

# New Ways to Think Spatially

## Introduction

Many children have difficulties thinking spatially. Here simple surveying CAD software is used to teach the concept of many things including bearings, map design and scale. Students get to go outside the classroom and perform a field survey, using a 30 metre tape and either a compass or protractor to collect data. The data is entered into miniCAD in a computer lab to produce a map, which is then plotted to scale. The concept of error and statistics can also be introduced to more advanced students.

## Surveying terminology

Because miniCAD is a professional survey tool, it is necessary to be familiar with some of the industry's terminology. If you are a teacher from a country other than Australia, surveyors may use different terminology to that described here.

When you first open miniCAD you see a blank graphic screen. Surveying software stores data in 3D, but the data is viewed in a plan view, with heights attached to the points (features). North is always up the screen, with bearings running in a clockwise direction from here. When a surveyor maps an area, they need to set their measurement device (theodolite) over a survey mark. This occupied point is known as a station. From this point they radiate features, such as trees, manholes, paths, buildings, or fences. Some are points (eg trees and manholes) and others are strings (eg paths, buildings and fences). The shot taken to record these features is known as a radiation. After all the features that can be seen from the current station are recorded, the surveyor needs to occupy a new station. In order to maintain spatial relativity between the stations, an observation, known as a traverse leg (but really just another radiation) is made to the new station. Both a radiation and a traverse leg consist of a bearing, a horizontal distance and a vertical distance taken to the feature.

The new station is now occupied and the features visible from this point are recorded in an identical manner to the previous station. However, before the radiations can be taken, the back-bearing must be set to the previous station so that the radiations taken from the new station are on the same azimuth as the last station.

A surveyor will usually try to do a "loop" traverse, observing a bearing and distance(s) back to the starting point. This allows the surveyor to close their work. Between each of the traverse stations, there is a "true" bearing, horizontal and vertical distance. The more accurate the survey equipment, the closer the surveyor should get to measuring the true bearing and distance(s). In other words there will always be a small error associated with the measurement of each traverse leg and the "misclose" can be calculated for a close. If the misclose is too great, it suggests that there may be a gross error in the survey and measurements should be rechecked. Survey accuracy can often be improved by measuring each leg multiple times and then taking a mean. Surveyors also try to improve the accuracy of their work by bracing their observations. For instance if a traverse has 4 stations roughly in the shape of a rectangle, the surveyor will take measurements across the diagonals of the rectangle if these stations are intervisible. This introduces a redundancy into the survey, and statistical methods (least squares) to apportion the misclose (known as an adjustment).

## Basic miniCAD commands

When you start a new miniCAD job you are prompted for a point. This is because all miniCAD jobs must have at least 1 point. Arcs and lines cannot exist without their supporting

points. A line is defined by its endpoints and an arc is defined by its endpoints and centre point.

The following descriptions use the menu. If a command also has an icon on the toolbar to the right of screen an asterisk (\*) is shown next to the command.

### **Data Creation**

\*Draw>>Point – Enter data for East and North. If you like enter a description of the point in the code section. Then hit the Store button. The easting and northing can be selected using the mouse on the drawing area after the code has been entered. You may also enter a point number. All subsequent points will be incremented by 1 from this point number.

\*Draw>>Traverse – Select a point to commence from either by using the mouse or entering it. by Enter a bearing and distance. Bearings are entered as north 0 degrees, east 90 degrees etc. Distances are in metres. A bearing or distance can also be selected by snapping to an existing line on the screen. The end of the line selected will change the bearing displayed by 180 degrees. Hit the Store button to create the vector. Note that the From point is updated and you are ready to enter the next traverse leg. Radiations can be entered by adding a minus sign before the bearing. In this case the From point is not changed and a line is not drawn. Normally you would enter all your radiated points before entering your next traverse leg.

\*Draw>>Line – Snap to the points you wish to join and a line will appear on the screen. The line command will join multiple points (eg 1-2-3-4etc). If you wish only to join 2 points at a time select the join 2 points checkbox (eg 1-2,3-4).

Arc menu – this will be left for you to explore yourself

### **Data Views**

\*View>All – Views the entire job on screen

\*View>>Window – select diagonally opposite corners of the screen to zoom in to an area.

View>>Scale – a scale of 0.5 will halve the size of the job on screen while a scale of 2 will double it.

\*View>>Pan – use the mouse to drag the drawing across the screen.

\*View>>Numbers – turns the point numbers on and off

### **Erase Data**

\*Erase>>Object – Select Point, Line or Arc and then select the data to erase with your mouse.

\*Undo and Redo commands are also available.

### **Data Queries**

\*Query>>Point – Displays the Easting, Northing, Height and the code (description) of the point

\*Query>>Line – Displays the bearing and distance between a line or 2 points

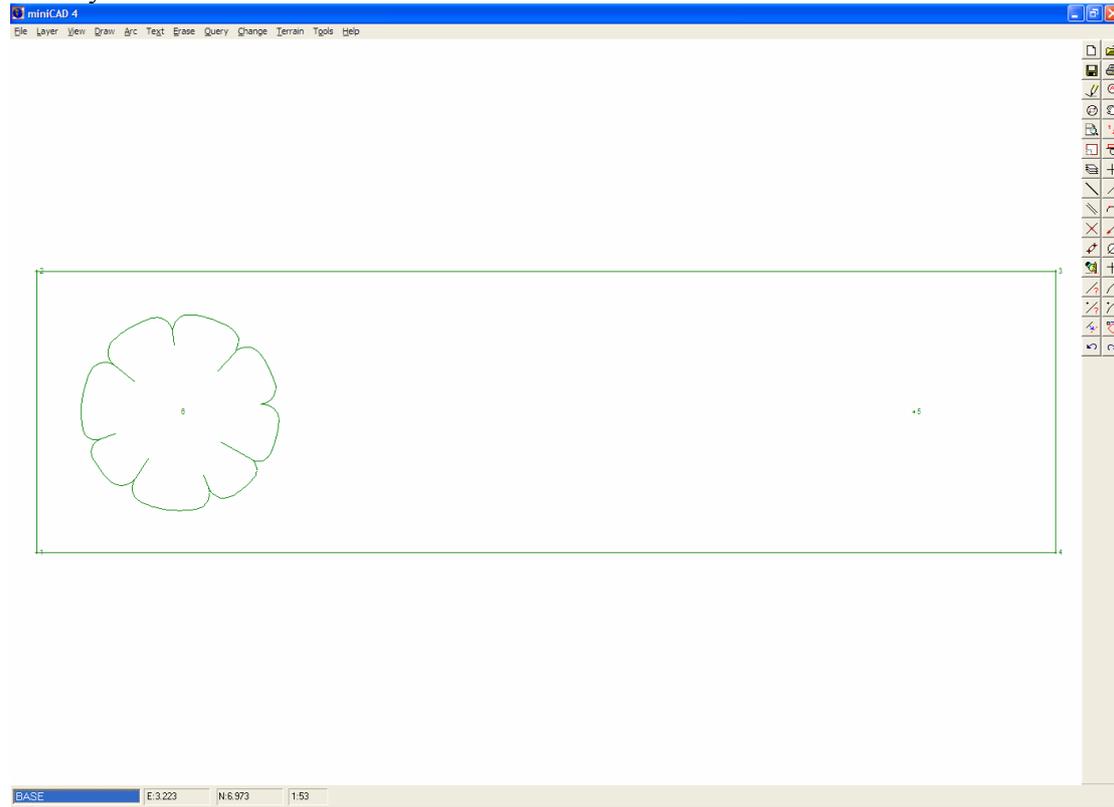
\*Query>>Arc – Displays the chord bearing and distance, radius and arc length of the arc

Query>>Area - Displays the area of a closed figure

### **A basic miniCAD exercise**

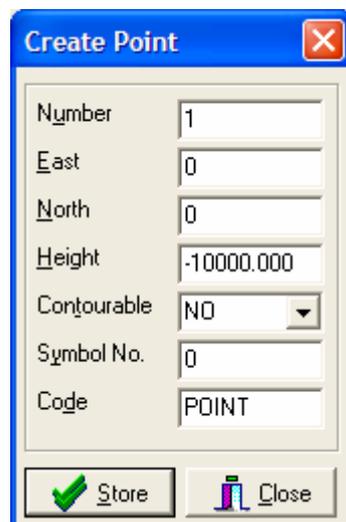
This exercise uses whatever resources the school may have, compass, protractor or watch for measuring angles, 30m tape, measuring wheel or pacing for measuring distances.

When you have finished the exercise it should look like this:



The kids who performed this exercise, had trouble understanding how to use a compass. To make it simpler they were told that line 1 to 2 was 12 o'clock on their watches. Aligning their watches to this line, they calculated where the small (hour hand) would point for all other lines to the nearest half hour. In the computer lab they referred to a table which converted the clock times to bearings. Two weeks and a few exercises later the same kids understood bearings and were able to use a compass. The distances were paced and so they varied slightly between students.

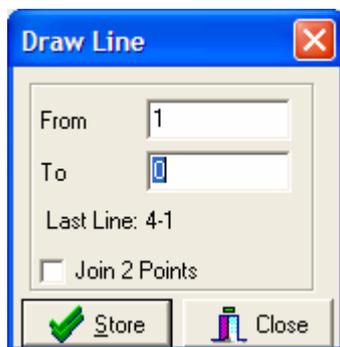
1. Open miniCAD (or start a new job). If the dialogue box below is not displayed select Draw>>Point. Enter 1 in the Number field, and 0 in the East and North fields. Left click on the Store button or hit the Enter key. This creates our first point.



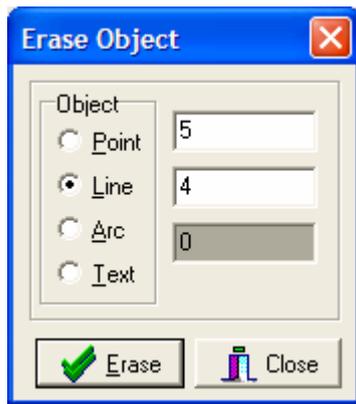
2. Turn point number on by selecting View>>Numbers.
3. Left Click on the Close button on the Create Point dialogue box
4. Select Draw>>Traverse from the menu. Left click on point 1 on the screen or enter 1 in the From field. Enter 0 in the Bearing field and 5 in the Distance Field. Left click on the Store button or hit the Enter key.



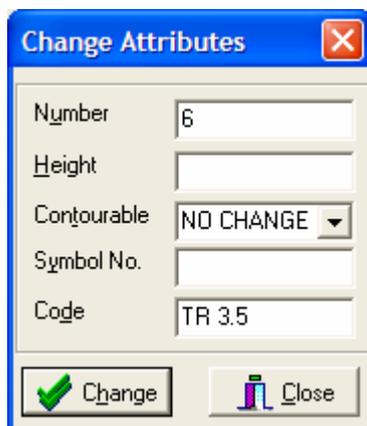
5. A line should have been drawn vertically on the screen. Notice that the From field of the Traverse dialogue box should have automatically been updated to 2. Continue entering the following bearings and distances as per step 4 above. Traverse leg 2 Bearing 90 Distance 18, Traverse leg 3 Bearing 180 Distance 5. (Note that Traverse leg 3 could also have been entered by left clicking the mouse near Line 1 to 2, closer to Point 2 to fill the Bearing field and then left clicking the near same line again to fill the Distance field.)
6. Enter Traverse Leg 4 Bearing 315 Distance 3.536.
7. Move the cursor into the From field by left clicking in it and then left click on point 1 on the screen. The From field should now contain 1. Enter Traverse Leg 5 Bearing -45 (note the minus sign) Distance 3.536. The minus sign before the bearing means this is really a radiation. Note that there is no line drawn this time and the From field retains the originally selected point. While we continue to enter negative bearings, the new points will continue to radiate from 1.
8. Select Draw>>Line and left click on point 4 and then point 1 to draw a line between these points. On your own jobs experiment with selecting the Join 2 Points check box to see what happens.



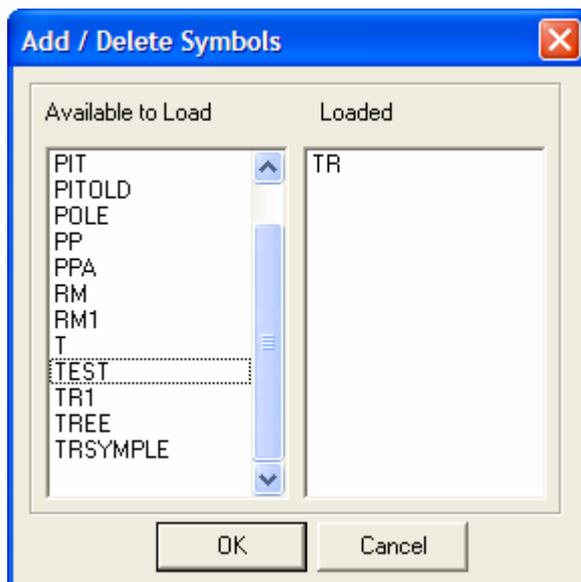
9. If the screen is getting cluttered, dialogue boxes can be closed by left clicking the Close button.
10. Select Erase>>Object, check the Line object and then left click on the screen near the line 4 to 5.



11. Point 6 is actually a tree with a radius of spread of 3.5 metres. To make it look like a tree change the code to TR 3.5. See below.

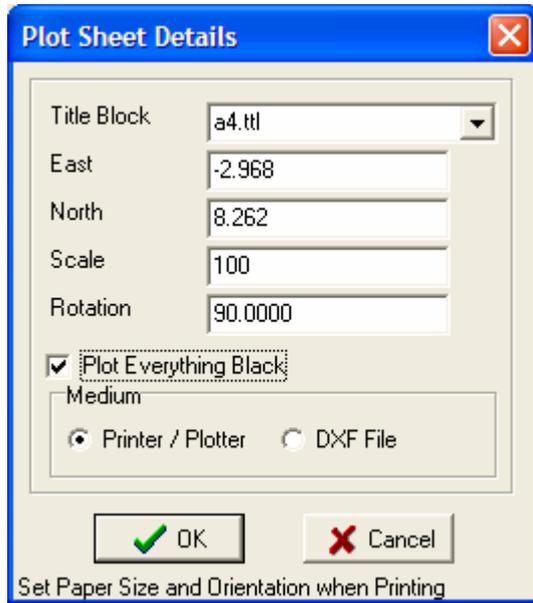


12. Next select Tools>>Add Symbol and drag the symbol TR from the Available to Load to the Loaded column. Left click on the OK button.



13. In some cases it is necessary to use View>>Redraw and View>>Check Extents to make data visible on the screen.

14. To plot the plan to your printer select File>>Plot Window and match the details below. After this dialogue box, your normal Windows print dialogue box will appear. Select your printer, and an A4 sheet of paper in Portrait.



Queries can be emailed to [support@mapsoft.com.au](mailto:support@mapsoft.com.au) and we will attempt to answer them as promptly as possible.