Olympic Nspiration

We hope you enjoy this edition of (n)sight, a magazine written by and for teachers who are using TI technology to improve teaching and learning.

The opening ceremony of the London Olympics 2012 is on 27 July and it is thought that 15% of the entire world population will be watching. No doubt that will include a huge proportion of UK school children and it is very likely that, in the two terms before the start of the games, schools will be joining the sense of eager anticipation. Although PE departments may be leading the way, there will be many opportunities for Maths and Science Departments to exploit students' interest in the course of relevant and interesting activities.

This edition of (n)sight includes several examples of how use of TI-Nspire enables the exploration of topics in the context of the Olympics.

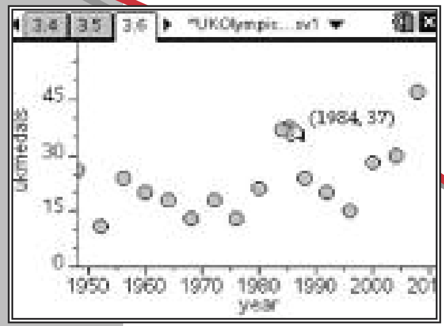
Nevil Hopley's article concentrates on the mathematics of the curved roofs of some of the Olympic venues.

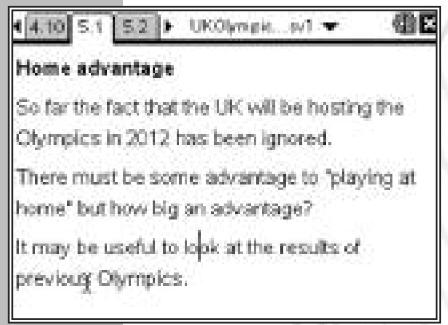
Jonathan Powell shares his ideas of activities based around his particular passion – cycling.

Karen Birnie shows how data such as the Men's High Jump Records can easily be transferred from websites into TI-Nspire.

Neil Anderson describes working with primary-aged children to gather real data and investigate big scientific questions.

How many UK Olympic medals will there be in 2012?
Have you seen this TI-Nspire activity in which, using a .tns document, students are able to use previous results to predict the number of UK medals there will be this year? This activity, complete with TI-Nspire document and Teacher Notes can be freely downloaded from the Nspiring Learning website: **nspiringlearning.org.uk**. It is just one of nearly 100 fully tested activities, all provided by teachers for teachers – a major classroom resource for all users of TI-Nspire. How about contributing your own activity for this resource?





Home advantage

So far the fact that the UK will be hosting the Olympics in 2012 has been ignored.

There must be some advantage to "playing at home" but how big an advantage?

It may be useful to look at the results of previous Olympics.

Which Olympic athlete moves fastest?
Could your students answer this question? It could be investigated in all sorts of ways at all sorts of levels. Mathematically it may involve the difference between actual and average speeds or even relative speeds. Students could compare the average speeds of runners, swimmers, cyclists, horse riders, etc. Or they may consider velocity at a single instant e.g. a long jumper at the point of take off, or a diver from a high board hitting the water. Or perhaps they may even consider the velocity of just part of an athlete's body e.g a sprinter's or cyclist's foot which, as it is brought forward, overtakes the body so must be travelling faster. What about the velocity of a javelin thrower's hand?

Olympic Challenge
So, we would like to challenge you to develop an Olympic themed activity for your students and then to share it with the rest of the TI-Nspire community in the UK. You could submit it to the Nspiring Learning website. You could write it up as an article for this magazine. Or perhaps you could present it at a conference or training event. Please send your ideas to **etcuk@ti.com**. The senders of the first five activities will receive a brand new TI-Nspire CX handheld and TI-Nspire Teacher Software pack. **We hope this magazine will provide you with plenty of ideas and we look forward to hearing from you about your Olympic Nspirations!**

From lines to Olympian curves

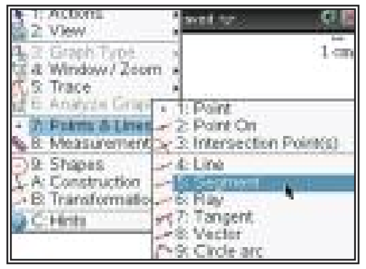
The architecture of several of the main Olympic venues such as the Aquatics Centre and Velodrome has received much critical acclaim. In particular the Velodrome's roof is actually a hyperbolic paraboloid. In this article Nevil Hopley describes how it can be modelled quite easily with school-level mathematics.

The key characteristic of the Velodrome's roof, like all such apparently curved roof structures, is that it can be constructed purely from straight roof beams or, in the case of the Olympic venue, 16km of cables. The curved shape is an illusion of sorts, when viewed from a distance.

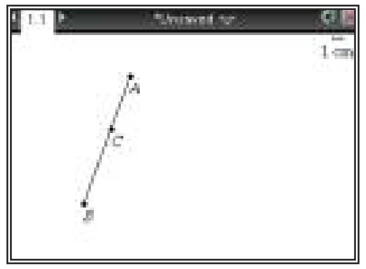
To demonstrate this phenomenon, you can first construct a 2D model. It is not too dissimilar to the 'nail-and-string-art' pictures that you may have made yourself when you were young.

2D Construction

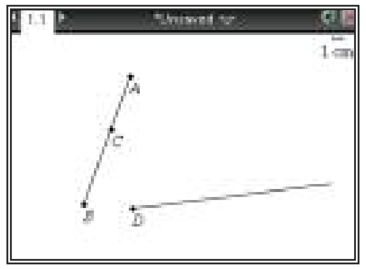
1 To begin with, create a New Document and insert a Geometry Page. Then press menu to access *Points & Lines* > *Segment*. Instructions on how to use any selected tool can be found by moving the cursor over the icon in the top left corner of the screen.



2 Draw a segment by clicking in two places on the screen. If you press the A key after clicking for the first point, it is automatically labelled with an A. Similarly, label the second point B. Press menu and choose *Points & Lines* > *Point On* to place a point C on segment AB.



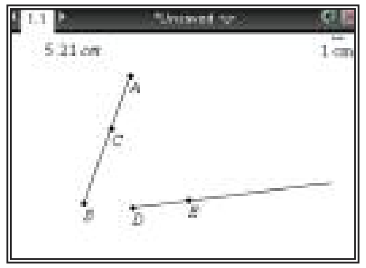
3 You should be able to grab point C and move it up and down segment AB. Now create a ray starting at point D going off to the right, as shown. A ray is like a segment, but it extends forever in one direction.



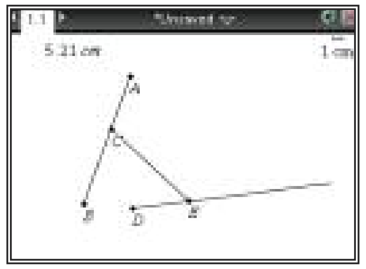
4 Next measure the distance AC and transfer it to the ray by completing the following steps.

- Press menu and choose *Measurement* > *Length*.
- Click in turn on points A and C.
- Place the resultant number in the top left of the screen, out of the way.
- Press menu to access *Construction* > *Measurement transfer*.
- Click first on the number just created and then on the ray.

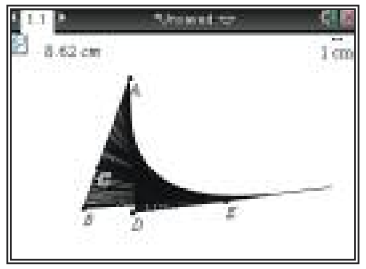
A point should appear the same distance away from D as length AC. Again, you can label this point E by pressing E just after the point appears on the ray.



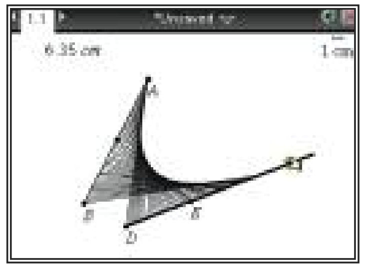
5 If you grab and move point C, then E should move as well, as they are dynamically linked by the transferred length. Now, draw in a segment to join point C to E. By moving point C back and forth along AB, you may now start to see where a curve may come from.



6 One quick way to capture a trace of the segment CE as point C moves is to press menu and choose *Trace* > *Geometry Trace*. Firstly click on segment CE and then grab point C and move it. You should obtain a view similar to this.

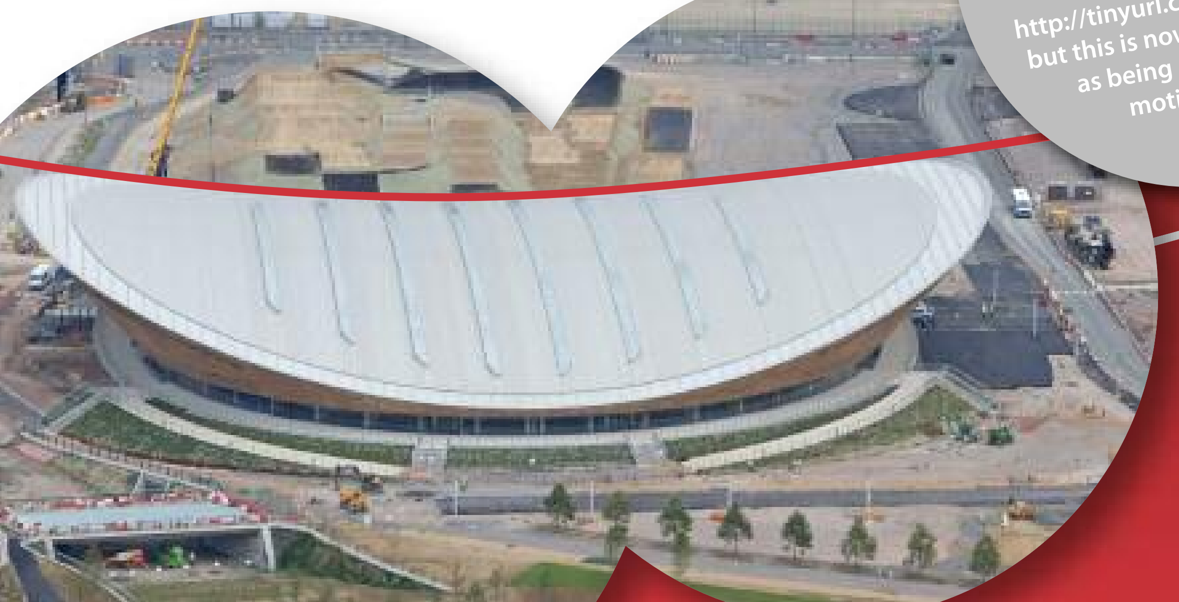


7 Sadly, this Geometry Trace is not dynamically linked to the segment AB or to D's ray, so if either of these is moved, the full trace is not updated. But there is another tool available, Locus, which provides a dynamic trace of the locus of segment CE.
So delete the trace by pressing menu to access *Trace* > *Erase Geometry Trace* and replace it with a locus by pressing menu and choosing *Construction* > *Locus*. Again, first click on segment CE and then on point C.
Grab and move any of points A, B, D or indeed the other end of the ray to see some rather cool effects:



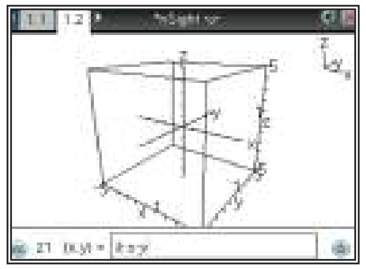
2D curves from straight lines are born!

It is well worth doing the 2D and 3D constructions for yourself so that you can experience the dynamic effects that Nevil describes. You can see a short video of the animations on http://tinyurl.com/OlympicCurves but this is nowhere near as good as being able control the motion yourself!

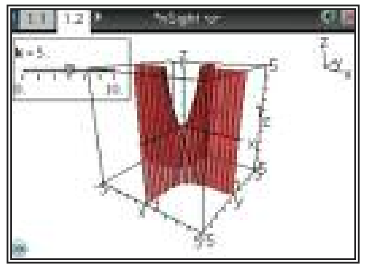


3D Construction

1 You can construct a similar end-effect in 3D, to show that straight lines can give rise to curved 3D planes like those of the roofs of the Velodrome and Aquadrome. The equation of a simple hyperbolic paraboloid is $z(x,y)=x^2-y^2$. You can transform this to rotate it around the z-axis and one such transformation is given by $z(x,y)=(x+y)^2-(x-y)^2$ which simplifies algebraically to $z(x,y)=4xy$. A more general form of this equation would be $z(x,y)=kxy$, where k is a parameter that controls the apparent 'curvature' of the plane.
So, insert a new Graphs page and from the menus access *View* > *3D Graphing*. Type in k·x·y (making sure to press × between each letter) and press enter. Nothing should appear, as you've not yet defined the value of k.

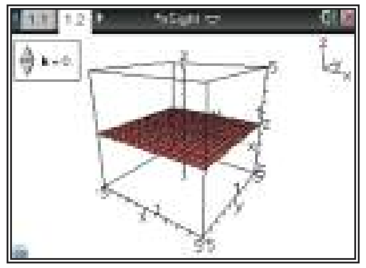


2 Press menu to access *Actions* > *Insert Slider* and position this slider in the top left corner of the screen. You can rename the default name of *v1* as *k*, by simply pressing the K key, and then enter. This graph should now appear.

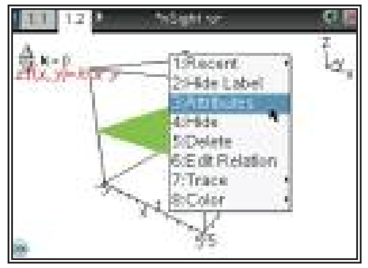


3 You can alter slider k's settings by moving over the slider handle, pressing ctrl then menu, and then select Settings. Adjust it to start from 0, running from -0.2 to 0.2 in steps of 0.01, with a *Vertical Style*, and *Minimised*.

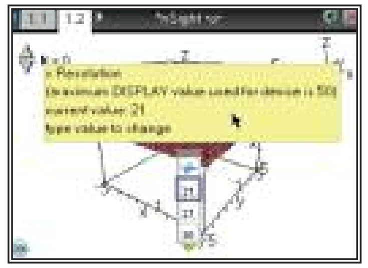
4 After clicking OK, you should see a screen like this.



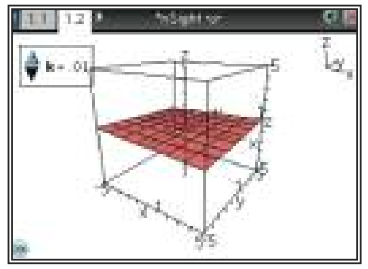
5 You also need to alter the attributes of the z plane. Move your cursor over the flat plane, click to select it and press ctrl then menu, and select *Attributes*.



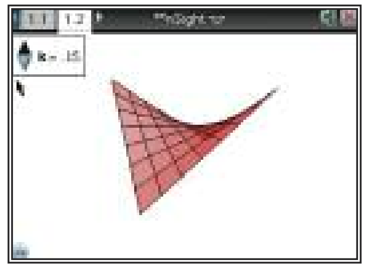
6 Move down to the second box, which has the default value of 21 in it, type 8 and press enter.



7 Repeat for the y resolution, replacing the value of 21 with 8. Press enter to submit the changes, and you should have a screen like this.



8 When you click on k's slider, you can control the amount of warping on the graph. Also, by first clicking on empty space (to de-select the slider) and then pressing the A key, you can animate your roof. Whilst it is spinning, you can continue to change k's value–don't get too dizzy doing this!



To further clean up the display access the *View* menu and then *Hide* each of *Box*, *Axes* and *Legend* in turn.

Conclusion

In all of your 3D constructions, you should be able to see the straight 'roof cables' that end up forming the hyperbolic paraboloid outline.

There are obvious architectural challenges when building such structures. What will be the precise length of each roof cable? (They are all different lengths in our model.) What will be each cable's required strength when in situ? The resulting surface area needs to be made watertight, so knowing how much exterior covering needed will be important. And what is the volume of air contained within the building, for the air conditioning system to filter?

They not only look amazing, these buildings have amazingly complex calculations behind them.