User Manual

Calcad

V4oct14

Contents

1 Introduction

This manual explains how to use Calcad to create a sundial in any position, at any angle, without any specialized knowledge.

Calcad is "exchangeware". You can copy it, pass it on to your friends and use it free of charge. All we ask in exchange is that when you have created your own sundial, you transmit a picture of it to the program's author (yvon.masse@sfr.fr).

The current version should satisfy the most demanding users. In addition to the essential functionalities of a sundial software (measurement of the dial orientation, accurate definition of the different lines, layout of the shadow for educational objectives, back-up, export of the graphics, printing of the data, easy installation, complete documentation and help, etc.) this new version propose:
o   A multi-platform software: Calcal now runs on Windows, GNU Linux and Mac OS X
o   A functionality "Desktop sundial" to get, as the applications "Clock", the time always displayed on your desktop by the sundial of your choice (see Section 4.11, p. 23)
o   Detailed solar ephemeris (see Section 4.9, p. 21)

For a quick idea of the possibilities of Calcad, see the sample sundials (Section 4.14, p. 26)

Note: the users who have data files supplied by the old versions of Calcad will have to modify them in the following way:
o   Open each file with Notepad of Windows
o   Do *Save as...* and select the coding UTF-8 at the bottom of the selection window
o   To finish, press the button *Save*

2 Installation and uninstallation

You can download the latest update of Calcad at:
http://yvon.masse.perso.sfr.fr/calcad/index_enu.htm
Depending of the used operating system and the kind of selected installation, follow the indications below.

2.1   By installer in Windows

The installation will run automatically after you launch the file install_calcad_v4oct14.exe. Just answer the questions.

The installer file was compiled using the freeware Inno Setup by Jordan Russell (http://www.jrsoftware.org/)

Uninstall Calcad like all Windows applications, using either *Uninstall Calcad* in the *Start* menu, or the *Add/Remove Programs* option of the *Control Panel*. Uninstalling Calcad will not remove any data files or diagrams that you generated.

2.2 Portable zipped version in Windows and GNU/Linux

Unzip the archive after downloading; the software is within the unzipped directory (*Calcad.exe* for Windows and *Calcad* for GNU/Linux). It launches when you double-click on it. To facilitate the launch, create one or more shortcuts.

To uninstall, remove the directory and the eventual shortcut.

2.3 Application for Mac OS X

Open the disk image after downloading and drag the application *Calcad* to the *Applications* directory.

To uninstall, remove the application.

3 Instructions for use

3.1 Preparing the sundial

Choose a site for your sundial that is in sunlight for a large part of the day. The dial should be flat, but it can have any orientation, and it can be horizontal, vertical, or even sloping.

On the flat surface, draw a square or a rectangle of the size you want to give your sundial. Make sure that the corners are right angles: exactly 90°.

Select the side you will call "top". For a vertical or slanting sundial, the choice is obvious, but you also need to make this assignment for horizontal sundials. When Calcad produces the diagram of the sundial, it will represent the "top" side ... at the top!

Draw two straight lines between the centers of the opposite sides to get the center **O** of the square or rectangle. The straight line that connects the left and right sides will be the x axis *X'X*, the other one will be the y axis *Y'Y*, with Y on the "top" edge. This axis system will allow you to note the position of any point inside the dial (see Section).

Install a temporary gnomon[1], with its tip above point **O** (perpendicular to the plane of the dial), at a distance that is about a quarter of the shortest side of the sundial. You will measure the position of the tip's shadow on two separate occasions to provide Calcad with the information it needs to calculate the layout of the dial.

Check the perpendicularity by set square (photo 1). Do this at least twice, with the set square aligned in different directions.

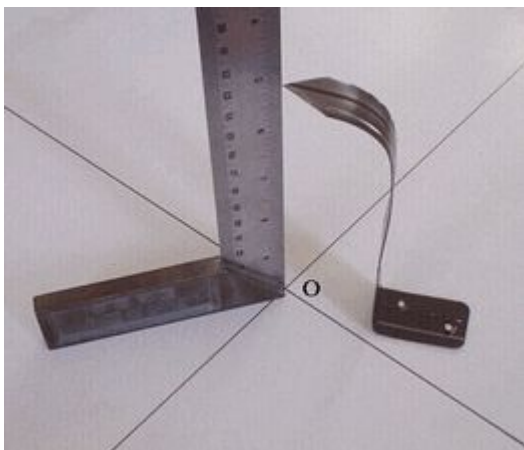Measure the height of the tip accurately (photo 2).

Photo 1   *Photo 2*

Now you can specify the dial information for Calcad. Open the input box by clicking on the *Input* menu or by typing 'Escape' on the keyboard, then enter the side of the square (or the height and width of the rectangle) and the height of the gnomon's tip.

3.2 Recording the shadow points

You need to do this twice, ideally with 4 to 6 hours between the times of the two readings. Record the position of the shadow of the gnomon's tip (see Section 4.1, p. 16) and the exact time and date. You can take the two readings on different days, as long as the clocks are consistent. If you take one reading in standard time and the other in daylight saving time (summer time) the results will be incorrect.

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[1] The word *gnomon* comes from the Greek and means 'indicator'. It is the object that casts the shadow used to indicate the time. It gives its name to gnomonics, the science of sundials.

For each of the two shadow points, enter the date, time, and coordinates in the Calcad input box.

Important: the kind of hour, standard or daylight saving, must be the same for the 2 points.

3.3   Place details

The values in the *Place* tab are optional, and can be approximate without affecting the sundial's accuracy. They define the position of the horizon and make it possible to restrict the layout to the useful part of the sundial face: the times when the sundial will be in sunlight.

Enter the latitude of the location. If necessary, to improve this restriction, enter either the time of the *Half-day* (true midday: the time when the sun is directly overhead) or the *Complete localization*: longitude and time zone.

Important:
o The time of the half-day must be consistent with the times of the 2 shadow points (all in standard time or daylight saving time).
o In the same way, the time zone must be associated to the hours used to record the shadow points or, more generally, to the sundial definition.

You can use Google maps (http://maps.google.com) to find the latitude and longitude:
o   Type the address in the Search box, or navigate to the sundial's location
o   Right-click on the marker that appears on the page and select *What's here?*
o   Google displays the geographical coordinates in the Search box in *latitude, longitude* form. The latitude is positive in the northern hemisphere and negative in the southern. The longitude is positive if the location is to the east of the Greenwich meridian, negative if it is to the west.

For the time zone, you should enter the time zone *offset*: the difference between your local time and UTC/GMT. Many sites list time zone offsets. See, for example, the bottom of the beautiful world map at http://en.wikipedia.org/wiki/Time_zone. The difference is positive at the east of the Greenwich meridian, negative at the west. For daylight saving time add 1 hour. At the east of USA, for example, the value of the time zone is -5 for the standard time and -4 for the daylight saving time.

3.4   Sundial with solar hours

The lines of solar hours (or true hours) are the lines of the olds sundials. If you want draw this kind of sundial, you have just to check the *Solar sundial* tick box and enter, if it is not done, the longitude and the time zone.

The sundial will indicate midday when the sun will be at the top, at the exact moment of the half-day. To get the legal hour, it is necessary to add a further correction supplied by Calcad.

3.5   Computing the sundial

When you have entered all the data, launch the computation by pressing the *Calculate* button of the input box or typing Ctrl + M.

Calcad then calculates the sundial parameters and displays the graphical layout in the main window, and the details in the text window. These include an accuracy indication, at the beginning of the large text window:
o   If the accuracy indication is between 0 and 1, the sundial will be very accurate
o   If the accuracy indication is between 1 and 4, the sundial will be fairly accurate
o   If the accuracy indication is greater than 4, the sundial will not be accurate enough to be useful. Verify all the previous stages. Displaying the 2 shadow points by the *Other* menu may help you to detect any input errors.

3.6   Sundial layout options

Calcad displays the diagram of the sundial in the main window. There are many options, allowing you to choose between simplicity and accuracy – because the Earth's axis is tilted, a simple sundial with straight hour lines can give readings that are incorrect by up to 15 minutes, depending on the time of year (see Section 3.11, p. 13). Calcad can draw curved hour lines (they look like a figure 8) that compensate for these seasonal variations, and diurnal arcs that show where to take the reading depending on the date (see Section 3.12, p. 15).

Select which lines to include by the *Hours*, *Arcs*, *Other* and *Shadow-caster* menus:

o   ***Hours***
  *   *Subdivision*   Draw the dotted half-hour, quarter-hour or 10-minute lines
  *   *Hour lines*   Draw straight hour lines (the readings will need to be adjusted by the equation of time), shown in black
  *   *Restriction*   Limit the layout of the hour lines to the useful length, which depends on the shape of the shadow-caster
  *   *S January-June*   Draw the curved hour lines for the period from December 21/22 to June 20/21, shown in blue
  *   *Z July-December*   Draw the curved hour lines for the period from June 20/21 to December 21/22, shown in red

o   ***Arcs***
  *   *Signs*   Draw the arcs of the solstices, the equinoxes and at the beginning of each zodiac sign, shown in purple
  *   *Date*   Draw the arc for the date specified in the input box in the *Other* tab
  *   *January-June*   Draw an arc for the first day of the months from January to June. These are shown in blue and the dotted arc corresponds to January 1
  *   *July-December*   Draw an arc for the first day of the months from July to December. These are shown in red and the dotted arc corresponds to July 1

o   ***Other***
  *   *2 points*   Show the position of the 2 shadow points used to perform the calculations
  *   *Axes*   Draw the axis system
  *   *Squares*   Display a grid of square boxes to make it easier to transfer curved lines

		on to the sundial. The *Other* tab of the input box allows you to choose the size of the squares
*	*Horizon*	Draw the horizon line (see Section 4.7, p. 21)
*	*Refraction*	Integrate the adjustment for refraction in the layout of curves. This is only possible if you have provided complete location information in the *Place* tab (latitude plus either half-day or longitude and time zone)
*	*Shadow*	Show the shadow of the style or the gnomon and enable its animation. If you have provided complete location information in the *Place* tab (latitude plus either half-day or longitude and time zone) the shadow is drawn according to the refraction effect (see Section 4.3, p. 18)
*	*Desktop sundial*	Run the "Desktop sundial" mode (see Section 4.11, p. 23)

o **Shadow-caster**

*	*Visible*	Display the shadow-caster, which will be represented lying on the sundial
*	*Type*	Show the shadow-caster as style (triangle or trapezoid) or gnomon (single perpendicular bar). See Section 4.8, p. 21
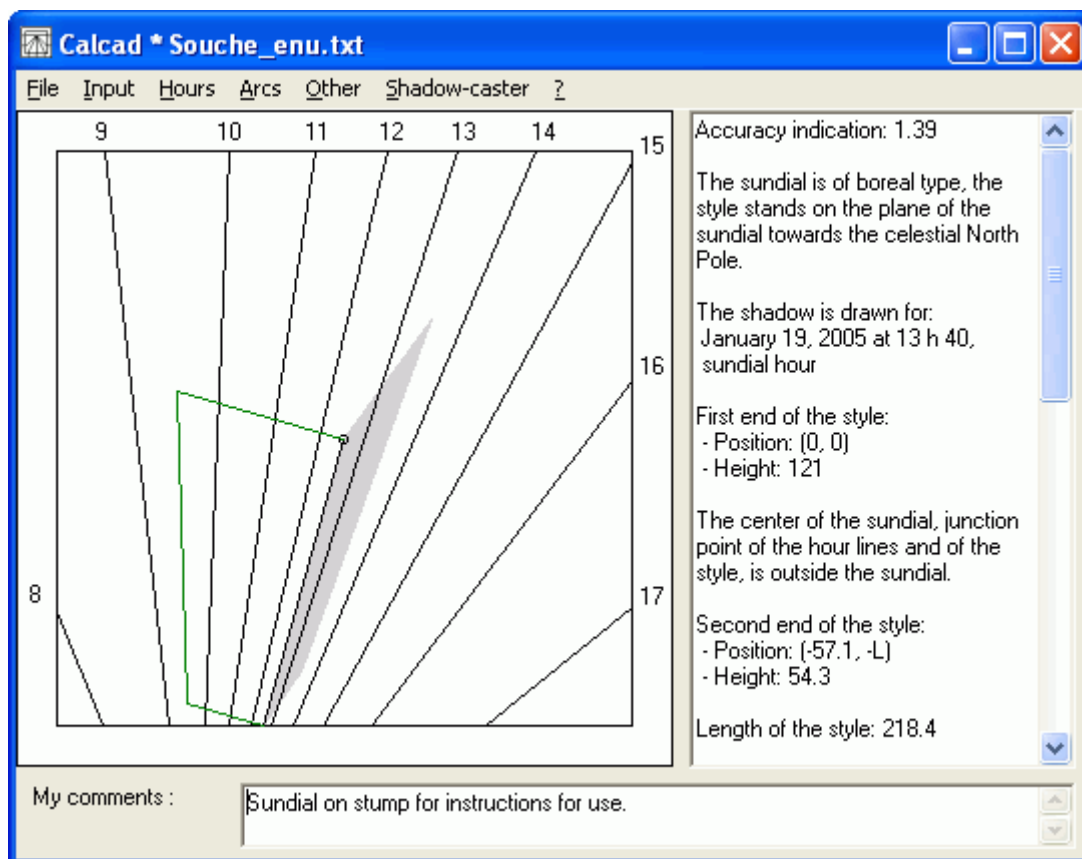
3.7 Adjusting the shadow-caster

Initially, Calcad creates the sundial layout with the shadow-caster identical to the temporary gnomon that you used to record the two shadow points. Changing its size or its position may lead to more accurate readings and/or a more useful layout. Calcad allows you to simulate moving and resizing the shadow-caster to see how the layout changes. You can do this using the mouse or the keyboard, or by entering values in the input box *Dial* tab.
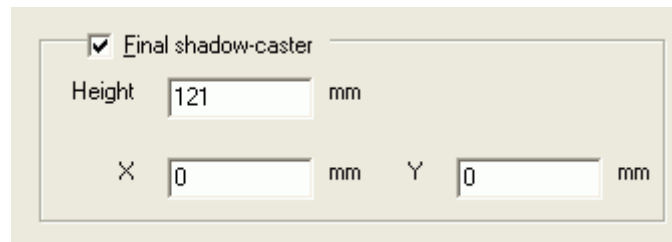
o **Using the mouse:**
   * Click on the sundial diagram. Its outline becomes red to indicate that the diagram is selected
   * Hold down the mouse button (the cursor takes the shape of 4 arrows) and move the mouse. The shadow-caster will follow the movement
   * Roll the wheel of the mouse to make the shadow-caster larger or smaller
   * Unselect the diagram by right-clicking or by clicking outside the diagram

o **Using the keyboard:**
   * If necessary, enable the main window by using the 'Escape' key
   * Select the diagram by pressing the 'Tab' key until its outline turns red
   * Move the shadow-caster using the up, down, left and right arrow keys, or the 8, 2, 4 and 6 keys of the numeric keypad
   * Make the shadow-caster larger or smaller by using the 'Page up' and 'Page down' keys, or the 9 and 3 keys of the numeric keypad

o **Using the input box:**
   * In the *Dial* tab, check the *Final shadow-caster* box
   * Modify the values that define the size and position of the style or the gnomon
   * Press the *Calculate* button

Note: when the *Final shadow-caster* box is unchecked, the gnomon or the first end of the style tallies with the temporary gnomon that you used to establish the shadow points.

The configuration of the sundial is now finished. The next step is either to make a small-scale model of the sundial (see Section 4.2, p. 17) or to go directly to its final realization. Beforehand, in both cases, use the *File* menu to save or print the data.

3.8   *File* menu

The *File* menu includes:

o *New*   Erase all the data and begin designing a new sundial

o *Open*   Open a file to load the saved data of a sundial. Another way to open a data file is to use "drag and drop" (don't work in Mac OS X) or, in Windows if using installer, to double-click on the files with .ccd extension

o *Save*   Save the data of the current sundial

o *Save As*   Save the data of the sundial into another file

o *Save the Diagram* Save the diagram of the sundial as shown in the main window

o *Export dxf*   Record the layout of the dial and the geometry of the shadow-caster in dxf format. Most CAD software accepts this vector format (see § 4.10, p. 22)

o *Print*   Print the numeric data of the sundial with its diagram. The printout will be very useful for the realization of the sundial (see § 3.10, p. 13)

o *Print the Diagram* Print the diagram in different formats. This option will help you to make a scale model of the sundial (see § 4.2, p. 17)

o *Quit*   Quit the program

3.9   Numeric data

Following the accuracy indication and a short description of the calculated sundial (boreal, southern, polar, equatorial), Calcad lists the information needed to build the sundial: the details of the shadow-caster and the coordinates of essential features, defined in the axis system drawn on the dial face (see Section 4.1, p. 16).

The data that is listed depends on whether the point where the hour lines intersect (the sundial center) is inside or outside the layout area:

o   If the center lies inside the dial, it will be the start point of all the hour lines. If you chose *Style* as the shadow-caster, it will be triangular, with its lower end point at the sundial center, as shown in green in the diagram
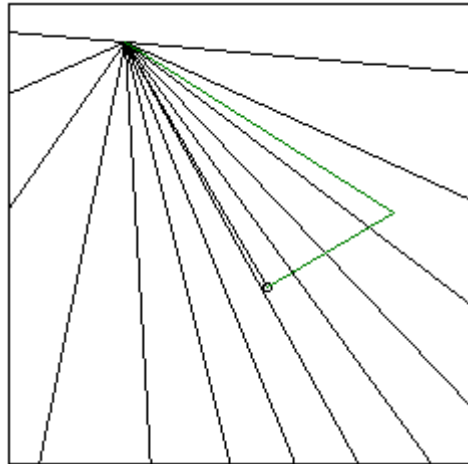

o   If the center lies outside the dial like the sundial made for these instructions for use, the data will list both extremities of the hour lines. If you chose *Style*, it will be trapezoidal and the data will indicate the position and height of both its end points

The numeric data depends on the layout options you choose in the different menus.

o   If the sundial is of solar hour type: the additional correction to make
o   If the selected shadow-caster is *Gnomon* (perpendicular rod) its position and height
o   If the selected shadow-caster is *Style* (triangle or trapezoid) the details of its two end points, as follows:
     *   The first point is always the business end of the style: position and height
     *   If the sundial center lies inside the dial, the style is a triangle and the second point will be the coordinates of the sundial center: the junction point of the hour lines and the style (height zero)
     *   If the sundial center lies outside the dial, the style will be a trapezoid and the data will include the coordinates and height of the second point
     *   The length of the style
o   If *Hour lines* is selected, for each hour (and subdivision, if selected) the position of the line's 2 end points
o   If the horizon line is selected, the coordinates of its end points
o   If the arcs of the zodiacal signs are drawn, the 2 end positions of the equinoctial (line of the equinoxes)
o   The reduced parameters of the sundial (see Section 4.16, p. 27) in case you want to draw it using other sundial software

3.10 Building the sundial

With the help of the numeric data, draw the lines of the sundial.
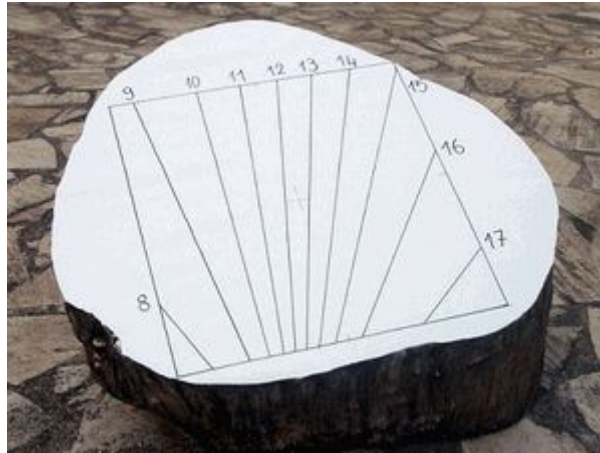
Then install the shadow-caster. In the case of a style, if it is accurately installed and the hour lines are properly drawn, the style will always be aligned with the hour lines, no matter what angle you look at the sundial from.
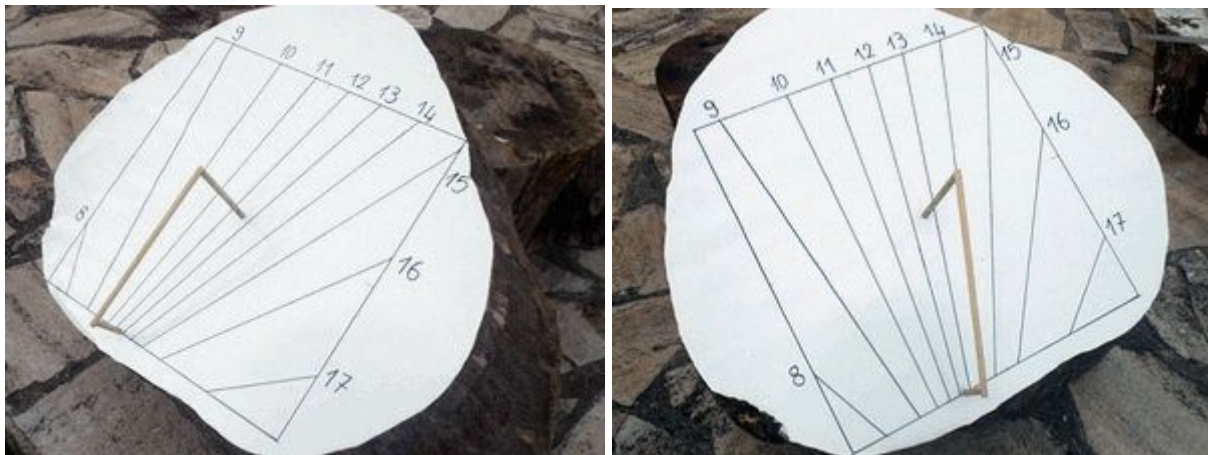

3.11 Reading the sundial

To get the current time from the sundial indication, first of all adjust for daylight saving time if necessary:
o   If the sundial was drawn for standard time, add 1 hour in summer
o   If the sundial was drawn for daylight saving time, subtract 1 hour in winter

If you chose straight hour lines, you also need to compensate for seasonal variations using the equation of time given by the curve below:
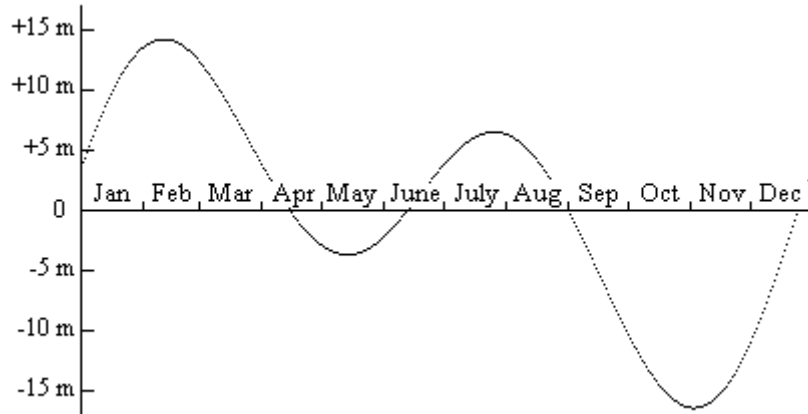
Or, if knowing the time within five minutes is good enough, just use to the following table:

Period	Adjustment [min]	Period	Adjustment [min]
From December 30 to January 10	+5	From June 25 to August 23	+5
From January 11 to 25	+10	From August 24 to September 8	0
From January 26 to February 28	+15	From September 9 to 22	-5
From March 1 to 19	+10	From September 23 to October 8	-10
From March 20 to April 5	+5	From October 9 to November 26	-15
From April 6 to 27	0	From November 27 to December 9	-10
From April 28 to May 29	-5	From December 10 to 19	-5
From May 30 to June 24	0	From December 20 to 29	0

Finally, if the sundial is drawn for the solar hours, it is necessary to add a correction that depends of the longitude and the time zone. This correction can be negative that is to say it must be subtracted. It is computed by Calcad and displayed in the numeric data.

The opposite picture was taken on January 19, 2005. This sundial is not of solar hour type, what time was it?

The answer may be found page .
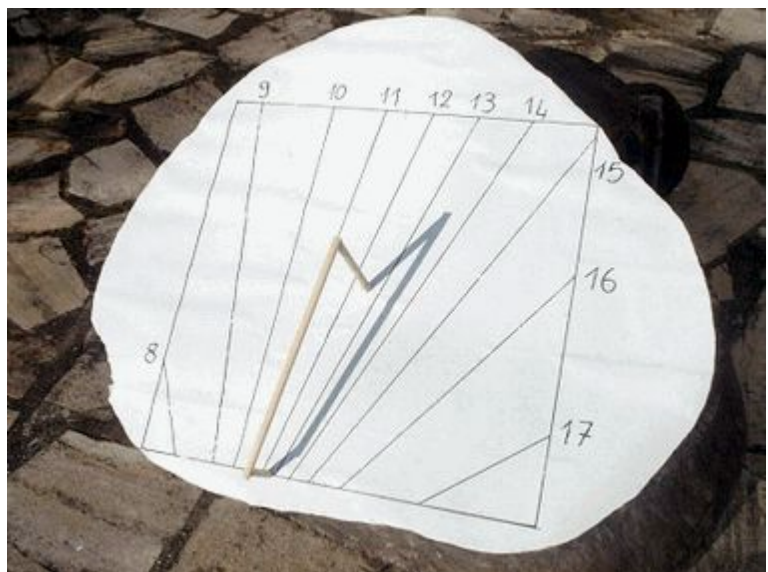
3.12 Equation of time adjustment on the sundial

You may have noticed that the sun is higher in the sky in summer than in winter. As a result, each day, the tip of the shadow will follow a slightly different path across the hour lines. These paths are called *diurnal arcs*. They range between two extremes: the summer solstice, when the sun is highest in the sky, and the winter solstice when it is lowest. The solstices generally fall on June 20/21 and December 21/22.

In the diagrams below, Calcad has drawn, in purple, the diurnal arcs for the winter and summer solstices and the changeover dates for the astrological signs. The central arc, the *equinoctial*, is a straight line corresponding to the equinoxes (March 20/21 and September 22/23).

If you choose to integrate the equation of time adjustment directly on the sundial by drawing the hour curves, Calcad calculates the exact position of the shadow's tip for each diurnal arc, including the adjustment. The resulting curves snake between the solstices, in the shape of an inverted "S" for the months from July to December, shown in red in all three diagrams, and an "S" for the months from January to June, shown in blue in the third diagram. Together, the complete hour curves form a figure-8 shape called an *analemma*.

Note: If you choose to draw the diurnal arcs for the first of each month, Calcad uses the same color as the corresponding "S" curves.
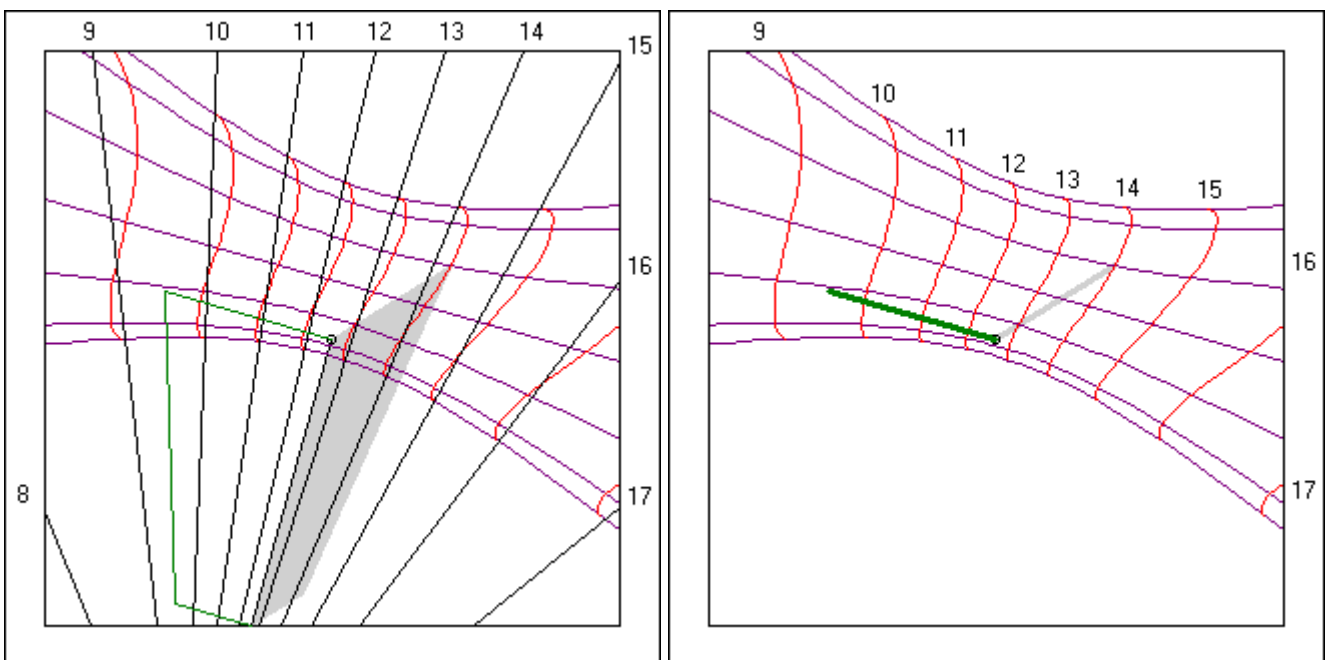
Adjustment of the equation of time from July to December
In the pictures, the shadow is on the diurnal arc for October 23 and it is exactly 14:00

Except for the arc of the equinoxes, which is a straight line, all the diurnal arcs and hour curves are complex shapes (you can't just draw a straight line between their end points). To make it easy to reproduce them on the sundial, choose *Squares* in the *Other* menu. Calcad will then superimpose a grid on the diagram, as shown below. You can adjust the size of the squares in the input box.

15
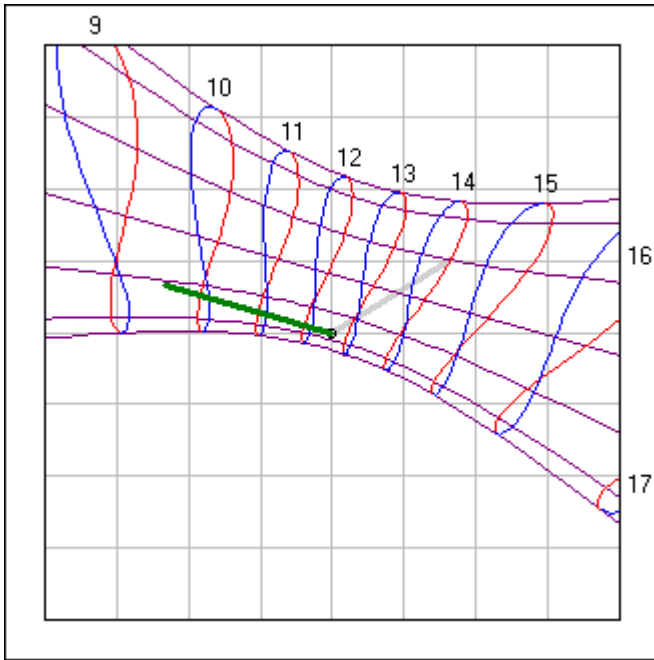
Superposition of the curves for the whole year.

4 Additional information

4.1 Position of a point

The position of the point **A** is obtained by measuring the distance from **A** to *Y'Y* **parallel with *X'X***, this gives the value X = 100 mm. Then, the distance from **A** to *X'X* is measured **parallel with *Y'Y*** to give the value Y = 84. Calcad will indicate the position of the point **A** by (100, 84). For the point **B**, proceed in the same way but, to indicate that **B** is at the left side of the axis *Y'Y*, give X a negative value. Calcad will then indicate the position of the point **B** by (-118, 134). Finally, for the point **C**, which is located under the axis *X'X*, give Y a negative value. Generally speaking, Calcad will use the letter L for the X or Y value when the indicated point is located on the outline of the sundial. When the value is negative a minus sign precedes the letter L. So, for the point **C**, Calcad will indicate (-L, -150).
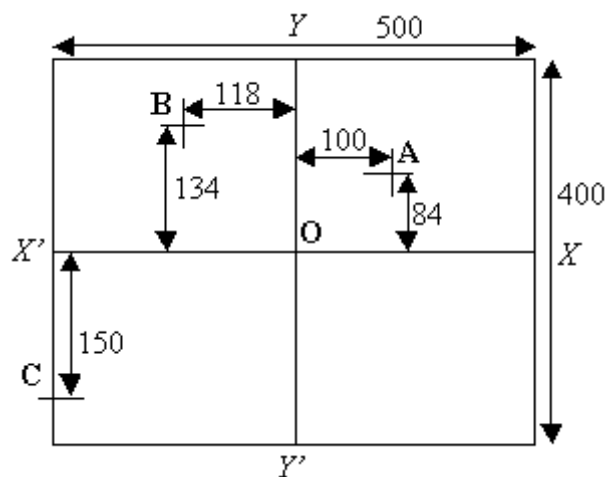
4.2   A scale model with 3 scissor cuts

When all the data have been entered, you can quickly create a small-scale functional model from paper to get an idea of the future sundial. To do this, select *Print the Diagram* in the *File* menu and make separate printouts of:
o   The diagram of the sundial without the shadow-caster
o   The shadow-caster element alone
Use the same format for both (Calcad can use from half a sheet to 4 sheets to place side by side).

Cut out the shadow-caster, keeping a strip of paper at its base. To make it more rigid, you could stick it to a piece of card. Bend this strip at 90° and glue it on the sundial print.
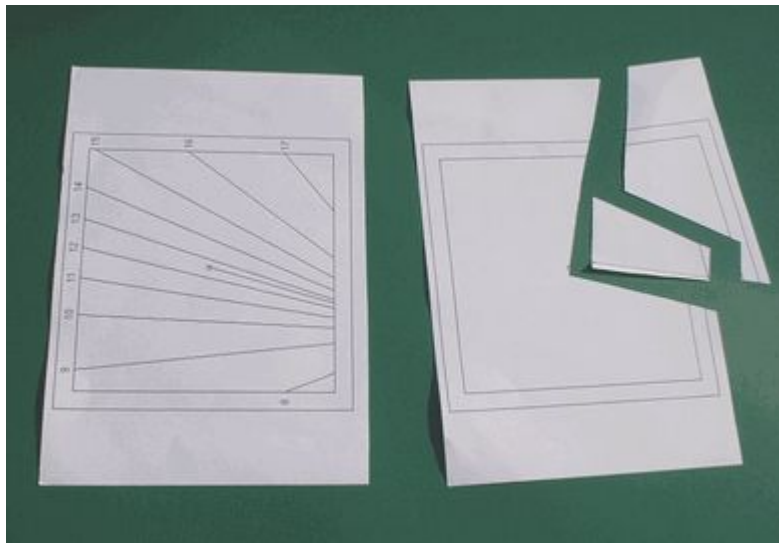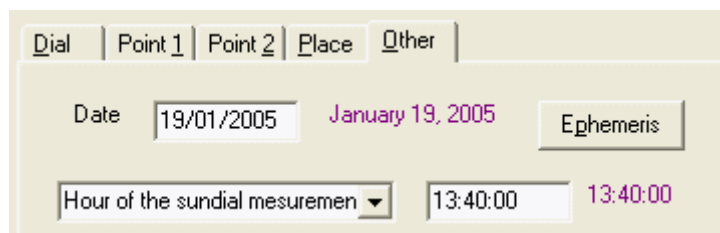

Use 4 pieces of adhesive tape to fix the whole on the plane of the future sundial, aligning the edges of the sheet with the axes and ... wait for the sun!
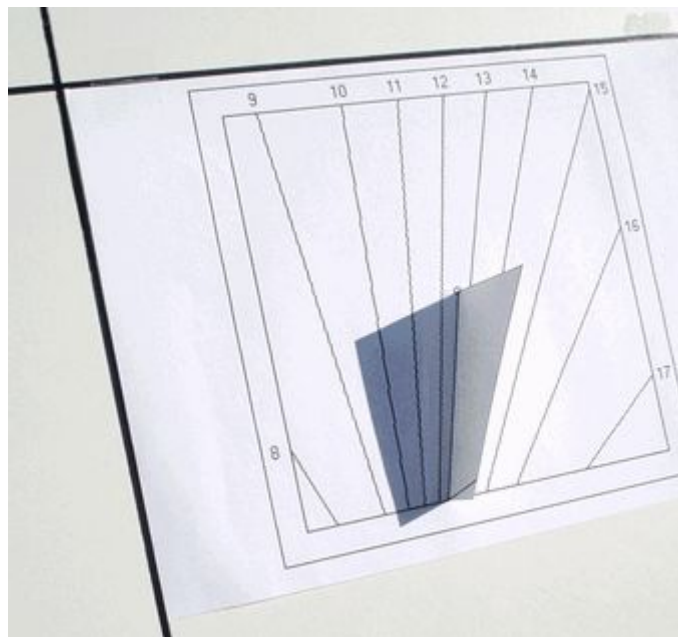
4.3   Animating the shadow

To display the shadow of the style or the gnomon you must select the *Shadow* option in the *Other* menu. You can animate the shadow to show how its position changes with date and time using the mouse, the keyboard, or the input box:

o **Mouse:**
   *   Click on the sundial diagram, its outline becomes red to indicate that the diagram is selected
   *   Modify the time of day of the shadow by holding the 'Ctrl' key down, keeping the mouse button pressed and moving its cursor, which takes the shape of 2 horizontal arrows
   *   Change the date of the shadow by pressing the shift key, keeping the mouse button pressed and moving its cursor, which takes the shape of 2 vertical arrows
   *   Unselect the diagram by right-clicking or by clicking outside the diagram

o **Keyboard:**
   *   If necessary, enable the main window by pressing the 'Escape' key
   *   Select the diagram by pressing the 'Tab' key one or more times, until its outline becomes red
   *   Modify the time of day using the space bar or the backspace key
   *   Change the date using the 'Home' and 'End' keys or the 7 and 1 keys of the numeric keypad

o **Input box:**
   *   In the *Other* tab, modify the values of the *Date* and *Time* fields
   *   If necessary, select the suitable configuration: used time / sundial time
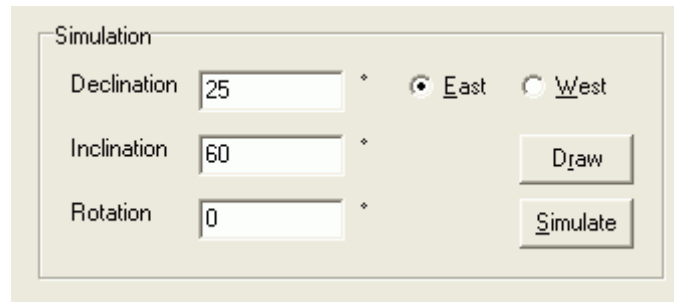   *   Press the *Calculate* button

4.4   Simulating sundials

Calcad approach using two shadow points is a quick and easy way to define the layout of a sundial … provided that you know exactly where you are going to install it. But what if you have the choice of several sites? For example, suppose you want a sundial that you'll consult mainly in the afternoon. Should you site it vertically on the side or the front of your house or horizontally in the middle of the lawn? You can simulate the three possibilities and choose the one that gives the most useful readings.

To simulate a sundial, you first enter its details in the appropriate tabs:
o *Dial*: enter the side(s) of the dial and the height of the provisional gnomon tool (the other values may be added later)
o *Place*: enter the complete localization of the sundial. Values within 1 degree are sufficiently accurate for simulation (when you have decided on the position, the real measurement of the 2 shadow points will allow you to calculate an accurate layout)
o *Point 1* and *Point 2*: optionally (if you are going to use the *Simulate* button) indicate two different moments when the plane of the dial will be lighted

18

Then, in the *Other* tab, enter the three angles that define the orientation of the sundial:

o   *Declination* measures the compass orientation: the angle between the sundial and the meridian. The declination is 0 if the sundial faces due south, and values can range from 0 to 180° east or west. You can get a sufficient estimation using a simple compass (see Section 4.5, p. 19)
o   *Inclination* measures the slope of the dial with respect to the surface of the Earth. The inclination is 0° for a horizontal dial (facing directly upwards) and 90° for a vertical dial (facing the horizon). For intermediate slopes, a protractor and a spirit level will allow you to get a sufficient estimation (see Section 4.6, p. 20)
o   *Rotation* measures on the sundial the angle between the x axis and an horizontal line of the dial (-180 to 180°). This will normally be 0, and the horizontal lines of the sundial will be represented horizontally on the diagram, unless you want to follow the example of Mr. Slope (see Section 4.14, p. 26).

Then, still in the *Other* tab, you can:
o   Press the *Draw* button or type Ctrl + K to draw the dial directly (this is in fact the classical method used by other sundial software)
o   Press the *Simulate* button or type Ctrl + L to compute the position of the shadow points and then use them to compute the dial. In this case, you may need to modify the time of the point(s) so that their shadow falls inside the dial

If the simulation succeeds, go to the sundial layout options (see Section 3.6, p. 8).

4.5   How to measure declination with a compass

A rough measure of the declination (compass orientation) can be simply made by … a compass. Verify that its needle is not perturbed by the proximity of ferrous metals and present the north/south axis of the graduation perpendicularly to the vertical plane of the dial or, if it is inclined, align the compass perpendicular to a horizontal line on the dial, as shown in the figure. For a horizontal dial, align the north/south axis of the compass with the y axis.
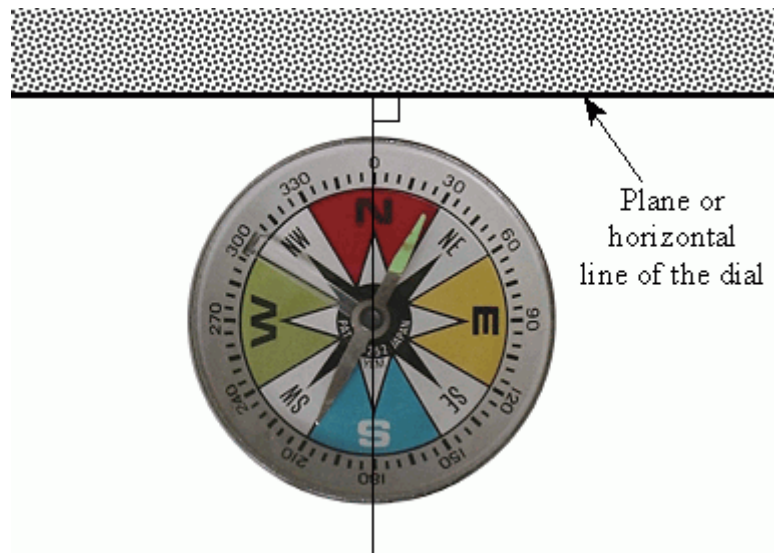
The type of declination (east or west) tallies with the side where the north point of the needle is located. Also:

o   If the point is on the east side, it indicates the value of the declination directly
o   If it is on the west side, subtract the value indicated by the point of the needle from 360° to get the declination

In the case shown in the diagram, the declination is 25° east.

4.6   How to measure inclination with a protractor

You can get a rough value of the inclination with a simple protractor. Apply it to the plane of the sundial, perpendicular to the area and in such way that it is also vertical. Read the measure on the horizontal line that goes through the center of the protractor.
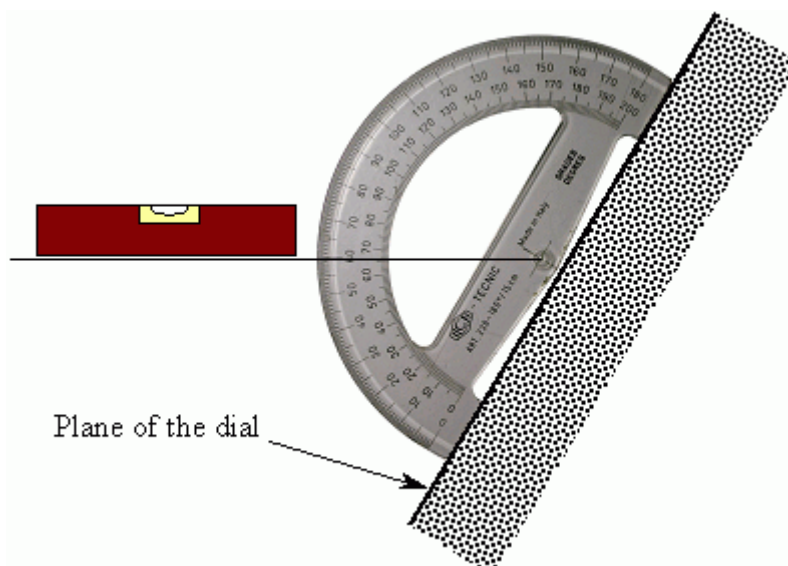
In the case of the figure, the inclination is 60°.

Note: Some spirit levels include a rotating tube that allows you to measure angles directly.

4.7   Does the horizon line have to be horizontal?

The horizon line is a direct result of the sundial's location, that is to say of the data you enter in the *Place* tab of the input box.

o   If the location is correct, the horizon line will be horizontal on the final sundial
o   If the location is wrong, the horizon line will be tilted. However the hour lines and the diurnal arcs will be perfectly correct, but their ends will be either truncated or extended

Note: If the axes of the sundial are drawn tilted, a horizontal line on the final sundial will be represented tilted on the diagram given by Calcad. In the same way, a line represented horizontally on the diagram will be tilted on the final sundial.

4.8   Difference between style and gnomon

The **style** is a linear shadow-caster device, which may include a point indicator (for example a pinhole). The linear edge has to be parallel to the Earth's axis of rotation, so it is often called a style-axis or polar style.

Calcad represents the style by a right-angled triangle if the sundial has a center, and if not by a rectangular trapezoid. In both cases, it is the shadow of the point most distant from the sundial plane, called the *first end*, that indicates the time with the hour curves.

In Calcad we use the term **gnomon** to refer to a style reduced to its first end: a rod vertical to the sundial plane.

4.9   Solar ephemeris

This functionality allows you to know the position of the sun in different reference at the date and time input in the *Divers* tab. No error for missing data is returned, an invitation to complete them is displayed to access at complementary results.

To get the Solar ephemeris, press the *Ephemeris* button in the *Divers* tab or type Ctrl + J. You will obtain successively:
o   With the date:
  *   The average of the equation of time on the day
  *   The average of the declination of the sun on the day
o   With the longitude and the time zone more (according to the kind of hours selected on the *Divers* tab):
  *   The time of the solar midday (passing of the sun in the meridian)
o   With the latitude more:
  *   The sunrise
  *   The sunset
o   With the time more:
  *   The equation of time
  *   The declination of the sun
  *   The solar time
  *   Its azimuth
  *   Its elevation with and without refraction
o   With the layout of the sundial more:
 *   The shadow position of the first extremity of the style
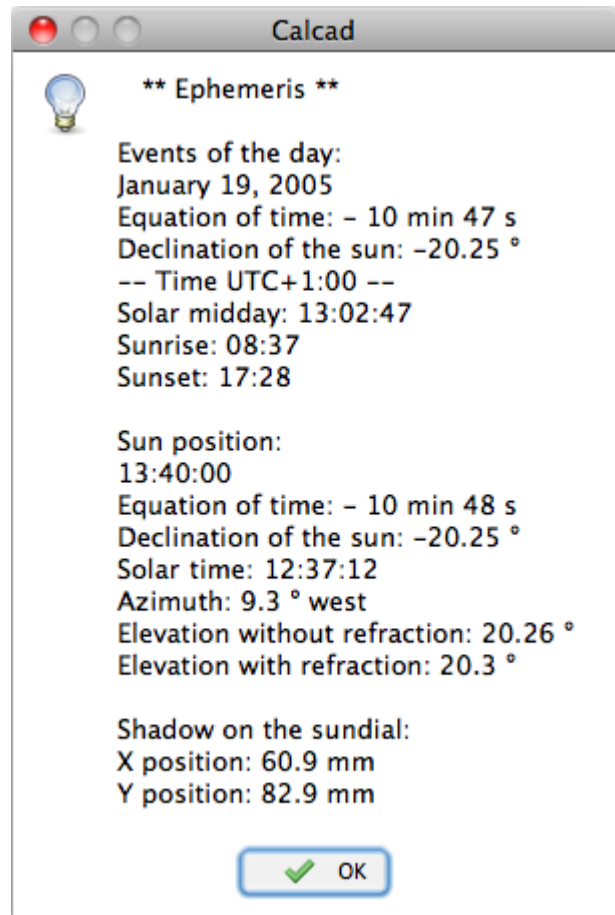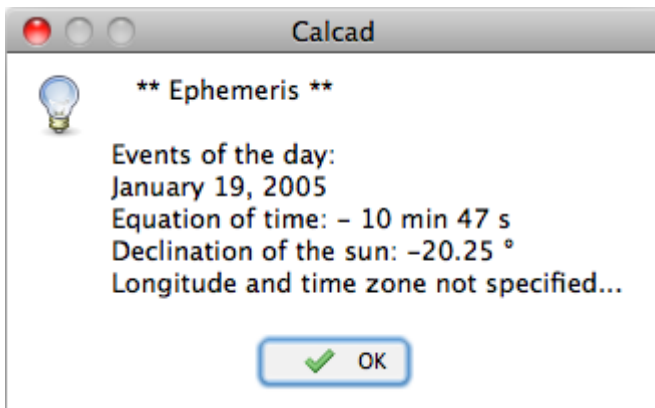
4.10 Export of the sundial to dxf format

The export is accessible by the *File* menu or typing Ctrl + X. The generated file holds 3D elements that allow you to visualize the sundial in the space with an appropriate viewer. In Windows, it is especially possible to use the software DXF Sharp Viewer of the company Wout Ware (1.26 Mb) that you can download at: http://www.woutware.com/dxfsharpviewer.html

After the 30 days trial period, functionalities are disabled particularly the exports, but the 3D visualization is always functional.

In DXF Sharp Viewer, after the loading of the dxf file and with the aim to enjoy the three-dimensional graphic:
o   Unselect the layer STYLE
o   In the tool bar, replace *Wireframe* by *OpenGL*
o   Turn the sundial by clicking and move the pointer on the graphic
o   In the tool bar, select the perspective type (wire-frame cube)
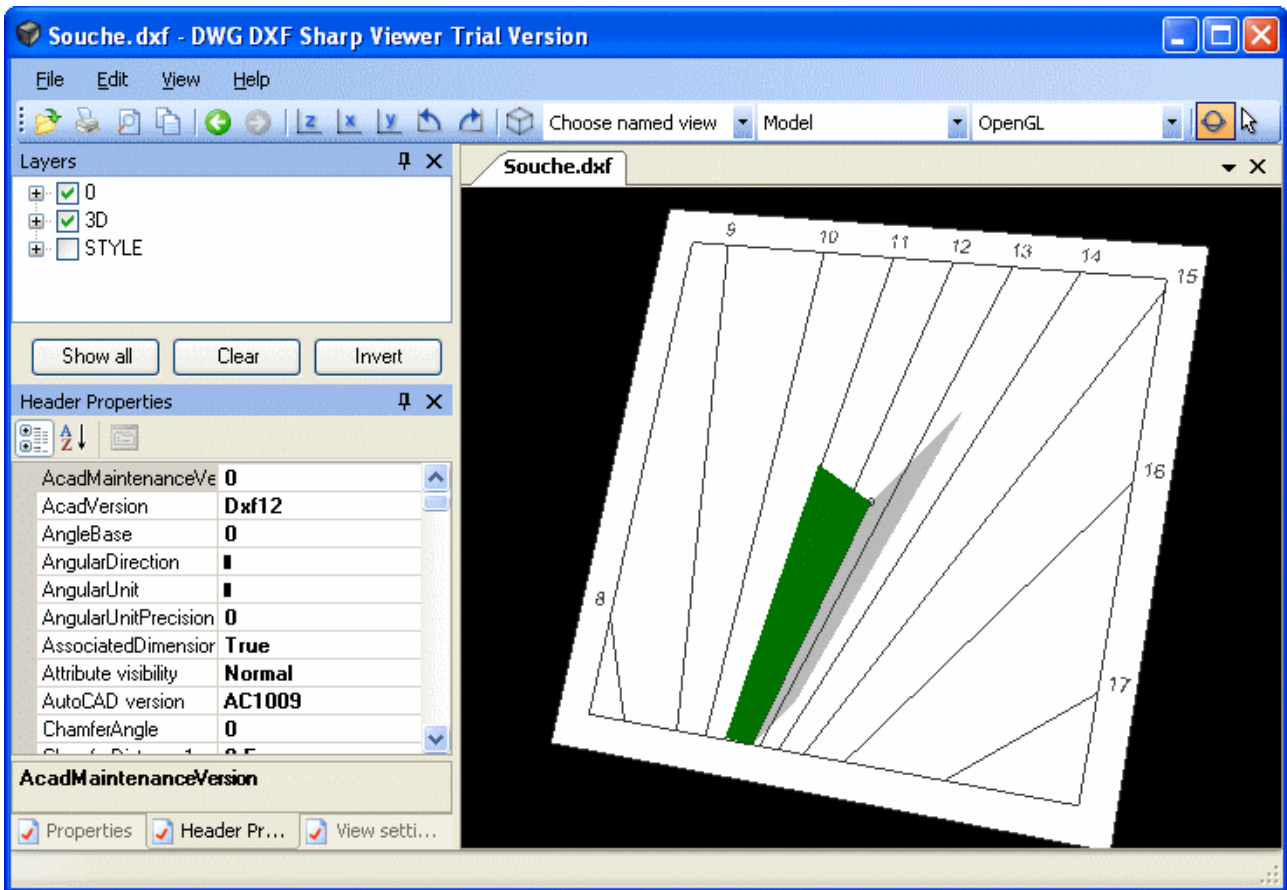
4.11 Desktop sundial

This functionality allows you to display, on the desktop of the computer, the sundial with its shadow that moves to indicate the time.

Two cases are to consider:
o   The sundial is defined without complete localization: the shadow is drawn – as in normal mode of Calcad – taking in account the choice standard / daylight saving time in the *Other* tab of the input box.
o   The sundial is defined with complete localization: Calcad take in account the time zones of the computer and the sundial. Therefore it is possible to display sundials set up in different countries of the word, they will indicate the local time of these countries.
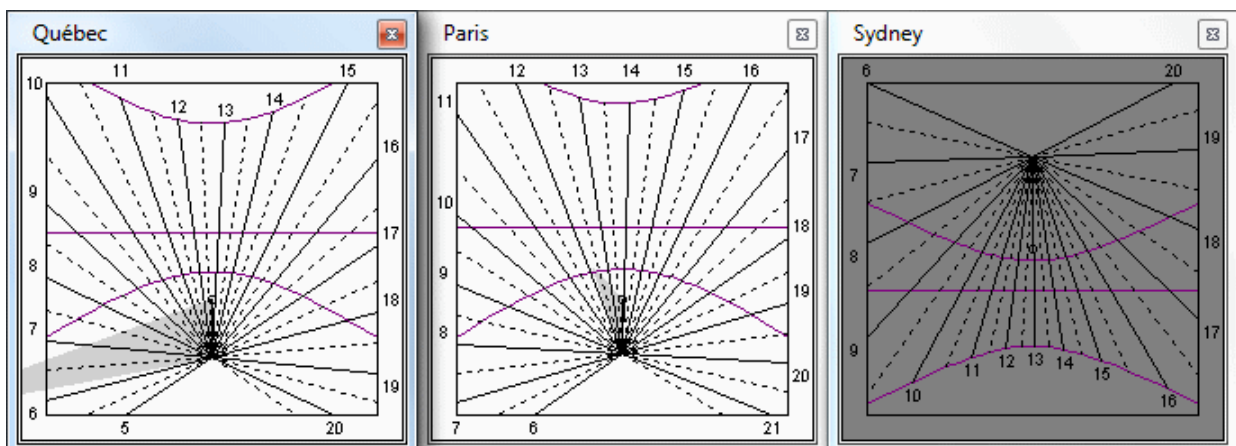
To run the "Desktop sundial" mode, after the drawing of the sundial to put on the desktop, use the *Other* menu or type Ctrl + H. To return to the normal mode, right-click on the sundial and select *Return Calcad* or type Ctrl + H when the sundial is selected.
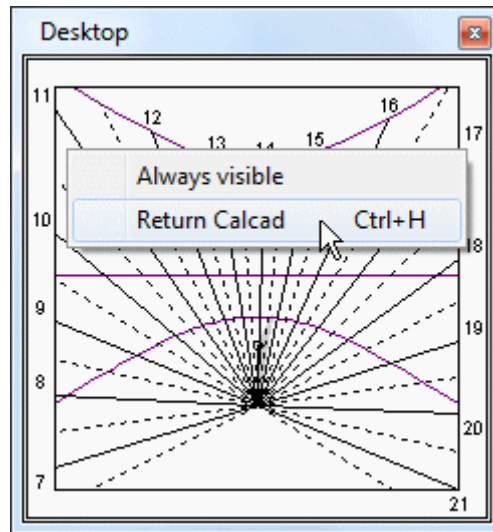
4.12 Tricks and cleverness

o **Entering dates**

To indicate your computer's current date, just enter one asterisk (*).

If the year is not specified, Calcad uses the current year. So *27/2* is a valid date.

One period (.) in the field allows you to duplicate the date of the *Point 1* tab, two periods (..) allow you to duplicate the date of the *Point 2* tab.

o **Entering times**

One period (.) in the time field of the *Other* tab allows you to duplicate the time of the *Point 1* tab, two periods (..) allow you to duplicate the time of the *Point 2* tab and finally one asterisk (*) allows you to input the time of the computer.

o **Entering angles**

You can enter angles either as decimal values separated by a period (for example, for 6.23° enter *6.23*), or as degrees, minutes and seconds separated by a degree sign (for example, for: 6° 13' 48" you should enter *6°13°48*). You can also mix the two methods: any of the degree, minute, and second values may be decimal. So Calcad accepts the angle *6°12.75* (6° 12' 45") and deduces the value 6.2125°.

4.13 Shortcuts

Additionally to the keyboard shortcuts inherent to the operating system, Calcad propose, depending of the context, the following keys and combinations of key that activate directly the associated actions.

In "Desktop sundial" and normal mode:

Shortcut	Action
Ctrl + S	Save the data of the sundial
Ctrl + D	Save the diagram of the sundial
Ctrl + H	Switch between the "Desktop sundial" and normal modes
Ctrl + Q	Quit the program Calcad

Only in normal mode:

Shortcut	Action
Escape	Switch between main window and input box
Ctrl + P	Print all the data concerning the sundial
Ctrl + J	Compute the ephemeris
Ctrl + K	Draw the sundial with the parameters of simulation
Ctrl + L	With the parameters of simulation, simulate the input of the 2 points and draw the sundial
Ctrl + M	Compute the sundial
Ctrl + N	New sundial
Ctrl + O	Open a sundial data file
Ctrl + X	Export the sundial into a .dxf file
Ctrl + Y	Compute complementary data
Ctrl + 0	Print the diagram of the sundial on one half page
Ctrl + 1	Print the diagram of the sundial on one page
Ctrl + 2	Print the diagram of the sundial on two pages
Ctrl + 4	Print the diagram of the sundial on four pages

When the main window is activated, the 'Tabulation' key select successively the diagram, the value zone and the commentary zone.

When the diagram is selected (its border is red):

Shortcut	Action
Left arrow or 4 (num. pad)	Move the shadow-caster toward left
Right arrow or 6 (num. pad)	Move the shadow-caster toward right
Up arrow or 8 (num. pad)	Move the shadow-caster upwards
Down arrow or 2 (num. pad)	Move the shadow-caster downwards
Previous page or 9 (num. pad)	Increase the height of the shadow-caster
Next page or 3 (num. pad)	Decrease the height of the shadow-caster
Backspace	Decrease the current time used for the drawing of the shadow
Space	Increase the current time used for the drawing of the shadow
Home or 7 (num. pad)	Decrease the current date used for the drawing of the shadow
End or 1 (num. pad)	Increase the current date used for the drawing of the shadow

4.14 The examples

Calcad is delivered with 4 sample sundial calculations. You can load them using *Open* in the *File* menu. For each example, the *My comments* window tells the associated story. Enjoy.

o **Mr. Slope**
This example shows that there is no constraint on the orientation of the initial outline. Here it is rectangular but ... crooked.

o **Mr. Rush**
This example shows that the way to record the shadow points is very flexible. Here they are recorded on different dates but at the same time of day.

o **Mr. Scatti**
This example is for sundial specialists who, normally, use particular angles to define the sundial orientation (it is these "reduced parameters" that are used for the simulation: see Section 4.4, p. 18. Although the Calcad method does not use these angles, it does calculate their values (see Section 4.16, p. 27). As a result:
   *   You can measure these angles without the usual instruments
   *   You have a bridge towards other more advanced sundial software

o **Mr. Southern**

The goal of this example is to show that Calcad can be used anywhere in the world, including the southern hemisphere, without particular care.

4.15   Format of the input-output files

The input/output data is stored in a file of text type (.txt) that can be especially edited with Windows Notepad, GNU/Linux gedit, Mac OS X TextEdit or a more advanced text editor. From the version V14avr12, the extension change and become .ccd. It is automatically linked to Calcad by the Windows installer. From the version V4oct14, the coding change to UTF-8. The file includes three parts, separated by lines of 3 dashes (---):

o   The first part includes all the input values and the configuration of the layouts
o   The second holds the user comments
o   The third includes the calculated results as shown in the large text window

The desktop sundial file (*.ccb) is automatically generated when Calcad run this mode. It mainly holds the positions and sizes of the windows. It is a text file.

The output diagram file is a .png file (Portable Network Graphics). It contains the diagram of the sundial as it is shown in the main Calcad window.

The format of the dxf file was defined by the company Autodesk Inc. for its popular software AutoCAD. It is a vector format that is now accepted by the majority of CAD systems, as well as many graphics software packages. The dxf file generated by Calcad holds the layout of the dial as it was configured and the complete geometry of the shadow-caster. It holds also 3D elements that allow you to visualize the sundial in the space.

4.16   Reduced parameters

These are the parameters that are used in traditional gnomonics: they are based on the use of an intermediate local reference. In Calcad you supply this reference via the *Place* details, which are optional and can be approximate. While the parameters can take different values, they do form a coherent set that allows you to draw all the lines of the dial identically, except, of course, the horizon line. This reflects the principle of the "sundial out of place" which is well known by gnomonists: a sundial that has been properly designed for a given geographic situation can be used elsewhere provided that you change its orientation appropriately.

o **Time zone**

The value from the input box if the localization is complete, otherwise 0.

o **Longitude**

The value of the input box, in other words the real geographic longitude, if the localization is complete. Otherwise the zero meridian of Greenwich is replaced by the one where the mean sun is located at midday (in standard or daylight saving time, corresponding to the time used to record the shadow points). The value is positive if the sundial is to the west of the zero meridian, negative if it is to the east.

o **Latitude**

The value of the input box when the localization is complete, otherwise the latitude of the equivalent horizontal sundial. The latitude is positive in the northern hemisphere and negative in the southern.

o **Declination**

Zero if the sundial is not localized, otherwise the orientation of the sundial plane, measured as the angle with respect to south. The declination is positive westwards (0 to 180°) and negative eastwards (0 to -180°).

o **Inclination**

Its value is 0 if the localization is not complete. Otherwise it the slope of the sundial plane: 0° for a horizontal sundial and 90° for a vertical sundial. The inclination varies from 0 to +180°.

o **Rotation**

If you enter the other data in classical sundial software, the result must be rotated by this angle, anticlockwise if the value is positive, clockwise if it is negative.