CABRI® II Plus

CABRILOG

Innovative Maths Tools

REFERENCE

WELCOME!

Welcome to the interactive world of Cabri II Plus!

The following **Reference** document describes in details all possibilities offered by the software to discover, learn and explore the exciting world of dynamic geometry.

This manual consists of 6 chapters:

• Chapter **[1] OBJECTS AND TOOLS** describes the various objects and tools offered by Cabri Geometry to build your figure.

• Chapter **[2] INVESTIGATIVE TOOLS** presents tools that can be used to investigate and explore deeper the dynamical aspect of a figure.

• Chapter **[3] ATTRIBUTES** shows the attributes available to control the graphical aspect of your figure.

• Chapter **[4] PREFERENCES AND CUSTOMISATION** shows you how to change preferences and customise the software.

• Chapter **[5] USER INTERFACE** describes Cabri Geometry user interface, both on Windows and Macintosh environments.

• Chapter **[6] EXPORTING AND PRINTING** describes how to print and export figures to graphing calculator (Texas Instruments).

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OBJECTS AND TOOLS

This chapter lists the set of objects manipulated by Cabri II Plus, all different ways of creating them and their attributes. The list of attributes and the way to change them is detailed in chapter **[3] ATTRIBUTES**. All objects can have an associated label. It consists of alphanumeric characters attached to an object, for example, the name of a point. When an object is created, it can immediately be given a name, typed in on the keyboard. The label can be changed subsequently, using the tool [Text and Symbols]Label .

1.1   POINT

The point object is the basis of all shapes. Cabri II Plus manipulates points in the Euclidean plane, with an appropriate behaviour for points at infinity.

An independent, movable point can be created on the plane, using the [Points]Point tool and clicking on an empty part of the drawing area. The point can then be moved anywhere in the plane (using [Manipulation]Pointer).

A point can be created on a line (segment, line, ray...) or on a curve (circle, circular arc, conic, locus) either implicitly using the tool [Points]Point , or explicitly with [Points]Point on Object . A point created this way can be moved freely on the object. Finally, one can create a point of intersection of two lines/curves, either implicitly with [Points]Point , or explicitly with [Points]Intersection Points . All points of intersection of the two objects are constructed simultaneously using [Points] Intersection Points and selecting objects.

The [Constructions]Midpoint tool constructs the point which is midway between two existing points, or the midpoint of a line segment, a vector or side of a polygon.

The [Constructions]Measurement Transfer tool transfers a length onto:

- a ray (select measurement and ray),
- a vector (select measurement and vector),
- an axis (select measurement and axis),
- a circle (select measurement, circle and a point on circle),
- a polygon (select the measurement and the polygon). In all these cases a new point is constructed.

A point can be constructed as the image of a point under a transformation, using one of the tools in the [Transformations] toolbox.

When any other tool is used which requires the selection of a point, this can be done either by selecting an existing point or by constructing a point implicitly with the current tool (on a line or curve, or at the intersection of lines or curves). In this case, the operation is the same as for the [Points]Point tool.

When a line or a ray is being created, the second point can be created on the fly as an explicit point by holding down the `Alt` key until the position for the second point is selected. The attributes of a point are its colour, shape, size, label and picture (optional).

1.2 LINE

Cabri II Plus manipulates lines in the Euclidean plane, with the additional possibility of a line of points at infinity if the treatment of infinity has been activated in the Preferences.

The [Lines]Line tool is used to create a line through a given point. First select the point then, by clicking, fix the direction of the line which is otherwise rotating freely as the cursor moves. This tool can also be used to construct a line through two points. The second point can be created on the fly by holding down the `Alt` key. In the case of a line defined by two points if the two points coincide, the line is undefined. Constructing a line through one point while holding down the ⇧ key will constrain the direction of the line relative to the «screen horizontal» to multiples of 15° (15, 30, 45, 60, 75, 90…).

The tools [Constructions]Perpendicular Line and [Constructions]Parallel Line construct the unique perpendicular or parallel line in a direction (given by a segment, a line, a ray, a side of a polygon, a vector or an axis), passing through a given point.

The [Constructions]Perpendicular Bisector tool creates the line equidistant from two points, or the perpendicular bisector of a line segment, a vector or side of a polygon.

The [Constructions]Angle Bisector tool constructs the line which bisects an angle. By selecting the three points A, B and C, the angle defined by the segments ($\overrightarrow{BA}$ and $\overrightarrow{BC}$) is bisected. The second point selected must be the vertex of the angle.

A line can be constructed as the image of another line under a transformation by using the tools from the [Transformations] toolbox.

The attributes of a line are its colour, thickness, line style and label.

1.3   LINE SEGMENT

The [Lines]Segment tool is used to construct the segment between two points. If the two points coincide, the segment is still defined, but is reduced to a point. A segment can be constructed as the image of another segment under a transformation. Pressing ⇧ key will constrain the direction as for a line.

The attributes of a segment are its colour, thickness, line style, endpoint style, label and picture (optional).

1.4   RAY

The [Lines]Ray tool is used to create a ray starting from a point. First the point is selected, then, as the mouse is moved, a ray from the point appears which pivots freely about this point until its direction is fixed by a click. This tool will also construct a ray starting from a first point and passing through a second point. Alternatively, the second point can be created on the fly by holding down the `Alt` key. Pressing ⇧ key will constrain the direction as for a line.

In the case of a ray defined by two points, if the two points coincide, the ray is undefined. A ray can be constructed as the image of another ray under a transformation by using the tools from the [Transformations] toolbox.

The attributes of a ray are its colour, thickness, line style and label.

1.5   VECTOR

A vector is defined by its two endpoints. Consequently, a vector is manipulated as if it is a directed line segment, the direction being shown by an arrow.

The [Lines]Vector ![icon] tool uses two points to construct a vector. If the two points coincide, then the vector that has been defined is the zero vector. The [Constructions]Vector Sum ![icon] tool constructs the resultant of two vectors. Select the two vectors and the initial point of the sum, which can be created on the fly. The order selection is not relevant.

A vector can be constructed as the image of another vector under a transformation by using the tools from the [Transformations] toolbox.

The attributes of a vector are its colour, thickness, line style, label and picture (optional).

1.6   TRIANGLE

A triangle is a polygon with three vertices. Triangles and polygons are generated in the same way. Since the triangle is by far and away the most frequently used polygon, a special tool is available for it. The [Lines]Triangle ![icon] tool uses three points to create a triangle. It is possible to have triangles with zero area, or with two or three coincident points.

An image triangle can be created of another triangle under a transformation by using the tools from the [Transformations] toolbox. The attributes of a triangle are its colour, thickness, line style, fill colour, label and picture (optional).

1.7   POLYGON

In mathematics, the concept of a polygon can be defined in several ways. In Cabri II Plus, a polygon is the sequence of n segments defined by n points ($n \geq 3$).

$$P_1P_2,\ P_2P_3 \ldots P_{n-1}P_n,\ P_nP_1$$

The [Lines]Polygon ![icon] tool constructs a polygon using at least three points. To finish off the construction, the first point created must be reselected, or the final point must be created by double-click. If all points are collinear, it has zero area and is represented by a segment.

The [Lines]Regular Polygon ⬡ tool is used to construct regular convex polygons or stars. First select the center of the polygon, then the first vertex. The number of sides, and the interval between vertices for a star, can be chosen next.

In the final phase of construction, a pop-up message follows the cursor to display the numbers describing the type of polygon. For example, {5} indicates a regular pentagon, while {10/3} is a ten-branch star, drawn by linking vertices 1, 4, 7, 10, 3, 6, 9, 2, 5, 8, and 1 of a regular decagon.

A polygon can be constructed as the image of another polygon under a transformation by using the tools from the [Transformations] toolbox. The attributes of a polygon are its colour, thickness, line style, fill colour, label and its picture (optional) in the case of a quadrilateral.

1.8   CIRCLE

Select the [Curves]Circle ⊙ tool to create a circle anywhere on the drawing area. Click once to position the center and second to fix the radius of the initially variable circle. The radius can then be changed at will. Alternatively, a second point (which will be on the circumference) can be created on the fly by holding down the `Alt` key.

The [Curves]Circle ⊙ tool also constructs a circle by selecting first its center, then a previously created point on the circumference. Pressing the ⇧ key constrains the radius to be integer.

A circle can be constructed as the image of another circle under a transformation by using the tools from the [Transformations] toolbox.

The attributes of a circle are its colour, thickness, line style, fill colour and label.

1.9   CIRCULAR ARC

An arc of a circle can be determined by 2 end-points and one intermediate point.

The [Curves]Arc ⌒ tool constructs an arc using three such points: the first is an extremity, the second is an intermediate point, and the third is the other extremity. If the three points are collinear, the arc becomes a line segment or the complement of a line segment (a line with a gap in it), depending on the relative positions of the three points on the line.

An arc can be constructed as the image of another arc under a transformation by using the tools from the [Transformations] toolbox.

The attributes of an arc are its colour, thickness, line style, fill colour (of the associated segment) and label.

1.10 CONIC

Cabri II Plus enables all proper conics (ellipses, parabolas, hyperbolas) to be manipulated in the Euclidean plane. Degenerate conics, consisting of two intersecting straight lines, are also possible. The [Curves]Conic tool constructs a conic through five points. If four of the points are collinear, or two of the points coincide, no conic is created. In contrast, if only three points are collinear, two intersecting straight lines (a degenerate conic) are constructed.

A conic can be constructed as the image of another conic under an affine transformation by using the tools from the [Transformations] toolbox.

The attributes of a conic are its colour, thickness, line style, fill colour and label.

1.11 LOCUS

Different types of objects are created by Cabri II Plus under the name «locus». In general, a locus represents all those positions which can be assumed by an object A as a point M moves on an object. Normally, the construction of A makes use of the point M.

A locus is constructed using [Constructions]Locus , first selecting the object A, then the variable point M.

Object A can be one of the following types: point, line, ray, segment, vector, circle, arc, or conic. Point M can be a variable point on any type of line or curve, including a locus, or even a point on a grid. Object A can equally well be a locus, a set of loci is then constructed.

In the case where A is a line, ray, segment, vector, circle or conic, the locus is either the envelope of the lines, rays... or the entire set of the objects, depending on whether or not the box Envelope has been ticked in the Preferences dialog box. (See chapter [4] PREFERENCES AND CUSTOMISATION). Vectors behave in just the same way as segments for the creation of a locus.

The envelope of a set of rays, segments, or vectors is the same as the envelope of the lines of which they are part, but restricted to those points through which they pass.

In the case where *A* is an arc, the locus is automatically the set of positions taken up by *A*.

The attributes of a locus are its colour, thickness, line style, label, construction method (envelope or set of positions), drawing method (continuous or set of points) and the minimum number of positions to be calculated when its representation is not continuous.

1.12 TRANSFORMATION

Cabri II Plus does not have an explicit object-type which is transformation. Rather, transformations are accessed by tools. Each tool, in applying a transformation to an object, requires various elements to define it (center, axis, angle...). Cabri II Plus enables the usual affine and Euclidean transformations (dilation, translation, reflection, point symmetry, rotation) to be used, as well as inversion. In all cases, the object must be selected, in addition to the elements which define the transformation. If the object to be transformed is of the same type as one of the elements that define the transformation, it has to be selected first. In other cases, the order of selection is not relevant. For example, for the point symmetry transformation of point *M* with point *C* as center, *M* is selected first, then *C*. For point symmetry of line *D* with respect to point *C*, select first *D* and then *C*. The tool [Transformations]Inversion , transforms only points. However, it is possible to create the reflection of other objects by using a macro or the tool [Constructions]Locus .

The tool [Transformations]Reflection applies orthogonal symmetry with respect to an axis. The object for transformation is selected and then the line which is to be taken as the axis: line, ray, segment, vector, side of polygon, axis.

The tool [Transformations]Point Symmetry applies symmetry with respect to a point (point symmetry or half-turn). The object for transformation is selected and then the center of symmetry (a point).

The tool [Transformations]Translation applies a translation. The object is selected and then the vector which defines the translation.

The tool [Transformations]Dilation applies a dilation. The object to be enlarged is selected, then the scale factor (a real number on the drawing area), and the center of dilation (a point). It is possible to use the dilation tool in order to create a «Similitude». Instead of selecting a numerical scale factor and a center of dilation, the user must select three points, *A*, *O* and *B*. If those points are collinear, the dilation will be performed with respect to point *O* as center with a scale factor *OB/OA*. If the three points are not collinear, an enlargement is computed according to center *O* with a factor *OB/OA*, combined with a rotation of center *O* having an angle *AÔB*.

The tool [Transformations]Rotation applies the rotation: Select the object to be rotated, select the center of rotation (point) and finally the angle of rotation. The angle of rotation can be defined by:

- 3 points, existing or created. The three points can be created on the fly.
- a numerical value entered through [Text and Symbols]Numerical Edit **2.1** tool.

The tool [Transformations]Inverse constructs the inverse of a point with respect to a circle. The point to be transformed is selected, then the circle which is invariant under the inversion or vice versa. Remember that an inversion with center *O*, and positive power *k*, has invariant points on the circle, center *O*, whose radius is the square root of *k*.

In Cabri II Plus inversion is applied to points. For a more powerful inversion tool replace the inversion by a more flexible macro.

1.13 MACRO

A macro definition is based on a figure. Once it has been defined, a macro can be used in just the same way as any other tool, and reproduces this part of the construction process using the initial elements that are selected by the user.

For example, a macro can be defined to construct a square on a given diagonal.

To define the macro, first construct the square using any segment as the diagonal, then select the initial objects – here the segment – and the final objects – here the square – and finally save the macro. This is now a new tool in the [Macros] toolbox, which requires the selection of a segment, upon which it constructs a square. The objects which are created as part of the construction method are hidden, and cannot be displayed.

To define a macro, it can be seen that the corresponding construction must already have been carried out. With the construction displayed on-screen, the [Macros]Initial Objects X→ tool is activated and the initial objects of the construction are selected. For objects of the same type, the order of selection is important, and the same order will be required when the macro will be used. For initial objects of different types, the order of selection is not important. The set of initial objects on the figure flash or are displayed with «marching ants» outlines. To add objects to or remove them from the list of initial objects, simply click on them. When the selection of initial objects has been completed, the final objects must be defined. The [Macros]Final Objects →Y tool is used, with selection of members of the final objects set being made in the same way as before. Until the macro is saved, the sets of initial and final objects are held in memory and can be changed at will. Finally, the macro just has to be defined, using [Macros]Define Macro X→Y. Cabri II Plus first checks that the final objects can indeed be constructed from the set of initial objects selected. If this is not the case, the macro will not be defined, and an error message is displayed: This macro-construction is not consistent. Cabri cannot determine all final objects with the given initial objects.
If the macro is a consistent entity, a dialog box is displayed, for the user to edit the attributes of the macro. The only item mandatory to be completed is the name of the construction. All other attributes are optional.

• **Name of the construction**. This is the name of the macro as it will appear in the [Macros] toolbox.

• **Name of first final object**. This name appears to identify the object, as the cursor is moved over the drawing area. For example if the macro constructs the perpendicular bisector of the segment joining two points, the name of the final object could be This perpendicular bisector.

• **Password**. If a macro is assigned a password, its intermediate construction objects are inaccessible from the figure description window, which displays the macro in text form. (This window is opened using the F10 key for Windows, ⌘+F10 key for Mac.

• **Icon**. An icon for the construction can be created in the other part of the dialog box. A set of predefined icons is also available. Since icons in the toolbar can be displayed either small or big, there are two icons to edit. A button is available to automatically adjust the big icon to the small one.

Clicking on Save button allows the macro to be saved as a stand-alone file. The macro is saved also within the document where it has been created and within any document where it is used. A macro which is loaded into a document is available to all other documents opened simultaneously. If a macro has the same name as one already defined, Cabri II Plus gives users the alternative of adding the new macro to the existing macro or replacing it. If users decide to add it to the existing macro, Cabri II Plus will choose the appropriate macro to use depending on the initial objects selected. For example, if a macro is defined with two points as initial objects, another macro could be added to it which is identical apart from having a segment as the initial object. The standard tools [Constructions]Perpendicular Bisector ✳ and [Constructions]Midpoint ✳ have been added to in this way.

To use a macro, the corresponding tool in the [Macros] toolbox is activated, and then the initial objects are selected. When the initial objects have been selected, the construction follows automatically, and the new set of final objects appears. The objects which are created as part of the construction method are hidden, and cannot be displayed by using the [Attributes]Hide/Show ✳ tool. When a macro is used, an object can be defined as an implicit argument of the macro by holding down the `Alt` key when the object is selected. When the macro is used subsequently, it will not be necessary to select this object as an argument: it will be selected automatically. If, for example, a macro requires the selection of two points and a circle, and on one occasion two points are selected, and the `Alt` key is held down while a circle is selected, then in future the macro will only require the selection of two points but the circle is selected automatically. This would be useful in the case of a macro designed for hyperbolic geometry: the horizon or limiting circle of the *Henri Poincaré*[1] model can be implicitly added to the macro. If the attributes of the final objects are not the same as the default attributes when the macro is defined, they will be saved with the macro and applied to those objects which are created when the macro is used.

1.14 NUMBER

A number which is displayed on the drawing area is a real number, and can be given an associated unit. To change measurement units, type `Ctrl` + `U` (Windows) or double-click and select `U` (Mac OS) this will open a pop up menu. (Also see chapter **[1.1.5]**). Numbers are displayed as dynamic elements within text messages. (See section **[1.17] Text**). When a number is created, Cabri II Plus creates a text message whose sole content is the number. The text message can be edited subsequently.

[1]*Henri Poincaré 1854 - 1912*

The [Text and Symbols]Numerical Edit 2.1 tool enables users to enter the number directly onto the drawing area. The number can then be edited and animated. The up and down arrows immediately to the right of the number, and also animation, can be used to modify its value, increasing or decreasing it. The step size for the change is dependent upon the position of the cursor within the number. For example, if the number is 30.29 and the cursor is between 2 and 9, animation or the use of the arrows will change the value of the number by steps of ±0.1. The [Measurement]Distance or Length ⟷ tool creates a number representing the distance between: two points, a point and a line, a point and a circle; the length of a segment, a vector, an arc of a circle; the perimeter of a polygon; or the circumference of a circle or ellipse. The resulting value is given with cm as the default unit of measurement. The [Measurement]Area tool creates a number representing the area of a polygon, circle or ellipse. The text message includes a unit of area, the default unit being cm^2. The [Measurement]Slope tool measures the gradient of a line, ray, segment or vector relative to the «screen horizontal». The value is dimensionless. The [Measurement]Angle tool measures the size of an angle. The required arguments are three points: A, O and B in that order, where the sides containing the angle are $\overrightarrow{OA}$ and $\overrightarrow{OB}$, or a single argument, being the already existing mark of an angle. The [Measurement]Calculate tool is used to perform calculations on numbers displayed in the drawing area, the constants pi and infinity, or directly entered real values. The usual operators used are: $x+y, x-y, x*y, x/y, -x, x^y$, and brackets. The calculator also recognizes the following $arcsin(x), arccos(x), arctan(x), sinh(x), cosh(x), tanh(x), arcsinh(x), arccosh(x), arctanh(x), ln(x), log(x), exp(x), min(x,y), max(x,y), ceil(x), floor(x), round(x), sign(x), random(x,y)$. Some variants of these spellings are recognized: an initial capital letter, $asin, sh, ash, argsh...$ The inverses of functions can be used by combining the inv button with the function button. For example, to use the arcsin function, click on buttons inv then sin. This extends to inv-sqrt which gives sqr, inv-ln which gives $exp (e^x)$, and inv-log which gives 10^x.

Apart from standard operators, for which the syntax is well-known, $floor(x)$ returns the largest integer less than or equal to x, $ceil(x)$ returns the smallest integer greater than or equal to x, $round(x)$ returns the integer nearest to x whose modulus is also nearest to that of x, $sign(x)$ returns - 1, 0 or + 1, depending on whether x is negative, zero or positive and finally, $random(x,y)$ returns a randomly-generated real number belonging to the uniform distribution over $[x,y]$. To ensure that $random(x,y)$ is updated as the figure is modified, it is sufficient to introduce a parameter from the figure into one of its arguments, even if this parameter has no effect on the resulting value, for example random (0,1 + 0 * a), where a is a number, dependent on some independent element of the figure. The = button calculates the result. It can then be placed anywhere on the drawing area, using drag-and-drop directly on the answer or by double-clicking on = and dragging the result to the desired position.

This result will be updated as the figure changes. Different units can be used, for instance 0,1 m + 1 cm is evaluated as 11 cm.

The [Measurement]Apply an Expression 3x+/2y= tool calculates the value of an expression which is displayed in the drawing area. Users must first select the expression, and then a number in the drawing area for each variable of the expression.

Suppose, for example, that the expression is 3* *x*+ 2 * *y*- 1: Cabri II Plus requires a number for *x* and another for *y*, when it produces a new number which is the value of the expression, and this can then be placed anywhere in the drawing area. The number can now be selected for use in new calculations.

As it has been said above, a number is only displayed on the screen as part of a text message. A number inherits the graphical attributes of the text of which it is part. (See text attributes in the **[1.17] Text** section). In addition to these attributes, there is one attribute specific to a number: the number of figures to be displayed. For each letter *a*, *b*, *c*...or *x*, *y*... Cabri II Plus asks for a value after a click on the expression. When the expression is of the form *f(x)*, clicking on the axis after a click on the expression plots the graph of *y*= *f(x)* automatically.

1.15 PROPERTY

A property is displayed as a text message on the figure. It is generated in a similar fashion to a number, and is updated as the figure changes. The text message corresponding to a property can be edited.

The tool [Properties]Collinear? checks the alignment of three points. The corresponding text message is either:
• The points are collinear, or
• The points are not collinear.

The tool [Properties]Parallel? checks whether two directions are parallel. Each direction is defined by a line, ray, segment, vector, side of a polygon, or axis. The text message displayed is either:
• The objects are parallel, or
• The objects are not parallel.

The tool [Properties]Perpendicular? checks whether two directions are perpendicular. Its use is identical to that of [Properties]Parallel? . The text message displayed is either:
• The objects are perpendicular, or
• The objects are not perpendicular.

The tool [Properties]Equidistant? ⬚ requires the selection of three points: *O, A* and *B*, and checks whether the distances $\overrightarrow{OA}$ and $\overrightarrow{OB}$ are equal. The text message displayed is either:

- These points are equidistant or
- These points are not equidistant.

The tool [Properties]Member? ⬚ requires the selection of a point and another object other than a point. It checks whether the point lies on the object. The text message displayed is either:

- This point lies on the object or
- This point does not lie on the object.

The text relating to a property inherits the attributes of the text message of which it is part. (See text attributes in the **[1.17] Text** section).

1.16 EXPRESSION

An expression is a text message displaying a syntactically correct calculator expression – a function of one or more variables. The names that are allowed for the variables are: *a,b...z* (lower case).

The [Text and Symbols]Expression ⬚ tool enters a new expression. Expressions are edited as text. The syntax is only checked at the moment the expression is evaluated. (See the previous section on numbers).

Operators cannot be omitted («3 *x» is recognized but «3x» is not). The expression can be evaluated for different values of its variables, using the [Measurement]Apply an Expression ⬚ tool. This tool requires the selection of an expression, then of numbers that correspond to the values of the variables. If the expression *f(x)* contains the *x* variable, this tool also enables users to select the expression and then an axis on which the graph of *y=f(x)* will be drawn. When the expression to graph contains others variables than *x*, the tool also needs the selection of numbers to fix them. The attributes of an expression are its character font, its alignment and the colours of the background, border and characters.

1.17 TEXT

A text message is a rectangular box in which «static» characters are entered, as well as»dynamic» elements. Dynamic elements are updated with the figure; these are the numbers and properties displayed on the working area. All the text messages displayed on the drawing area can be changed at will. The tools which create numbers and properties construct implicitly a text message which contains the number or the property. If the distance between two points, *A* and *B*, is measured, then AB = can be inserted directly in front of the value of the measurement produced.

The [Text and Symbols]Text **Abl** tool can be used to create a text message. Once created, dynamic elements such as numbers can be added to it.

If a label in the figure has been inserted in a text message, it will be updated automatically if the label is modified.

The [Measurement]Equation or Coordinates **(x,y) y=f(x)** tool produces a text message which represents the coordinates (of points) or the equation (of other objects) according to the object selected. The object can be a point, a line, a circle, a conic, or a locus. In the case of points, a text message of the type (3.14, 2.07) is displayed. For other objects, an algebraic equation is displayed, according to which of the various preferences has been selected:

For lines:
- $ax + by + c = 0$
- $y = ax + b$

for conics:
- $ax^2 + bxy + cy^2 + dx + ey + f = 0$
- $(x-x^0)^2 / a^2 \pm (y-y^0)^2 / b^2 = \pm 1$

For a locus, the algorithm produces its algebraic equation if its degree is no greater than 6. For loci whose points are of very different magnitudes, numerical errors appear very rapidly as the degree increases.

When several sets of axes exist, [Measurement]Equation or Coordinates **(x,y) y=f(x)** requires the relevant set to be selected.

The attributes of a text message are: character font, size and style, and the three colours of the background, the border and the text. Equations have additional attributes: equation type and the associated coordinate system.

1.18 ANGLE MARK

The mark of an angle is created with [Text and Symbols]Mark angle ⧙. It requires the selection of three points, *A, O* and *B*, in that order and marks the angle between the arms $\overrightarrow{OA}$ and $\overrightarrow{OB}$, whose vertex is at *O*. If the angle is a right angle, the shape produced is automatically changed to the standard form.

The [Manipulation]Pointer ⧘ tool is used to change the size of a mark, also to change from marking the convex angle to the concave one (the other side of a convex angle).

For the latter procedure, it is sufficient merely to drag the angle mark «through» the vertex of the angle and drop it on the other side. The attributes of an angle mark are: its colour, thickness, line style, mark type, and label.

1.19 AXES

A set of axes consist of a point – the origin – and two lines which pass through this point, each of them marked one unit away from the origin. The axes are not necessarily perpendicular, but they must not coincide if they are to define a system of axes.

Every figure has a default origin and set of axes. The origin is initially at the center of the drawing sheet and the axes are perpendicular with the unit distance being 1cm.

The [Attributes]Show Axes ⧙ and [Attributes]Hide Axes ⧙ tools will show or hide the default axes.

The [Attributes]New Axes ⧙ tool creates a new set of axes according to two possible procedures:

• One point and two direction: with three clicks, you successively select the origin, the direction of the first axis, and the direction of the second axis. Scale is automatically indicated with one unit equal to 1 cm for both axes.

• One point, one direction and one scale: create one point before activate [Attributes]New Axes ⧙ tool. Activate it and with three clicks, you successively select the origin (anywhere), fix simultaneously the direction of the first axis and its scale by clicking on the existing point (user can also create the point on the fly by using the `Alt` key), then fix the direction and scale of the second axis by clicking.

The attributes of a system of axes are: its colour, thickness and line style.

1.20 GRID

The definition of a grid is based on the current system of axes. It represents an infinite set of points spread regularly according to the current reference system on the working area (either Cartesian coordinates or polar coordinates).

A grid is created with the [Attributes]Define Grid tool, which requires selection of the relevant set of axes.

The attributes of a grid are: the colour of its points and the type of coordinate system (Cartesian or polar).

1.21 TABULATE

A table is initially blank, and is used to store and display numbers extracted from the working area. A figure can only contain one table.

A table is created with [Measurement]Tabulate. A first click creates a blank table at the cursor position (on Mac, drag and drop creates and resizes the table in a single action.) then, clicking on existing numbers, they are placed in the first row of cells. This table can be subsequently selected and resized by dragging on the bottom right-hand corner. If text has been added in front of the number, this text will be used as the column heading.

If the figure is now changed, the `Tab` key can be used to create a new line containing the current values of the numbers chosen in the previous line. If the table is selected before starting an animation, the table will be filled automatically by the animation up to a maximum of 1000 lines. If the table is selected before using the command [Edit]Copy, the numerical contents of the table are copied to the clipboard in text format and can be pasted into any spreadsheet such as Microsoft® Excel, so that the produced data can be analysed.

| CHAPTER	2
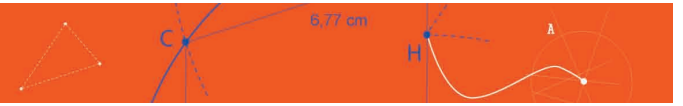
INVESTIGATIVE TOOLS

2.1   TRACE

The [Text and Symbols]Trace On/Off ✓ tool enables users to select the set of objects which will leave a trace of their movements as the figure is manipulated. When the tool is active, those objects which will leave a trace are displayed with marching ants outlines. Objects can be added to or removed from this set by selecting them, in the same way as described for other tools of this type (initial objects, final objects, hidden objects). As the different parts of the figure are moved around, the selected set of objects leaves behind a trace of their position, which enables users to study the way that they change.

2.2   PUNAISES

The [Text and Symbols]Fix/Free 📌 tool is used to fix the position of points which are free to be moved around the working area, or free to move on an object. When this tool is activated, such points are indicated by a small thumbtack. Fixing a point means that not only is this point immovable, but it cannot be deleted.

2.3   REDÉFINITION

Redefinition is a powerful function which enables users to redefine elements whose construction is already complete. For example, users could replace one construction method by another, or change the number of degrees of freedom of an object. To redefine an object, the [Constructions]Redefine Object tool is activated, and the object selected. An object dependent menu appears, with the redefinition options listed. Depending on the option chosen, one or more objects will have to be selected, or just possibly none (for example for the redefinition of a point on object into a free point).

2.4 ANIMATION

The [Text and Symbols]Animation tool and the [Text and Symbols]Multiple Animation tool are used to animate one or more elements of a figure. Animation consists of «launching» one or more objects along a trajectory defined by users.

To start a simple animation, activate [Text and Symbols] Animation , then click on the object to be animated, but hold down the mouse button while moving the cursor slowly away from the object. A small «spring» appears, which is stretched by users to fix the direction and speed of the animation. Overall speed of the animation is initially set by the size of the spring. Later pressing + or - increases or decreases animation speed. The animation is launched when the mouse button is released, and continues while the tool is active. It is stopped by clicking in a free part of the drawing area. Points on object are animated continuously alongside their support. For instance, points on a segment are animated back and forth. In addition, a number (free or in text) can be animated up and down.

To define and start a multiple animation, activate the [Text and Symbols]Multiple Animation tool. A control window appears, in which one can define or remove springs (top row of buttons), start or stop the animation (bottom left button), and restore the diagram to its initial state (bottom right button).

When using Multiple Animation, click once on each object to be animated. This will create a spring with one side attached to the object to be moved. Use the mouse to move the other end of the spring, to set the direction and speed of the object during animation. The animation parameters for a multiple animation are kept when the tool is no longer active, and when the figure is saved. An option during the save process allows for the animation to start automatically when the figure is loaded in future.

2.5 ENREGISTREMENT DE LA SESSION

The [Session] menu enables users to record a session, for example to analyse the strategies used by students in solving a problem, and then to print it out stage by stage (several stages per page). It allows users to review the construction of the last step and also acts as an unlimited undo function.

2.6   DESCRIPTION DE LA FIGURE

The `F10` key for Windows, ⌘+`F10` key for Mac displays or hides a window which contains a textual description of the figure. In this window, the full set of steps used in the construction can be seen, in the order used.

This window can be used to help with the design and naming of objects. A single click on an object highlights in bold the objects that were used to create it. This window can also be used to help with the design of objects and to name those not previously named.

The contents of the window can be copied and pasted into other applications, as a textual description of the figure. To create this copy, use the shortcut menu, which appears following a right click in the figure description window. This shortcut menu can also be used to display hidden objects and intermediate objects in macros (possibly after entering a password, if this was a requirement in the macro's creation or when the figure was saved).

A click on an object in the figure highlights the corresponding line in the figure description window. Conversely, a click on a line in the figure description window selects the corresponding object in the figure.

CHAPTER 3
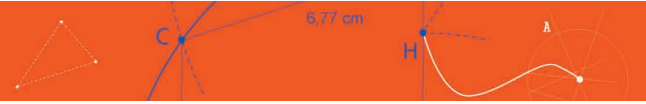
ATTRIBUTS

The attributes of an object can generally be accessed in several ways:

• using a tool from the [Attributes] toolbox to change one specific attribute,

• using the [Attributes]Modify Appearance ⬚ tool,

• by means of the shortcut menu for the object, which is opened by right-clicking on the object (`Ctrl` + clic with Mac),

• with the assistance of the attributes toolbar, which is displayed by selecting the menu item [Options]Show Attributes or pressing `F9` key for Windows, ⌘+`F9` key for Mac,

• opening the Preferences dialog box to change the default attributes of new objects, or those of selected objects. (See chapter **[4] PREFERENCES AND CUSTOMISATION**.)

3.1   COLOUR

The colour is changed with the [Attributes]Colour ✏ tool, by selecting a colour from the palette displayed, then clicking on those objects which are to take on that colour.

The colour of one or more objects can also be changed by using the ✏ tool from the attributes bar. The object(s) are selected, then the colour.

Finally, the colour of an object can be calculated. This can only be done via the shortcut menu for the object, by clicking on the right mouse button and selecting Variable Colour and then Select Red/Green/Blue Parameter. Cabri II Plus then requires a number to be selected from the working area. The correspondence between the intensity i of a colour component (in the interval [0,1]) and the number x selected from the working area is determined by a «sawtooth» function of period 2. The function is defined by the identity ($i = x$) between 0 and 1 and a linearly decreasing function ($i = 2 - x$) to return its value to 0 over the interval [1,2]. For example, the number 7.36 corresponds to the same intensity as the numbers 5.36, or 3.36, or 1.36, or - 0.64... because the function has periodicity 2.

Undefined colour components are assigned the current values. Using coordinates (R,G,B): $(0,0,0)$ corresponds to black, $(1,1,1)$ is white, $(1,0,0)$ is red, $(0,1,0)$ is green, $(0,0,1)$ is blue, $(1,1,0)$ is yellow, $(1,0,1)$ is magenta, and $(0,1,1)$ is cyan.

3.2 FILL COLOUR

This colour applies to circles, arcs, polygons, and text messages. For text it is the background colour of the rectangular box enclosing the text.

The fill colour is changed with [Attributes]Fill... , by selecting the new colour from the palette, then the objects to be coloured. To revert to the original colour, it is just reselected in the same way. The fill colour can also be changed with the tool from the attributes bar, by selecting the object(s) to be coloured, then the colour. The shortcut menu can be used (as in the preceding section) to assign an object's colour numerically.

By default, when filled objects are overlapping, their colours are mixed. To control this, an object can be made opaque or transparent, using its shortcut menu. When the colours are mixed, the final colour is the result of a logical and between the colours of the concerned objects.

For example, a mixture of yellow with cyan gives green ($(1,1,0)$ and $(0,1,1)$ = $(0,1,0)$).

Opaque objects are displayed «in front» of transparent objects, in the order in which they were created.
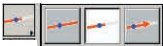
3.3 TEXT COLOUR

The [Attributes]Text Colour... A tool is used to modify the colour of the individual characters. The colour is selected first, then the objects to be coloured. The A tool from the attributes bar can also be used to colour text. The objects are selected first, then the colour in the palette.

3.4 POINT STYLE AND SIZE

The size of points is changed with the [Attributes]Thick... tool. The corresponding tool is also accessible from the attribute bar. The point style is accessed via [Attributes]Modify Appearance and also from the attributes bar.

3.5 LINE STYLE AND THICKNESS SMART LINES

The line style (plain, dashed, dotted) and the thickness (standard, thick, very thick) is accessed via [Attributes]Dotted ⬚ and [Attributes]Thick... ⬚, and also via the corresponding tools on the attributes bar. The display of lines and rays can be limited to the visible window (default setting), or to the region used on the lines and rays (smart lines). In this case, Cabri II Plus decides where to cut off the line according to the position of points marked on it. There are two possible styles for these «smart» ⬚ lines: with or without an arrow – accessible from the attributes bar. How much of a «mart» line is displayed can be changed at will. If two non-parallel smart lines do not currently extend to their point of intersection, but the [Point]Intersection Point(s) ⬚ tool is used with them, the lines will be extended automatically beyond the point of intersection.

3.6 CHARACTERS AND ALIGNEMENT

The shortcut menu of a text box is used to change the alignment (left, right, centered) of sections of text within it. This menu is also used to change the font, size and style of selected characters in a text box. Each character can have different attributes. The [Options]Font... menu can also be used to change the attributes of characters.

3.7 EQUATIONS AND FIGURES

The precision displayed for a number is defined as a default setting in the Preferences. The number of figures displayed can be changed by selecting the number and using the + or - keys. The type and format of an equation can be changed via the shortcut menu and also in the preferences dialog box.

3.8 PICTURES/TEXTURES ATTACHED TO OBJECTS

Cabri II Plus allows bitmap images (in GIF, JPG or BMP formats) to be linked to points, segments, triangles, quadrilaterals, and to the background of the window. This possibility allows the user to change the default appearance of these objects to an image of their choice. In the case of a triangle, the picture is sized to fit a parallelogram derived from the triangle.

In all cases, this function is accessed via the shortcut menu for the appropriate object (right-click on the object while the [Manipulation]Pointer tool is active (Ctrl + cilc with Mac OS)). For the background of a window, right click in an empty part of it.

The menu then enables the user to choose from a default list of images: the screens of the TI-83, TI-84, TI-89 or TI-92; or by reading a GIF, JPG or BMP file from any directory.

Once the image has been attached to an object, it can be removed using the shortcut menu.

| 3.9 | «ON THE FLY» USE THE ATTRIBUTE BAR |

Once a user has already started a construction, for instance when having already clicked on a first point to draw a line, it is possible to click in one of the Attribute boxes from the Attribute bar to change on the fly the corresponding attribute (colour, thickness, smartness for lines) of the coming line.

C H A P T E R	**4**

PREFERENCES AND CUSTOMISATION

4.1 DIALOG BOX FOR PREFERENCES

The dialog box for preferences details the available options for the attributes of new and existing objects, and the settings for software parameters. It is accessed through the [Options] Preferences menu. This dialog box shows a number of themed tabs which will be described in detail in the following paragraphs.

On all tab sheets, clicking on the button labelled Factory settings will restore the factory settings: these are the settings in effect as the software is installed.

On the tab sheets which deal with objects attributes, there are two tick boxes next to the Apply to button, offering the choice of applying the new set of attributes to the current Selection, or to New Objects.

A button labelled Save to file can be seen in the lower section of the dialog box which is common to all tab sheets. Clicking on this saves a new version of a file with the .ini extension, containing all the current preferences. These preferences will be applied when this file is opened with [File]Open.

Clicking on the Cancel button closes the dialog box without making any of the changes selected, and without changing the default settings file. Clicking on OK closes the dialog box after all the changes specified in each tab sheet have been made and, if the Keep as defaults check box has been ticked, the default settings file is updated.

The following paragraphs detail one by one the various tab sheets in the Preferences dialog box.

4.1.1 Loci Options

This tab is for attributes specific to loci. The «Number of objects in a locus» is the number of positions of the variable object which will be used to draw the locus as a discrete set. In the case of point loci, they can be connected to create a curve, or left as a set of unconnected dots. For the locus of lines, segments, vectors and circles, Cabri II Plus can calculate the envelope of these objects, that is to say the curve which is tangent to all of the objects in the locus, or simply draw the set of objects, depending on whether or not the Envelope box is ticked.

4.1.2   Default Styles

This tab deals with those attributes which are common to text and graphical objects. For each type of text, a font can be chosen, together with a style, size and colour. Choices can be made for each type of graphical object: colour, line style, line thickness, point style, point size, extremity style and angle mark style. Depending on the type of object, some of the attributes are not relevant, and so are not displayed.

4.1.3   Geometry

Options under this tab control the manner in which the geometrical constructions evolve. By default, Cabri II Plus creates points implicitly during a construction: when a point is selected which has not yet been defined on a curve or at an intersection. This will often increase considerably the ease of use and the speed of construction of figures. However, this behavior can be turned off. The way Cabri II Plus manages infinity is to draw extensions to the Euclidean plane which serves as the geometric model for the software. If this option is active, the model is extended by a line «to infinity»: two parallel lines will have a point of intersection, a circle can have its center at infinity, etc. Certain constructions which are specifically not projective, cannot be extended. For example, a segment cannot have one of its extremities at infinity, and would not be defined in this case, whatever option has been chosen.

4.1.4   System Options

On this tab sheet, the user can change a few system parameters in relation with the interface.

If the option Bitmap Copy is activated, the command [Edit]Copy causes a bitmap image of the selection rectangle to be held in the clipboard. If this option has not been activated, selected objects will be held in the clipboard in vectorial format (Windows Enhanced Metafile). For more information on this option, see chapter **[6] EXPORTING AND PRINTING**. The Tolerance is the distance within which the software searches for elements under the cursor. A larger tolerance facilitates the selection of isolated objects, but is a difficulty in case of close or overlying objects.

The Cursor Font is the character font used to display dynamic text messages which appear alongside the cursor as it is moved, for example Symmetric to this point...

The Menu Font is used when the various toolboxes are opened, to display the names of the tools.

4.1.5 Display precision and Units

This tab sheet manages the attributes of numbers, obtained when measurements are made on the figure. For the various types of numbers («Length», «Angle», «Other»), the number of digits to be displayed after the decimal point is chosen, as well as the units (for length and angle).

4.1.6 Coordinate System and Equations

This tab controls the display style and the system of coordinates to be used for the equations of lines, circles and conics. In all these cases, Cabri II Plus attempts to obtain integer or rational coefficients in the equations.

For lines, the user chooses between equations of the type $y=ax + b$ (which possibly becomes $x=$ constant) and $ax+ by+c= 0$.

For circles, the choice has to be made between the general equation, $x^2 + y^2 +ax + by + c = 0$, and the equation which shows clearly the coordinates of the center and the length of the radius, $(x- x_0)^2 +(y - y_0)^2 = R^2$.

In this case, if the center of the circle is at infinity, and if infinity management has been activated, Cabri II Plus displays an equation of the type $y=ax + b$ and line at infinity, and the circle is represented by a line. If the line itself is at infinity, it shows double line at infinity. (Center point at infinity and a different radius point at infinity).

For conics, the choice must be made between the general equation $ax^2 + bxy + cy^2 +dx + ey +f= 0$, and the equation which shows the center of the conic $(x- x_0)^2/a^2 \pm(y - y_0)^2/b^2 =\pm1$. In this case, the conic must be the one which has a center (ellipse, hyperbola), and its axes must be parallel to the coordinate axes. If this is not the case, the general form is used.

For loci, only the Cartesian system of coordinates is used. If one of the coordinates x or y can be isolated from the equation obtained, the display is given in the form $x= f(y)$ or $y= f(x)$; otherwise the display is in a general form with the sum of the terms $a_{ij}x^iy^j$ equal to 0.

4.2   CUSTOMISED TOOLBAR

Users can add their own tools (constructed with macros) to the toolbar, and also move these tools to other toolboxes. It is also possible to remove tools from toolbars.

This customisation is useful for extending the features available in Cabri II Plus, and also in class for working on exercises with a restricted number of tools (for example without perpendiculars or parallels). For work in class, the customised toolbar can be protected with a password, preventing students from modifying it.

When macros are created, the corresponding tools are added to the [Macros] toolbox.

The toolbar is changed by selecting [Options]Tool Configuration... the customisation dialog box then appears. Whilst this dialog box is displayed, the tools can be moved from one toolbox to another: one click to select the tool, another to put it in position. To remove the tool, it is moved to the Recycle Bin whose icon appears to the right of the toolbar. Changes to the toolbar are not saved with the figures. Thus, to re-use it in another session, the toolbar must be saved separately.

If a password is entered when the toolbar is modified, it will be requested before the toolbar can be changed again.

4.3   LANGUAGE

The menu item [Options]Language... displays a dialog box which opens a file. This dialog box enables a Cabri II Plus language file to be selected, extension .cgl, containing the full set of text messages displayed by the software for a given language. The new language is installed immediately without having to restart the software. After installing the new language, Cabri II Plus asks if this language file is to be used routinely whenever the software is run.

It is also possible to drag and drop a software language file xxx.cgl into Cabri II Plus.

The set of language files distributed with the software varies between distributors. Cabri II Plus has been translated into most languages by mathematics teachers, practicing in the countries concerned. You can contact us at *support@cabri.com* with any questions you may have on the available languages.

C H A P T E R **5**

USER INTERFACE

5.1 MENU BAR

1. File

MAC	PC	MENU	ACTION
⌘ + N	Ctrl + N	**New**	Opens a new drawing sheet, which becomes the active document.
⌘ + O	Ctrl + O	**Open**	Opens a Cabri II Plus document.
⌘ + W	Ctrl + W	**Close**	Closes the active document.
⌘ + S	Ctrl + S	**Save**	Saves the active document.
		Save As...	Saves the current drawing under a name to be specified.
		Export(HTML,PNG,TI-xx)	Saves the figure as an html, a png (72 or 150 dpi), or a Cabri Jr. file (Cabri application available for Texas Instruments graphing calculators).
		Revert	Reverts to the previously saved version of the figure.
		Show page...	Shows the full drawing page (1mx1m) in order to select which portion is to be seen on the screen.
		Page setup...	Definition of parameters for printing.
⌘ + P	Ctrl + P	**Print...**	Prints the curent drawing sheet or a selected portion.
	Alt + F4	**Exit**	Quits Cabri II Plus. Mac users: see Cabri II Plus menu.

2. Edit

MAC	PC	MENU	ACTION
⌘ + Z	Ctrl + Z	**Undo**	Cancels the most recent operation.
⌘ + X	Ctrl + X	**Cut**	Removes the current selection from the figure and place it to the clipboard.
⌘ + C	Ctrl + C	**Copy**	Copies the current selection to the clipboard.
⌘ + V	Ctrl + V	**Paste**	Pastes clipboard contents to current drawing.
	DEL	**Clear**	Deletes all selected elements.
⌘ + A	Ctrl + A	**Select All**	Selects all objects in the drawing.
		Replay Construction...	Enables the construction to be replayed. There are several possible options.
⌘ + F	Ctrl + F	**Refresh Drawing**	Redraws the entire contents of the window.

3. Options

MAC	PC	MENU	ACTION
⌘ + F9	F9	**Show Attributes**	Displays or hides the attribute bar which controls appearance of objects.
⌘ + F10	F10	**Show Figure Description**	Shows or hides the figure description window.
		Preferences...	With possibility to save in a file as default settings for locus, axes, units, precision, equations. Mac users: see Cabri II Plus menu.
		Tool configuration...	Selection and arrangement of tools.
		Language...	Language selection.
		Font...	Selection of font characteristics.

4. Window

MENU	ACTION
Cascade	
Tile Horizontal	
Tile Vertical	Standard Windows menu for managing open files and display open windows.
Close all	
Figure 1...	The list of open diagrams is shown in this menu. Mac users: see Edit menu.

5. Session

MAC	PC	MENU	ACTION
⌘ + F2	F2	**Start Recording...**	Starts or stops recording a session.
⌘ + F4	F4	**PlayBack**	Selects a file. Reviews the stages of a construction.
⌘ + F5	F5	**Print a session**	Prints a session using the selected print settings.
⌘ + F6	F6	**Previous**	Shows the previous step of the construction.
⌘ + F7	F7	**Next**	Shows the next step of the construction.

6. Help

MAC	PC	MENU	ACTION
⌘ + F1	F1	**Help**	Displays a help message for the current tool, at the bottom of the screen.
		About Cabri II Plus	Displays the software version number as well as the type of registered license. Mac users: see Cabri II Plus menu.
		Companion	Displays a tool help, containing tutorials and pedagogical resources ready-to-use in a classroom.

7. Others

MAC	PC	ACTION
⌘ + D	Ctrl + D	Toggles the display between Bold and Normal to improve legibility for the visually impaired or for presentations.
⌘ + +	Ctrl + +	Global dilation (Zoom in effect)
⌘ + −	Ctrl + −	Global reduction (Zoom out effect)
⌘ + U	Ctrl + U	Displays the menu which enables the selected units of measurement to be changed.
⌘ + Tab	Ctrl + Tab	Brings a previously opened figure to the front of the window.
		A sustained click in a blank portion of the drawing sheet makes all movable points pulsate.

The default tool bar is the one shown below:

Properties

Points

Measurement

Lines

Text and symbols

Curves

Attributes

Macros

Transformations

Constructions
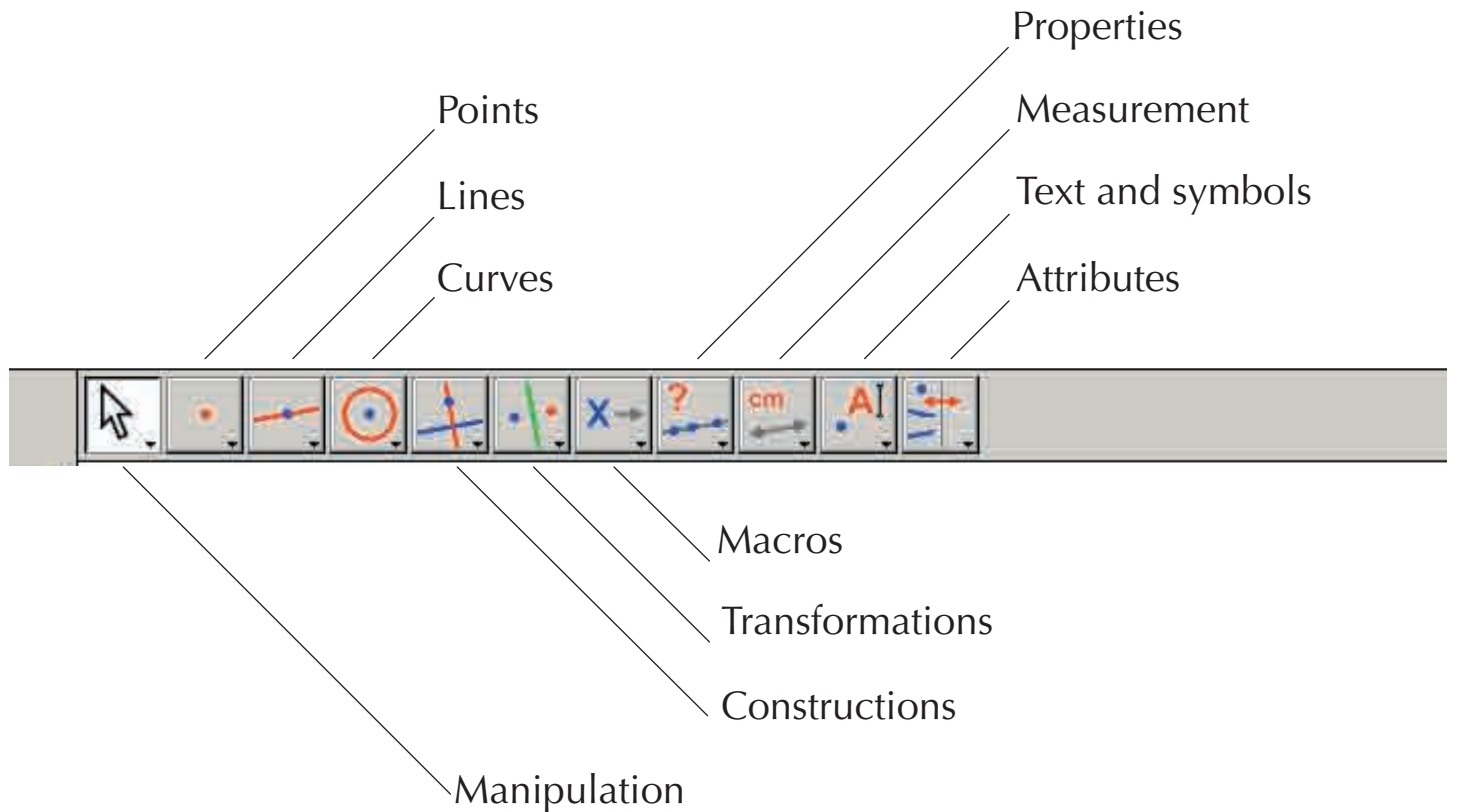
Manipulation

It can be completely redefined by the user. (See Chapter **[4] PREFERENCES AND CUSTOMISATION**).

Each icon corresponds to a word (or phrase) which describes the appropriate object. This is fundamental for teaching geometry to children who manipulate objects and learn the terminology at the same time, thus enabling them to talk about the geometry they are doing.

Line
Segment
Ray
Vector
Triangle
Polygon
Regular Polygon
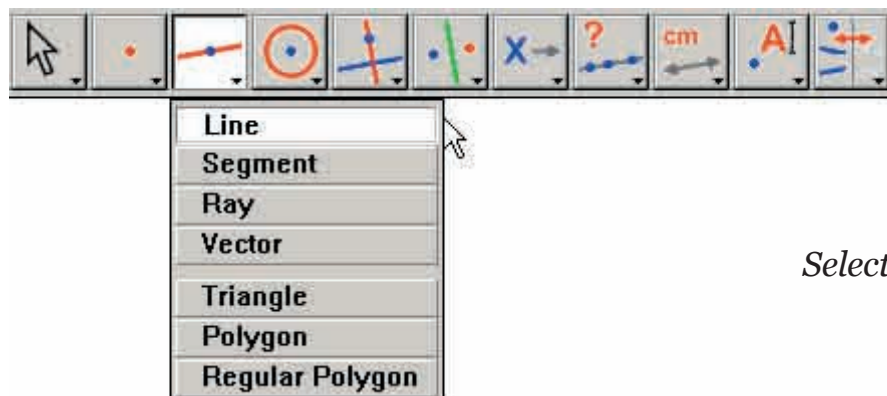
Selection of the line tool in the line toolbox.

Click and Hold (hold down the lefthand mouse button for a while until you move the pointer down) when pointing at an icon to open a toolbox: a list of tools appears from which the new tool can be selected. The icon of the chosen tool then replaces the original one on the toolbar. A quick single click on an icon selects the tool displayed on the toolbar. All the icons available from the toolbox are shown in the following lists.

1. Manipulation

Pointer		Select and move objects (translation).
Rotate		Dilate an object about its centroid or a selected point.
Dilate		Dilate or shrink an object about its centroid or a selected point.
Dilate and Enlarge		Simultaneously rotate and dilate an object about its centroid or a selected point. (A combination of dilation and rotation).

2. Points

Point		Mark a point, a separate point, or a point on an object or at the intersection of two objects (depending on the position of the cursor).
Point on Object		Mark a point on an object (Create a point on an existing object).
Intersection Points		Construct the intersection of two objects. Clicking successively on two objects constructs all their intersection points. Note that clicking close to one of their graphical intersections will construct only that intersection point.

3. Lines

Line		Construct the straight line defined by a point and either a direction (selected by a second click) or a second point. If the `Alt` key is held down as the direction is selected, a second point is created.
Segment		Construct the segment defined by two points.
Ray		Construct the ray (half-line) defined by a point and a direction or a second point.
Vector		Construct the vector defined by two points. The first is the starting point of the vector. The `Alt` key can be use as for the construction of a line.
Triangle		Construct the triangle defined by three selected points.
Polygon		Construct the polygon defined by n points ($3 \leq n \leq 128$). To complete the construction, either double-click on the last point, or re-click on the first point.

		Construct a regular polygon by selecting a point at its center, a second point to define the «long radius» and the number of vertices. The number of sides or branches of a star is selected by moving the cursor around the central point: in the semi-circle to the right of the center for a polygon, and in the semi-circle to the left of the center for a star. A message $\{n/p\}$ is displayed for a star of n points, taking a point every p points around the vertices of a regular n-sided polygon. [A pentagram is a $\{5/2\}$ star polygon.]
Regular Polygon		

4. Curves

Circle		Construct a circle. First select an existing point or create on the fly a new one which becomes the center of the circle, then select the size of the radius by clicking at the desired distance. If the `Alt` key is held down as the radius is selected, a second point is created.
Arc		Construct an arc of a circle defined by three points: first an end-point then an intermediate point and finally the other end-point.
Conic		Construct the conic defined by 5 points (No more than 3 of them can be collinear).

5. Constructions

Perpendicular Line		Construct the line passing through a point, perpendicular to a given direction: line, ray, segment, axis…
Parallel Line		Construct the line passing through a point, parallel to a given direction.
Midpoint		Construct the midpoint between two points or of a segment (defined by two points), a vector or the side of a polygon. The two points can be created on the fly.
Perpendicular Bissector		Construct the perpendicular bisector of two selected points or of a selected segment, side or vector.
Angle Bissector		Construct the bisector of an angle defined by three points, ABC, where B is its vertex.
Vector Sum		Construct the resultant of two vectors. Select the two vectors, and the starting point for the resultant. The order of selection is not relevant.
Compass		Construct the circle defined by a point and a radius. Select the radius length, by selecting a segment (or two points or a number) and select the center. The order of selection is not relevant.
Measurment Transfer		Transfer a measurement defined by a number, to a vector, a ray, an axis or a circle (in the counterclockwise direction from a selected point).
Locus		Construct a locus. Select an object A and a point M, constrained to move on another object. This tool constructs the locus of A as M moves.
Redefine Objects		Redefine the geometrical characteristics of an object (a point, line, circle, conic, etc) without having to delete it or redo the construction.

6. Transfomations

Reflection		Construct the mirror image of an object. Select first the object then the axis of symmetry.
Point Symmetry		Transform an object by point symmetry. Select first the object to be transformed then a point.
Translation		Construct the image of an object under a translation. Select first the object then the translation vector.
Rotation		Construct the image of an object under a rotation. Select first the object then the center and finally an angle defined by a number or by 3 additional points (second point as vertex).
Dilation		Construct the image of an object under a dilation or a similitude. Through Numerical Edit tool, enter anywhere on the drawing sheet the scale factor number. For a dilation, select in this order an object, a point for the center and previously entered scale factor nuber. For a similitude, select an object and three points A,O,B in this order. O is then the center of the similiture, OB/OA the scale factor and $A\hat{O}B$ its angle. If A,O,B are collinear, the similitude coincide with the dilation with center O and a scale factor of OB/OA.
Inverse		Construct the image of a point under inversion in a circle. Select the point and the circle.

7. Macros

Initial Objects		Select the set of initial objects to be used in the construction macro.
Final Objects		Select the final objects of the construction macro.
Define Macro...		Having defined the initial and final objects, this validates the macro.

8. Properties

Collinear?		Display a message to confirm or contradict the collinearity of three points.
Parallel?		Display a message to confirm or contradict the parallel direction of two lines, segments, sides of polygons…
Perpendicular?		Display a message to confirm or contradict whether two selected directions are perpendicular.
Equidistant?		Display a message as to whether a point is equidistant from two other points. The first point selected is the one to be tested relative to two other points.
Member?		Display a message to confirm or contradict whether a point belongs to an object.

9. Measurements

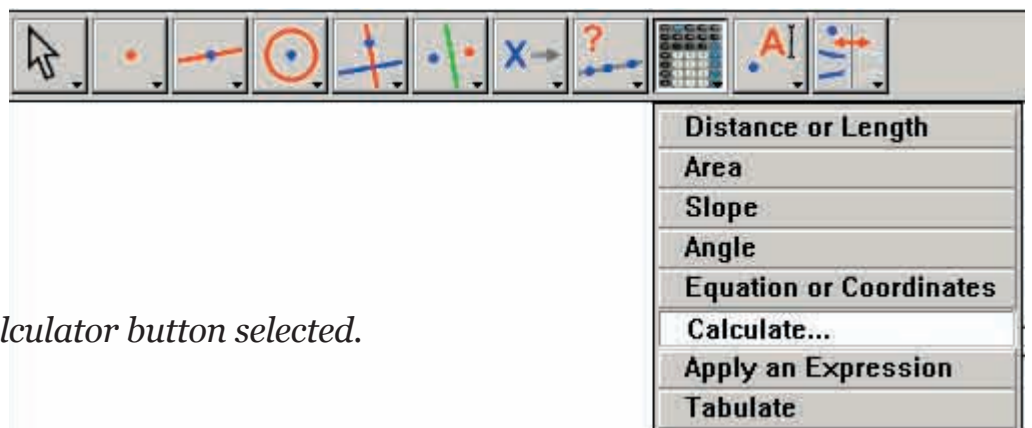|		
Distance or length	cm	Measure the length of a segment, the magnitude of a vector, the distance from a point to a line or a circle, or the distance between two points. Measure also the perimeter of a polygon, of a circle or an ellipse. The number displayed in the working area is given an unit (cm by default).
Area	cm²	Measure the area of a circular disc, an ellipse or a polygon. The units of area are displayed.
Slope	%	Display the gradient of a line, ray, segment or vector. A dimensionless number is displayed, which is infinity if the direction is vertical.
Angle	α	Display the size of an angle defined by three points (the second of which must be the vertex).
Equation or coordonates	(x,y) y=f(x)	Give the equation of a line, a circle, a conic or a locus. The type of displayed equation depends on the settings made in [Options]Preferences menu item. Give the coordinates of a point too.
Calculate…		Display a calculator upon which scientific calculations can be carried out using numbers from the keyboard or values taken from the figure.
Apply an Expression	3x+ 2y =	Calculate the value of an expression displayed in the working area. Select the expression, and then a number in the drawing area for each variable of the expression. The calculated value of the expression can be used for new calculations.
Tabulate		Display a table into which successive numerical values taken from the figure can be placed. The `Tab` key enables the current values to be placed in the table, in a new row.

10. Texte and symbols

Label	A	Name points, lines, circles, rays, triangles, polygons, loci… by means of a label attached to the newly named object.
Text	Ab	Let users enter text anywhere on the drawing sheet. Dynamic elements from the figure such as numbers, names can be included by selecting them.
Numerical Edit	2.1	Enable a number to be entered anywhere on the drawing sheet.
Expression	3x+ 2y	Enter a new expression anywhere on the drawing sheet. Expressions are edited as text. The syntax is checked only when the expression is evaluated i.e. when values are entered for variables.
Mark Angle		Mark an angle with an arc. The second point of the three which define the angle is the vertex.
Fix/Free		Fix and unfix the position of a point.
Trace On/Off		Produce or suppress the outline of an object during its displacement.
Animation		Move objects automatically.
Multiple Animation…		Move several objects automatically.

11. Attributes

Hide/Show		This tool is used to select a set of objects in the figure which are to be hidden. These objects are no longer seen on the screen nor printed. This simplifies the work on complex figures. This same tool is also used to show objects that have previously been hidden.
Hide/Show Button		This tool is used to let users who will look at the figure to control the display of one or more objects. A button will appear on the figure and pressing/releasing this button will hide/show some objects. To associate one or more objects to a button, first drag and drop the button, then click on one or more objects (⇧ key + objects). In case of modification of an existing button, select the button through [Attribute]Hide Show Button and associate the new objects. Once created or modified, the button is activated with pointer tool. It can be moved on the drawing sheet by drag and drop.
Colour...		Let users choose the colour of an object. First select a colour from the palette then the objects to colourize.
Fill…		Fill polygons, circles and text with the colour chosen from a palette.
Text colour...		Change the colour of text. Select a colour from the palette and then the text to colourize.
Thickness...		Change the thickness of lines and points.
Line Style…		Change the line style.
Appearance…		Change the appearance of certain objects: points, angle marks, line marks and axis.
Hide/Show Axes		Hide or show the default system of axes.
New axes		Define a new system of axes, by selecting the origin, a point on the x-axis and a point on the y-axis. If two last points already exist, they define the units on axis.
Define Grid		Display a grid for a system of axes.

12. Calculator

The toolbar showing the calculator button selected.

The calculator enables calculations to be carried out on values coming from the figure (measurements, displayed numbers, calculation results) or entered from the keyboard.

The results are displayed temporarily at the right of the calculator window. In order to save the answer it must be copied to the drawing. (In the calculator window, click and drag the answer to the point in the drawing where it is to go).
When the figure is altered, measurements and associated calculations are instantaneously updated. The change in a calculation is immediately updated in the figure.

There are other functions available on the calculator than those which are listed on the screen. The list of functions and their alternative forms is given below.

Functions	Synthax
Arc Cosine	ARCCOS(x), arccos, acos, ArcCos
Hyperbolic Arc Cosine	ARGCH(x), argch, ArgCh; Arccosh
Arc Sine	ARCSIN(x), arcsin, asin, ArcSin
Hyperbolic Arc Sine	ARGSH(x), argsh, ArgSh, arcsinh
Arc Tangent	ARCTAN(x), arctan, atan, ArcTan
Hyperbolic Arc Tangent	ARGTH(x), argth, ArgTh, arctanh
Round (to nearest integer)	ROUND(x), round, Round
Square	SQR(x), sqr, Sqr, Sq
Cosine	COS(x), cos, Cos
Hyperbolic Cosine	COSH(x), cosh, CosH, ch
Exponential e^x	EXP(x), exp, Exp
Common Logarithm	log10(x), Log10, lg, log
Natural Logarithm	LN(x), ln, Ln
Maximum of (a, b)	MAX(a ,b), max, Max
Minimum of (a, b)	MIN(a ,b), min, Min
Random number between 0 and 1	Random (a ,b), random (a ,b), Rand(a ,b), rand (a ,b)
Pi (π)	π, $\prod$, pi, Pi
Least integer $\geq$ x	CEIL(x), ceil, Ceil
Greatest integer $\leq$ x	FLOOR(x), floor, Floor

| Powers of 10	10^ x
Square Root	SQRT(x), sqrt, Sqrt, SqRt,
Sign (-1 if x < 0, +1 if x > 0, 0 if x = 0)	Signe(x), signe, sign
Sine	SIN(x), sin, Sin
Hyperbolic Sine	SINH(x), sinh, SinH, sh
Tangent	TAN(x), tan, Tan
Hyperbolic Tangent	TANH(x), tanh, TanH, th
Absolute Value (Modulus)	ABS(x), abs, Abs

5.3   ATTRIBUTES BAR

The attributes bar is displayed vertically to the left of the drawing sheet, and is shown/hidden by [Options]Show Attributes `F9` key for Windows, ⌘+`F9` key for Mac. The attributes bar behaves differently from the Attributes toolbox. When a tool is selected to construct a particular type of object (point, line...) the attributes bar is updated to show the default attributes of this type of object. These can then be modified, and changes will affect all new objects of this type. For example, if [Points]Point 	• is activated, the attributes bar is updated to show the default properties of points (colour, style, size). If blue is then chosen as the drawing colour, all new points created after this will be blue. It is also possible to select objects in the Pointer mode and then choose a value for an attribute on the attributes bar. This value will then be applied to the selected objects.

The first three buttons 🖊, 🖌, **A** on the attributes bar relate to drawing colours, fill colours and text colours. The current colour appears on the icon (black here).

The ᴬA AA buttons are used to increase and reduce the size of characters.
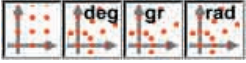
The — — buttons are used to change the size of points and the thickness of curves and lines.

The — ···· ⁻ ⁻ buttons are used to control the line style (plain, dotted, dashed) of curves and lines.

The • ■ ○ × + buttons control the form of points.

The ∠ ∠ ∠ ∠ ∠ and — — — — buttons control the type of mark used to mark angles and segments. These marks show, for example, that angles are the same size, or that segments are the same length.

The buttons determine the endpoint style of «smart lines».

Finally, the buttons control the type of coordinate system (linked to a grid): Cartesian, or polar in degrees, radians, or grades.

CHAPTER	6

EXPORTING AND PRINTING

There are several ways in which a figure created in Cabri II Plus can be used in other documents, or in published work. To use all or part of a figure in most other applications, or in another Cabri II Plus document, select the objects required, possibly select all of them with **Ctrl+A** (⌘+A for Mac OS), then [Edit]Copy and then [Edit]Paste in the other document.

To use the figure in another application, it can be copied into the clipboard in two formats: bitmap or vector. The choice between the two is made in the Preferences dialog box, under the System Options tab. In both cases, a selection rectangle must be defined using click-and-drag in Pointer mode. The contents of the rectangle will be copied to the clipboard.

The bitmap format is more suitable for the publication of static figures (non-manipulable) on the Internet, and will have a «pixelated» appearance when printed. The vector format is the enhanced Windows Meta file type, and can be copied in vector form into most software. The appearance when printed will be excellent, since it uses the same resolution as the printer.

To obtain high resolution bitmaps, or PostScript files, the [File]Print command is used. The page is printed using a PostScript printer driver (for example the Adobe® PostScript generic printer driver) by selecting Print to file and, for example, the «Encapsulated PostScript» (EPS) option in the driver. In this way one obtains a vector format which is portable (for example to other operating systems, which is not possible with Windows Metafiles). An Encapsulated PostScript version can be converted later into other formats using suitable utilities: Ghostscript (freeware) for example, using whatever resolution one wishes. The textual description of the figure can also be copied from the Figure description window using the shortcut menu. Multi-page printing («poster» mode) and print preview are Mac OS specific functions.

Users can also save the figure as a Cabri Jr. file (Cabri Jr is a Cabri version available for Texas Instruments graphing calculators).