How Do Functions Shape the Sydney Harbour Bridge?

We can use functions to accurately describe shapes. Consider the Sydney Harbour Bridge. The approximate coordinates of key points of the bridge have been identified:

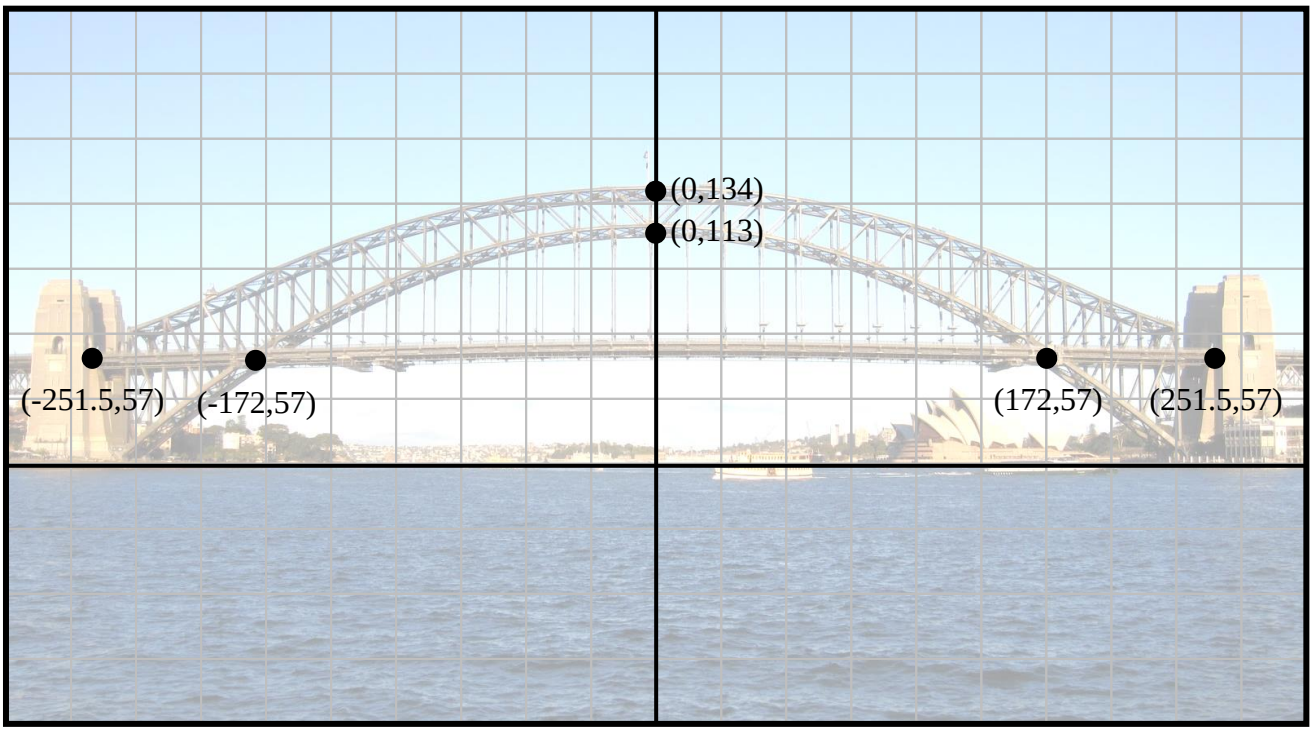
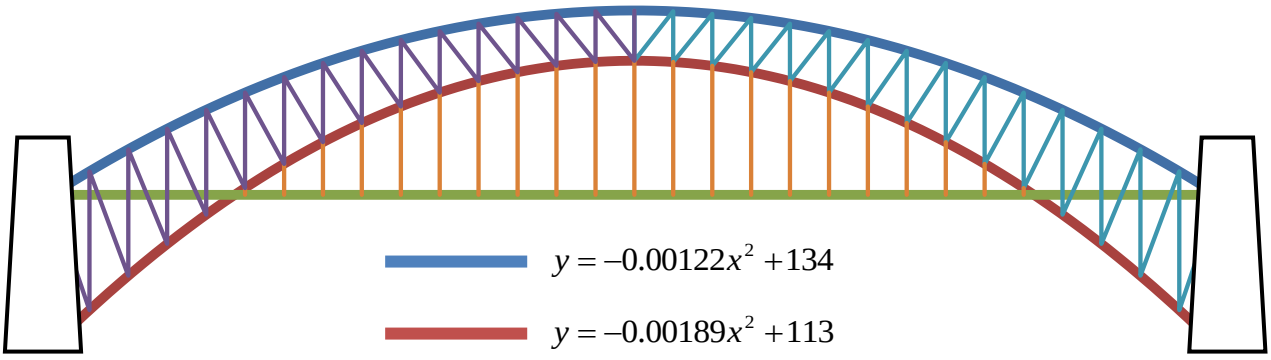


Image Source: http://sydney-city.blogspot.jp/2010/06/sydney-harbour-bridge.html

Using these points we can find the equations of the arches of the bridge. We can create the bridge in Excel by plotting just six sets of points. Each colour represents a different set of plotted points:



Choose a famous bridge to recreate in Excel. Your bridge should contain at least one parabola and diagonal and/or vertical supports (the example above has both).

Recreate the bridge in Excel and put together a report in Word that describes the mathematics behind your design (How did you determine coordinates key points? How did you determine the equation of the parabola(s)? How did you calculate coordinates of the supports? etc.)

Steps to get you started:

- Find a photograph of a suitable bridge. It should be taken perfectly from the side, not at an angle.
- Print out the photograph.
- By hand, draw *x* and *y* axes on top of your photograph.
- Determine coordinates of key points of your bridge. You may have to research facts about your bridge to determine these, and then determine the scale of your photograph to calculate other points.
- Use these coordinates to determine the equation of the parabola(s), and use the parabolas to determine coordinates of supports. Then recreate the bridge in Excel.
- Create a report in Word explaining how you created your bridge (explain the mathematics, do *not* explain how to use Excel). Your report should *at least* recreate and explain everything you did by hand in the steps listed here.

You should also include answers to the following questions in your report:

- How accurate is your design? Place your Excel bridge on top of the photograph and comment on the accuracy (fade the photograph to make your bridge easier to see, as the photograph on the previous page is faded).
- Why is it important to be able to describe shape mathematically? (For example, think about the manufacturing process where a product may be designed in one country, and built in another).

Criterion C: Communication in Mathematics		
Achievement Level	Level Descriptor	Task Specific Clarification
0	The student does not reach a standard described by any of the descriptors below.	
1 – 2	The student is able to: I. **use** limited mathematical language II. **use** limited forms of mathematical representation to present information III. **communicate** through lines of reasoning that are difficult to interpret.	The student is able to: o adequately create a famous bridge in Excel
3 – 4	The student is able to: I. **use** some appropriate mathematical language II. **use** different forms of mathematical representation to present information adequately III. **communicate** through lines of reasoning that are able to be understood, although these are not always clear IV. adequately **organize** information using a logical structure.	The student is able to: o create a bridge in Excel o adequately explain how parts of the bridge were recreated
5 – 6	The student is able to: I. usually **use** appropriate mathematical language II. usually **use** different forms of mathematical representation to present information correctly III. move between different forms of mathematical representation with some success IV. **communicate** through lines of reasoning that are clear although not always coherent or complete V. present work that is usually **organized** using a logical structure.	The student is able to: o create a bridge in Excel o explain how key coordinates were determine or calculated o explain how all equations of parabolas were determined o explain how coordinates of supports were determined o use the equation editor for equations and expressions
7 – 8	The student is able to: I. consistently use appropriate mathematical language II. use different forms of mathematical representation to consistently present information correctly III. move effectively between different forms of mathematical representation IV. communicate through lines of reasoning that are complete and coherent V. present work that is consistently organized using a logical structure.	The student is able to: o create a bridge in Excel o clearly explain how key coordinates were determine or calculated using explanations and diagrams o clearly explain how all equations of parabolas were determined using explanations and diagrams o clearly explain, using function notation where appropriate, how coordinates of supports were determined using explanations and diagrams o use the equation editor for all equations and expressions o reference any photographs used

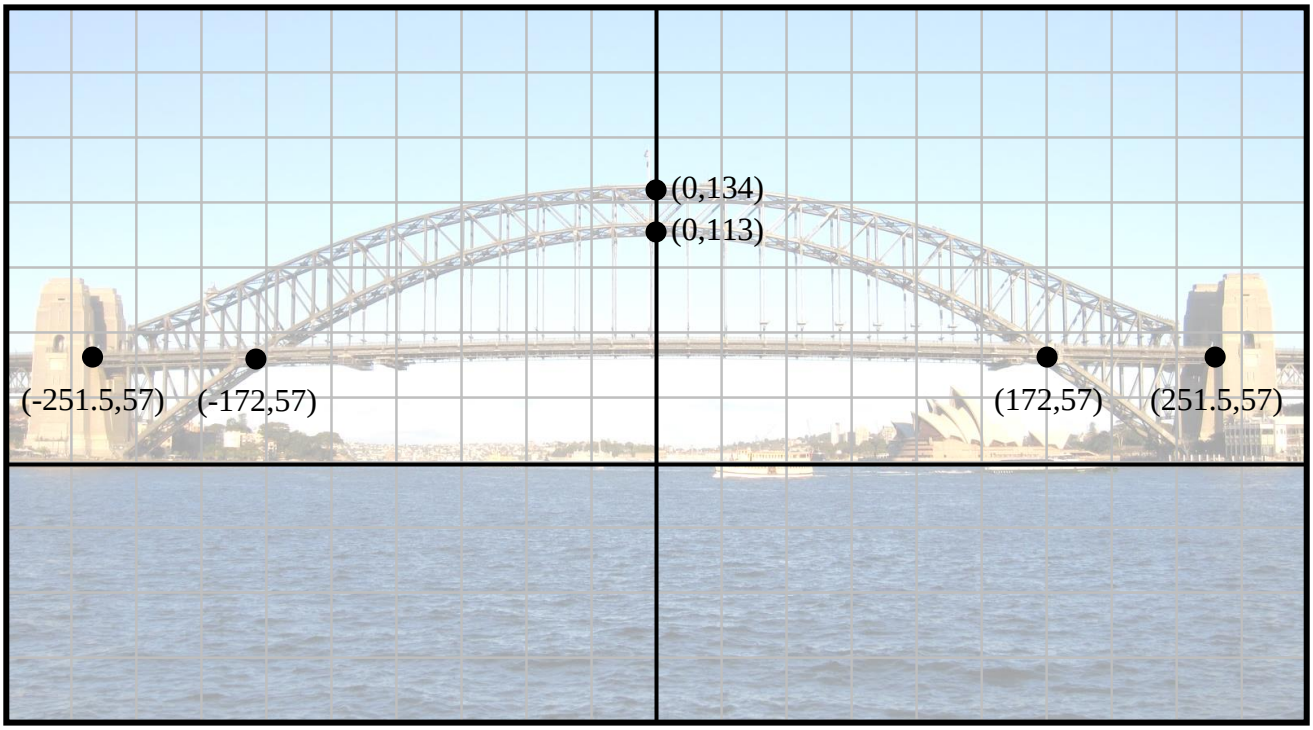
Criterion D: Applying Mathematics in Real Life Contexts		
Achievement Level	Level Descriptor	Task Specific Clarification
0	The student does not reach a standard described by any of the descriptors below.	
1 – 2	The student is able to: I. **identify** some of the elements of the authentic real-life situation II. **apply** mathematical strategies to find a solution to the authentic real-life situation, with limited success.	The student is able to: o attempt to determine key coordinates and use them to determine equations of parabolas
3 – 4	The student is able to: I. **identify** the relevant elements of the authentic real-life situation II. **select**, with some success, adequate mathematical strategies to model the authentic real-life situation III. **apply** mathematical strategies to reach a solution to the authentic reallife situation IV. **describe** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to: o attempt to explain why it is important to be able to describe shape mathematically o attempt to determine key coordinates and use them to determine equations of parabolas and key coordinates
5 – 6	TThe student is able to: I. **identify** the relevant elements of the authentic real-life situation II. **select** adequate mathematical strategies to model the authentic real-life situation III. **apply** the selected mathematical strategies to reach a valid solution to the authentic real-life situation IV. **describe** the degree of accuracy of the solution V. **discuss** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to: o explain why it is important to be able to describe shape mathematically o comment on the accuracy of the recreated bridge by overlaying it on top of a photograph of the actual bridge o determine key coordinates and use them to determine equations of parabolas and other key coordinates
7 – 8	The student is able to: I. **identify** the relevant elements of the authentic real-life situation II. **select** appropriate mathematical strategies to model the authentic real life situation III. **apply** the selected mathematical strategies to reach a correct solution IV. **explain** the degree of accuracy of the solution V. explain whether the solution makes sense in the context of the **authentic** real-life situation.	The student is able to: o thoroughly explain why it is important to be able to describe shape mathematically o comment on the accuracy of the recreated bridge by overlaying it on top of a photograph of the actual bridge and giving reasons for any inaccuracies o accurately determine key coordinates and correctly use them to determine equations of parabolas and other key coordinates

Steps to Help You Complete Your Project

Step 1: Find a structure which has a clear photograph taken from the side.

Step 2: Research the height / width / length etc. of your structure

Step 3: Add axes to your photograph and then write down the coordinates of all major points:



Step 4: Use these points to calculate the equations of all parabolas in your model

Step 5: Use Excel to plot these equations

Step 6: Add details to your model