(n)sight

Spring 2012

In this issue:

From lines to Olympian curves

How to import data

Olympic cycling

Explorative Quest

Texas Instruments

Your Vision. Our Technology. Learner Success.

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.

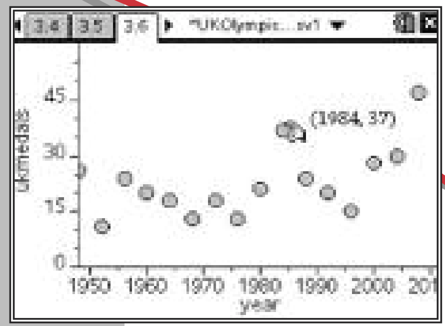
Jonathan Powell shares his ideas of activities based around his particular passion – cycling.

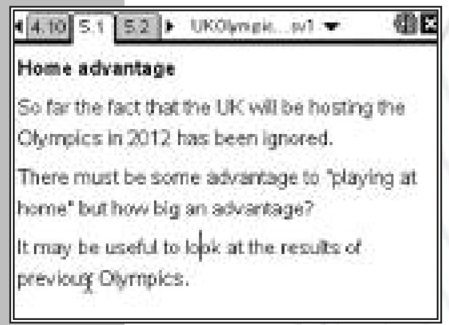
Karen Birnie shows how data such as the Men's High Jump Records can easily be transferred from websites into TI-Nspire.

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?





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!**

Olympic Nspiration

From lines to Olympian curves

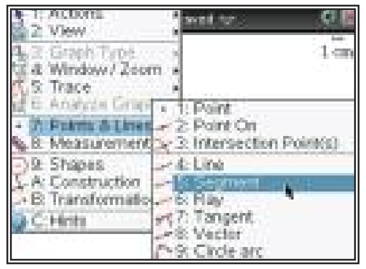
The architecture of several of the main Olympic venues such as the Aquatics Centre and Velodrome has received much critical acclaim. In particular the Velodrome's roof is actually a hyperbolic paraboloid. In this article Nevil Hopley describes how it can be modelled quite easily with school-level mathematics.

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.

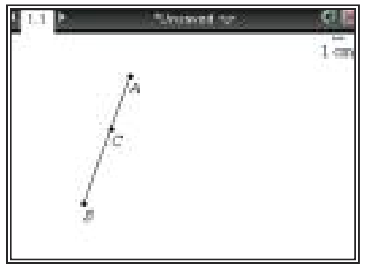
To demonstrate this phenomenon, you can first construct a 2D model. It is not too dissimilar to the 'nail-and-string-art' pictures that you may have made yourself when you were young.

2D Construction

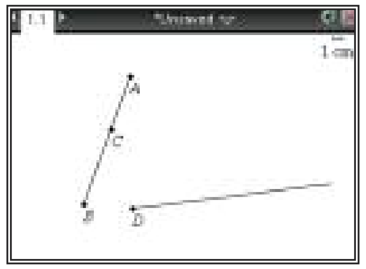
1 To begin with, create a New Document and insert a Geometry Page. Then press menu to access *Points & Lines > Segment*. Instructions on how to use any selected tool can be found by moving the cursor over the icon in the top left corner of the screen.



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.



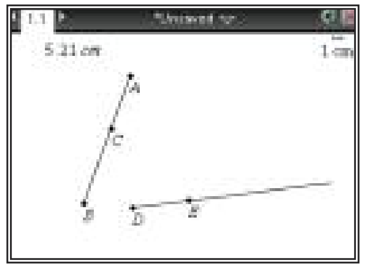
3 You should be able to grab point C and move it up and down segment AB. Now create a ray starting at point D going off to the right, as shown. A ray is like a segment, but it extends forever in one direction.



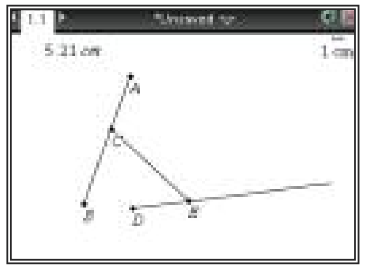
4 Next measure the distance AC and transfer it to the ray by completing the following steps.

- 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.

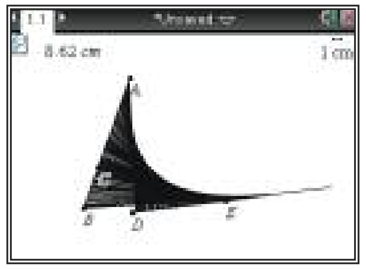
A point should appear the same distance away from D as length AC. Again, you can label this point E by pressing E just after the point appears on the ray.



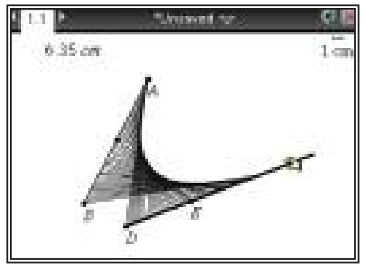
5 If you grab and move point C, then E should move as well, as they are dynamically linked by the transferred length. Now, draw in a segment to join point C to E. By moving point C back and forth along AB, you may now start to see where a curve may come from.



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.

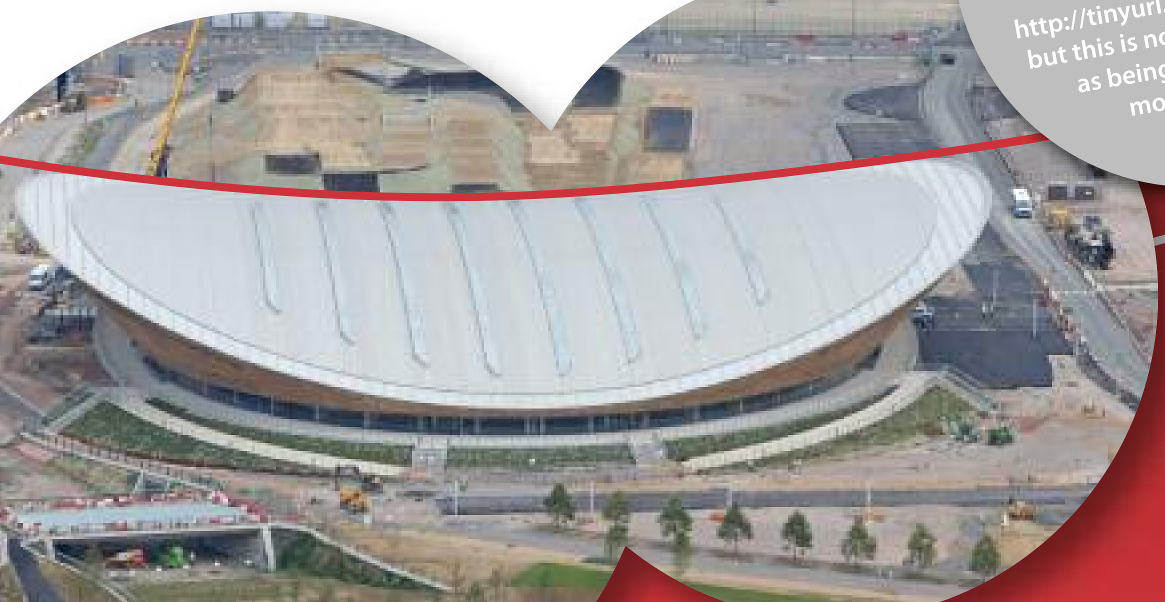


7 Sadly, this Geometry Trace is not dynamically linked to the segment AB or to D's ray, so if either of these is moved, the full trace is not updated. But there is another tool available, Locus, which provides a dynamic trace of the locus of segment CE.
So delete the trace by pressing menu to access *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:



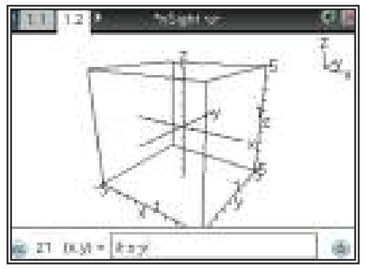
2D curves from straight lines are born!

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!

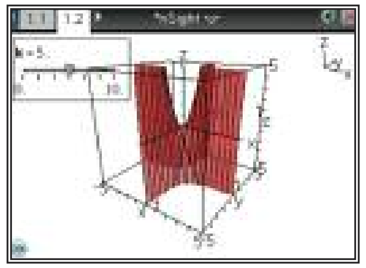


3D Construction

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.

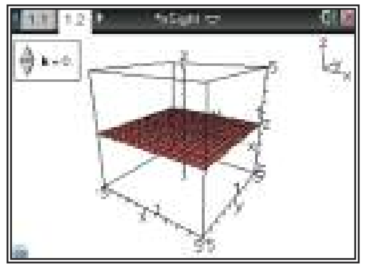


2 Press menu to access *Actions > Insert Slider* and position this slider in the top left corner of the screen. You can rename the default name of *v1* as *k*, by simply pressing the K key, and then enter. This graph should now appear.

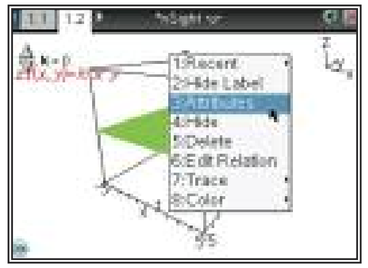


3 You can alter slider k's settings by moving over the slider handle, pressing ctrl then menu, and then select Settings. Adjust it to start from 0, running from -0.2 to 0.2 in steps of 0.01, with a *Vertical Style*, and *Minimised*.

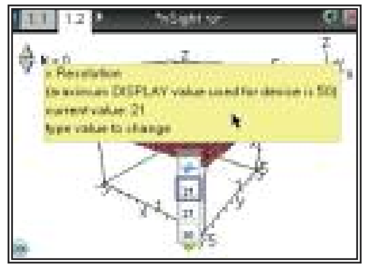
4 After clicking OK, you should see a screen like this.



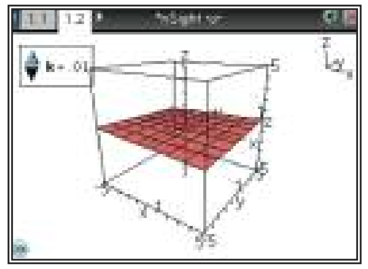
5 You also need to alter the attributes of the z plane. Move your cursor over the flat plane, click to select it and press ctrl then menu, and select *Attributes*.



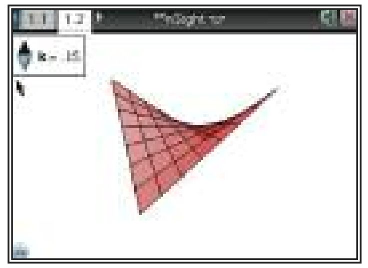
6 Move down to the second box, which has the default value of 21 in it, type 8 and press enter.



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.

How to import data

Teachers nowadays are encouraged to make mathematics lessons more relevant to students and to make cross-curricular links whenever possible. With TI-Nspire real-life data can be easily copied from the internet or other electronic source, pasted into a Lists & Spreadsheet page and then analysed using the tools in Data & Statistics. Karen Birnie, Principal Teacher of Mathematics at Aboyne Academy in Aberdeenshire explains the process.

Step 1: Data into Excel

First you need to download the data from the source into a spreadsheet. Some websites, such as Census At School, allow you to download data directly in spreadsheet form. In this case, simply download the file and open it in Excel. For other websites, however, such as those providing data of sports events and for the Olympics, you may need to copy and paste the data and then manipulate the data into a format from which you can then copy it into a TI-Nspire document.

For example, you might want to copy the men's High Jump records, from **www.topendsports.com/sport/athletics/records**. First select High Jump, then select and copy the data. Now open a new Excel spreadsheet and paste in the data. Sadly, in this case all the data will be contained in column A.

	A	B	C
1	2.00m George Horine USA 1912		
2	2.01m Edward Beeson USA 1914		
3	2.02m Clinton Larsen USA 1917		
4	2.03m Harold Osborn USA 1924		
5	2.04m Walter Marty USA 1933		
6	2.06m Walter Marty USA 1934		
7	2.07m Cornelius Johnson USA 1936		
8	2.07m Dave Albritton USA 1936		
9	2.08m Melvin Walker USA 1937		
10	2.09m Melvin Walker USA 1937		

However, with Excel it's easy to move each data item into its own cell:

- highlight column A by clicking on the 'A' at the top of the column,
- from the Data Menu select *Text to Columns*,
- follow through the Text to Columns Wizard, using "space" as the delimiter.

Once you click Finish, each piece of data will be in its own cell. The m's in Column A can be quickly removed using *Text to Columns* again with both "space" and "m" as delimiters. Finally, with little tweaks for West and East Germany in 1980, the data is ready to use.

	A	B	C	D	E
36	2.35	Jacek	Wszola	Poland	1980
37	2.35	Dietmar	Mögenburg	West Germa	1980
38	2.36	Gerd	Wessig	East German	1980
39	2.37	Zhu	Janhua	China	1983
40	2.38	Zhu	Janhua	China	1983
41	2.39	Zhu	Janhua	China	1984
42	2.4	Rudolf	Povarnitsyn	USSR	1985
43	2.41	Igor	Paklin	USSR	1985
44	2.42	Patrik	Sjöberg	Sweden	1987
45	2.43	Javier	Sotomayor	Cuba	1988
46	2.44	Javier	Sotomayor	Cuba	1989
47	2.45	Javier	Sotomayor	Cuba	1990

Step 2: Data into TI-Nspire

With data in an Excel spreadsheet, the next step is to copy it into a .tns document. On your PC use TI-Nspire software in Computer mode:

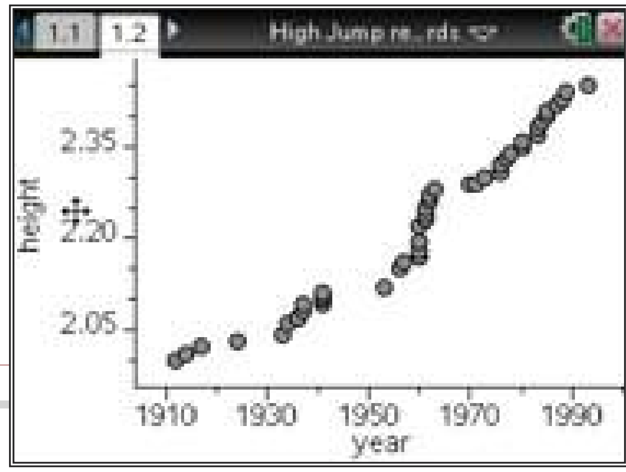
- open a new document with a Lists & Spreadsheet page;
- click in the column headers and label the columns you wish to use;
- go back to the Excel spreadsheet, select and copy the data you want;
- return to the .tns document, click in the cell where you want the data to start;
- paste the data in.

Et voilà!

	A height	B name1	C name2	D country	E year	F
1	2	George	Horine	USA	1912	
2	2.01	Edward	Beeson	USA	1914	
3	2.02	Clinton	Larsen	USA	1917	
4	2.03	Harold	Osborn	USA	1924	
5	2.04	Walter	Marty	USA	1933	
6	2.06	Walter	Marty	USA	1934	
7	2.07	Corneliu...	Johnson	USA	1936	
8	2.07	Dave	Albritton	USA	1936	
9	2.08	Melvin	Walker	USA	1937	
10	2.09	Melvin	Walker	USA	1937	

The document containing the data can now be distributed to students' handhelds, using either Connect-to-Class or TI-Nspire Navigator. Students can then explore and analyse the data using the tools available in Data & Statistics.

Further advice on exploring and analysing data can be found in the booklet series 'STEM Activities with TI-Nspire' **www.tinyurl.com/STEMactivities**.



Some online data sources

censusatschool.org.uk has gathered both personal data and opinions from students in the UK and overseas annually since 2000. See also the new site sportatschool.org.uk inspired by the Olympics.

metoffice.gov.uk/weather/uk/climate.html has historic and hourly weather data for the UK and worldwide.

The London Grid for Learning networked weather station weather.lgfl.org.uk displays live weather data from a number of stations in England and Wales.

worldometers.info has live world statistics on population and a variety of other categories.

stats.football365.com has historical results from football in the UK, Europe and beyond.

Suggested activities using data from some of these websites can be found on the Nspiring Learning website: nspiringlearning.org.uk

Olympic Cycling - turning planning on its head

Jonathan Powell is Assistant Curriculum Leader for Mathematics at St Thomas More RC High School in North Shields and is also a very keen cyclist. In this article he explains how his passion gave rise to a series of activities for his students.

When planning a lesson, I normally think about the mathematics I want to teach and then decide how I will teach it. That is the convention, right?

For this article, I tried a different approach:

- Firstly, I thought of a interesting topic.
- Secondly, the equipment I wanted to use.
- Lastly, I asked myself "where is the maths in that?"

The 2012 Olympics are just round the corner and there is already a buzz across the country about the various events and sporting facilities, so this seemed like a good starting point. I chose track cycling as the topic to focus on because I am a keen amateur cyclist and have dabbled in racing, so it is a subject I know a lot about. I had already decided I wanted to use TI-Nspire and Navigator in my teaching. Next, I asked myself "where is the maths in track cycling?" This article contains the result of that brainstorm.

After a few days of pondering (naturally, done whilst cycling to and from work!), I decided on four areas for possible investigations. Each is described below and some of the resulting activities appear on the Nspiring Learning website, **nspiringlearning.org.uk** – search the Resource Centre for Olympic Cycling.

The geometry of a bike frame

Cycling is a highly technological sport: millions of pounds are spent by Olympic teams to give their cycles that extra edge during a race. Both materials and shape are continually developing and over the years there have been several controversies surrounding bicycle design. One of the most famous involved the "superman position" used by Graham Obree in 1995 to enable a lower air resistance.

Cycling's governing body, the Union Cycliste International (UCI), banned this position and has many rules governing the size and shape of a frame. So, could we explore the geometry of bicycle frames? The new image functionality of TI-Nspire CX is an effective way of doing this. Images of bicycles can be found using Google Images and imported into TI-Nspire so that various dimensions can be measured on the image. This would be a laborious task to undertake for one person, but not for a class of pupils each with a TI-Nspire handheld.

Graham Obree - superman

"Did you know that... with TI-Nspire you can paste images into documents?"

This provoked several questions. How can I get a correct unit of measurement from a photograph? Won't all the bikes be different anyway, depending on the size of the rider?

These issues could be resolved in several ways: by using a standard unit of measurement common to all bikes i.e. the diameter of a wheel (70 cm), or by concentrating on angles and ratios which are independent of the unit of length.

A bit a trawling through the UCI website produced a whole list of rules that bikes must comply with.

If this were not the case, then the geometry of bikes would be very different. Ever wondered why you often see a cyclist on TV sitting right on the front of his saddle like Bradley Wiggins shown here?

The best position to generate maximum power? Yes. The most comfortable way to sit on a saddle? Definitely not. Why don't they simply redesign the bikes to allow the cyclist to sit more comfortably? UCI rules, that's why!

Cycle tracks around the world

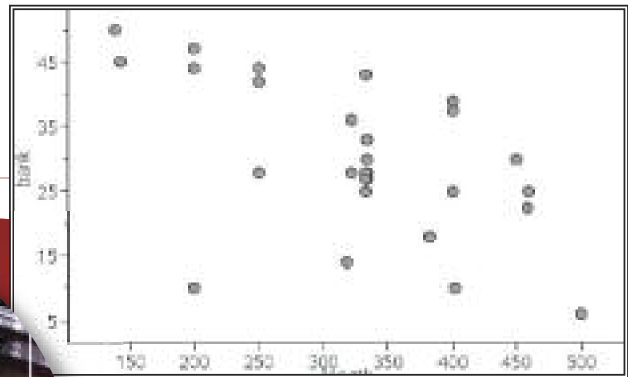
If bicycles are governed by rules, what about velodrome tracks? Are all tracks around the world the same length? If not, is there a more common length or surface? Several hours of internet searching later, I managed to "track down" lots of data about tracks and import them into TI-Nspire.

The quick use of a Data & Statistics page would help students answer the above questions and the question/polling facilities in Navigator could then be put to good use. Many of the questions have slightly ambiguous answers.

Rather than being a disadvantage, this creates a perfect opportunity for student discussion – real data handling is like this!

For example, playing around with the data I had found prompted a new question: is there a correlation between the length of the track and the angle of the banking? It appeared that there might be but my data was incomplete – I only had the angles and lengths for around 25 tracks. More research required!

	location	length	bank	surface	
100	Palma de Ma...	250	_	_	Indoor. 5,000 specta...
101	Córdoba	250			Outdoor.
102	Aldersley, W...	458.56	22.5	Asphalt	Outdoor track[19]
103	Bournemout...	250	_	Tarmac	Outdoor track opene...
104	Calshot (nea...	142.85	45	Wood	Short steeply banke...
105	Middlesbrou...	455.65	_	Tarmac	
106	Mansfield, N...	402	10	Tarmac	Built in 1908, the tra...
107	Welwyn Gar...	460.95	_	Asphalt	Outdoor track
108	London	450	30	Tarmac	A track in a shallow ...
109	Leyton, east...	250	_	Wood	Under construction f...



Dimensions of an indoor cycle track

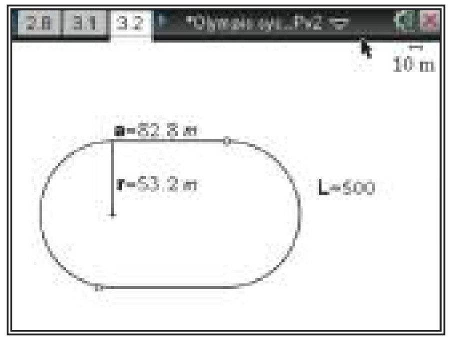
From analysis of the data, it appeared that tracks differ in length but 250m is the most common. A few more questions now sprang to mind.

- Are all tracks the same shape, or are some more circular than others?
- If you cycle one metre to the right of another cyclist, how much further do you travel in one lap?

This last question has very important implications for track cyclists since their bikes have no brakes! One of the ways they can slow down is by taking a larger circle.

How about challenging students to construct a model of a track on a Geometry page? It is an ideal opportunity for them to get to grips with lines, segments, perpendiculars and arcs. Ask students to make a track of length 250m but leave the other dimensions up to them. Then the *Screen Capture* tool on Navigator could be used to display all the different shapes of tracks, comparing the radius of the circle to the length of the straights.

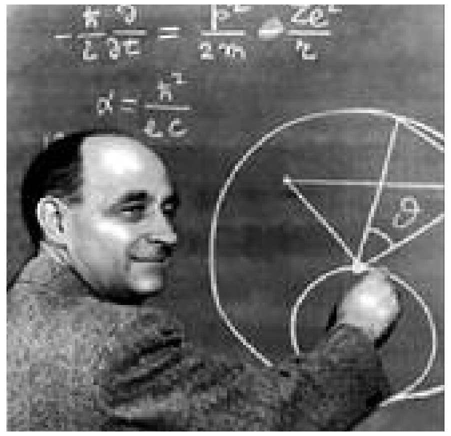
How does this effect the speed of the cyclists? Are some tracks faster than others? More research required!



A Fermi problem

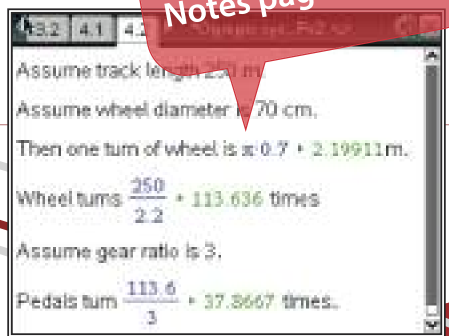
A track bike is very different from a normal bike designed for the road: it has no brakes and only one gear. This gear has a fixed link to the pedals and there is no freewheeling. If the rider stops pedalling, the rear wheel stops moving and this can lead to some heart-stopping moments for first time velodromists! However, it does make it easier to estimate, for example the number of pedal revolutions a cyclist makes during one circuit of a track. This is an example of a Fermi problem. Its solution would require a number of assumptions: length of the track, the cyclist's position on the track, the gear ratio on the bike (this depends on the particular event), the size of the wheel, etc.

> Enrico Fermi was an American physicist who developed the idea of a problem that involved limited information and would require justified guesses to approximate an answer. His most famous problem is "How many piano tuners are there in Chicago?"



Now why would I want to use TI-Nspire for this? Why not just simply ask students to make notes in their exercise books? Well, when I ask a question that can be answered in many different ways I find it instructive for students to be able to share and discuss their solutions with each other. If students document what they have done on a TI-Nspire Notes page alongside their calculations I can use Navigator and allow every member of the class to see what everyone else has done.

Did you know that... you can use a Maths Box like this on a Notes page?



As I write this article other questions start springing to mind. Unfortunately I have already run out of column space, so these questions will need to wait. But turning the order of planning on its head has been a very interesting exercise for me, so I encourage you to get out your TI-Nspire, pick a topic and ask yourself...

"Where's the maths in that?"

Explorative Quest

In Cornwall primary-age children have been using handheld technology to gather evidence and investigate big scientific questions. This innovative science project is described by Neil Anderson, Head Teacher of St. Michael's Catholic Secondary School in Truro.

Children are naturally inquisitive and can ask really big scientific questions: their creativity, ingenuity and imaginations are impressive. However, the laborious nature of gathering and recording evidence can often hamper the excitement of an investigation. But by using the TI-Nspire CX handheld and data loggers, they can collect results and display data and graphs in real time. This enables them to immediately see the patterns in the data and start trying to explain what is happening. They can begin to understand graphing in a very accessible way and can quickly describe graph lines, predict what might happen next and begin explaining.

Teachers at St. Michael's Catholic Secondary School, Truro, and three of its contributory primary schools are pioneering the use of TI-Nspire CX handhelds with students in Y4, 5 and 6 as part of an innovative transition-science project funded by the AstraZeneca Teaching Trust. They have been using TI's free Technology Loan Service, with technical support from Education Technology Consultant Mark Braley. Using the Navigator Wireless Classroom System has greatly enhanced the training of both teachers and students, facilitating the sharing of data and graphs on the interactive white board and allowing students to present to the rest of the class and so build up confidence with presentation skills.

Training

It was recognized that both teachers and students would need to acquire skills and confidence in thinking scientifically and in using the handheld equipment. So the project was launched with a day in which secondary colleagues and science coordinators from the primary schools were able to explore the possibilities and to become familiar and confident with the handhelds.

Then, on a second training day, each school brought along a few students to work on a selection of investigations. Children grow up with technology and expect to be using the latest available in the classroom, so they rose to the challenge and quickly mastered the handhelds and employed them effectively in their investigations. It was the teachers who were more hesitant and needed encouragement! However, they quickly grasped the great advantages of using the technology and so were prepared to take the time to get to grips with the handhelds.

School trials

The next phase of the project involved holding an Explorative Quest day in each primary school with whole classes of Y4, Y5 and Y6 students. Primary and secondary teachers team-taught these sessions together.

All the quests are linked to the curriculum and include support for assessing pupil progress. Subsequently Explorative Quest kit boxes, with everything needed for fun, exciting investigative quests, will be available to lend to primary schools. For example, the Survival Explorative Quest is about mountaineers getting cold and exploring the materials that are best for their clothing.

Students use a simple model of a human (a yoghurt-drink pot) filled with hot water and compare materials by monitoring cooling; one pot/mountaineer with a jacket and one without. The handheld is used in conjunction with temperature sensors and used in time-based mode over ten to fifteen minutes.

Continues overleaf

Explorative Quest continued

What's ahead?

Secondary phase quests are also in the development phase. Quests so far have been in the contexts of floating and sinking, heating and cooling, aquarium environment, sound and light and friction.

Some of the ideas will be linked to the forthcoming Olympics. For example, the friction quests, 'grip and slip' and 'tracks and tread', may explore the use of artificial surfaces used for athletics tracks and the velodrome, and perhaps the treads on cycle tyres, trainer soles, and the use of chalk by gymnasts for parallel bars and weightlifting. We also intend to have a Winter Olympics theme, designing and exploring a model bobsleigh run, which will involve looking at friction, speed and acceleration.

For more details about the project, please contact Neil Anderson at **stmichaelstruro@btinternet.com**.

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