) in the first column, x- and y-coordinates of the marked points in the second and third columns (in meters) respectively. The table also contains estimates of  $\frac{dx}{dt}$  and  $\frac{dy}{dt}$  at each t-value. The values shown in red correspond to the red data points on the graph, and the values shown in blue correspond to the blue data points on the graph.

You can also see the x- and y- coordinates on the graph by selecting the “Examine” tool and hovering over the data point of interest.



Now that you’ve collected some data using the video clip and LoggerPro, you will use this data and your mathematical knowledge to explore the answers to some of the questions you proposed.

## Part VI – Exploring Questions

Some possible questions or tasks you may have proposed include:

1. Can we find a model for the train’s horizontal position over time?
2. Can we find a mode for the train’s vertical position over time?
3. Interpret in context the parameters (constants) in the definition of the models.