OK Geometry Easy

Reference for OK Geometry Easy (v.17.2)

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1   OK Geometry (Easy mode)

OK Geometry is an aid for analysing dynamic geometric constructions. Given a dynamic geometric construction OK Geometry detects patterns in the construction as well as certain properties of the construction. OK Geometry (Easy mode) may be used for commenting or presenting pre-set properties.

You may think of OK Geometry as a pair of geometric spectacles that allow very precise observation of geometric constructions. OK Geometry helps students to notice properties they may not be aware of. With OK Geometry (Easy mode) they can also develop the sense of a proof: this is achieved with prepared tasks in which they are asked to organise properties of a construction into a deductive structure. **Students should be aware that one thing is seeing (observing) a property, another thing is to know that a property is true and still another thing is to have an explaination why something is true**. OK Geometry (Easy mode) also allows the presentation of properties or proofs of facts in planar geometry.

With OK Geometry (Easy mode) you can:

- import geometric constructions from some dynamic geometry systems (DGS), currently from Cabri, Cabri II, Cabri Express, GeoGebra, C.a.R., Cinderella, Sketchometry, JGEX, OK Geometry;
- spot patterns and properties in geometric constructions;
- organise properties, given in prepared exercises, into a proof and write a report;
- present the found properties.

Note: OK Geometry (Basic mode) offers much more: It is possible to make dynamic constructions, including implicit constructions and constructions based on optimisation, and study them. It is also possible to devise proof-like problems to be solved in the Easy mode.

2   Working with OK Geometry (Easy mode)

2.1   Accessing the Easy mode

To access the Easy mode of OK Geometry click in the menu line the command **Configure|Working mode|Easy** (Figure 1).
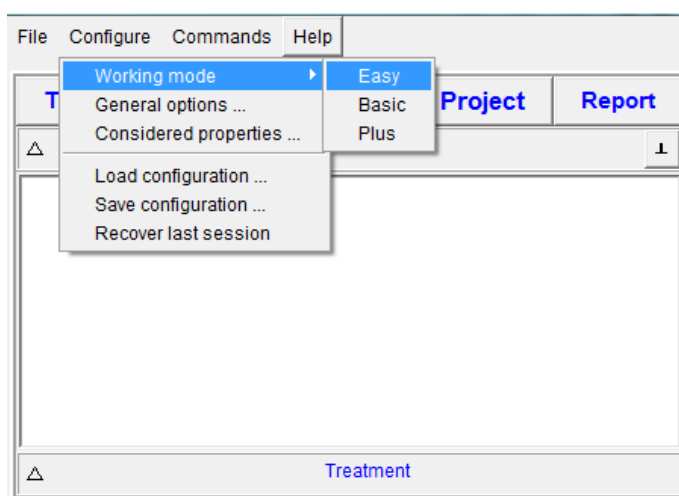
Figure 1

2.2   Spotting the properties of dynamic constructions

With OK Geometry Easy you can analyse geometric constructions made by dynamic geometry software. Here is what you need to do:

1. *Make a construction.* Make a construction using a dynamic geometry software (Cabri, Cinderella, GeoGebra, C.a.R., Sketchometry, JGEX). Save the construction to a file. Note that C.a.R. constructions should be saved in non-compressed native format (.zir), the Sketchometry files should be exported as .jc files, and JGEX constructions need to be written in text form (.txt). In the construction try to label all relevant vertices! (See 2.3 for additional information.) For convenience, some files made with various dynamic geometry software are already included in the Examples directory (Incircle.fig, Incircle.ggb, Incircle.cdy, Incircle.p, Incircle.jc, incircle.zir).
2. *Import the construction in OK Geometry.* Press the button **Task** in the main menu bar (see Figure 2) to choose a file with a construction and import it to OK Geometry. The drawing of the construction should appear on the right pane.
3. *Detect geometric properties.* Press the button **Observe** (see Figure 2) to detect the geometric properties of the imported construction. The found properties are listed in the Observed properties section in the left pane (see Figure 2).

4. ***Visualise instances of properties.*** To access to instances of a property click the + sign in front of the property (see Figure 3). Click on an instance of the property to visualise the instance (see Figure 3). Note that above the visualised property appears a symbolic description of it.

5. ***Visualise selected objects involved in a property.*** Click on any symbol in the symbolic description to emphasize the object represented by the symbol. (See Figure 3). You may find useful the arrow keys on the keyboard and the Shift arrow keys to navigate between the shown objects.

6. You can change the level of analysis (see Figure 2) and repeat the Observation. The higher the level the more sophisticated properties are checked.

7. You can also set which vertices to consider (see Figure 2). For example, if you want to consider only vertices ABCDP write in the entry ABCDP. If you want to list the vertices to be excluded from the consideration, write an exclamation point at the beginning, e.g. !ABP to exclude the vertices A,B,P.

8. If necessary, new labels of points may be added, changed or removed by right-clicking on the right pane and choosing the appropriate command.

9. In order to list only properties that involve a given object, use appropriate ? button ob right side to select the type of object and then point to object on display (or its vertices) (Figure 4).
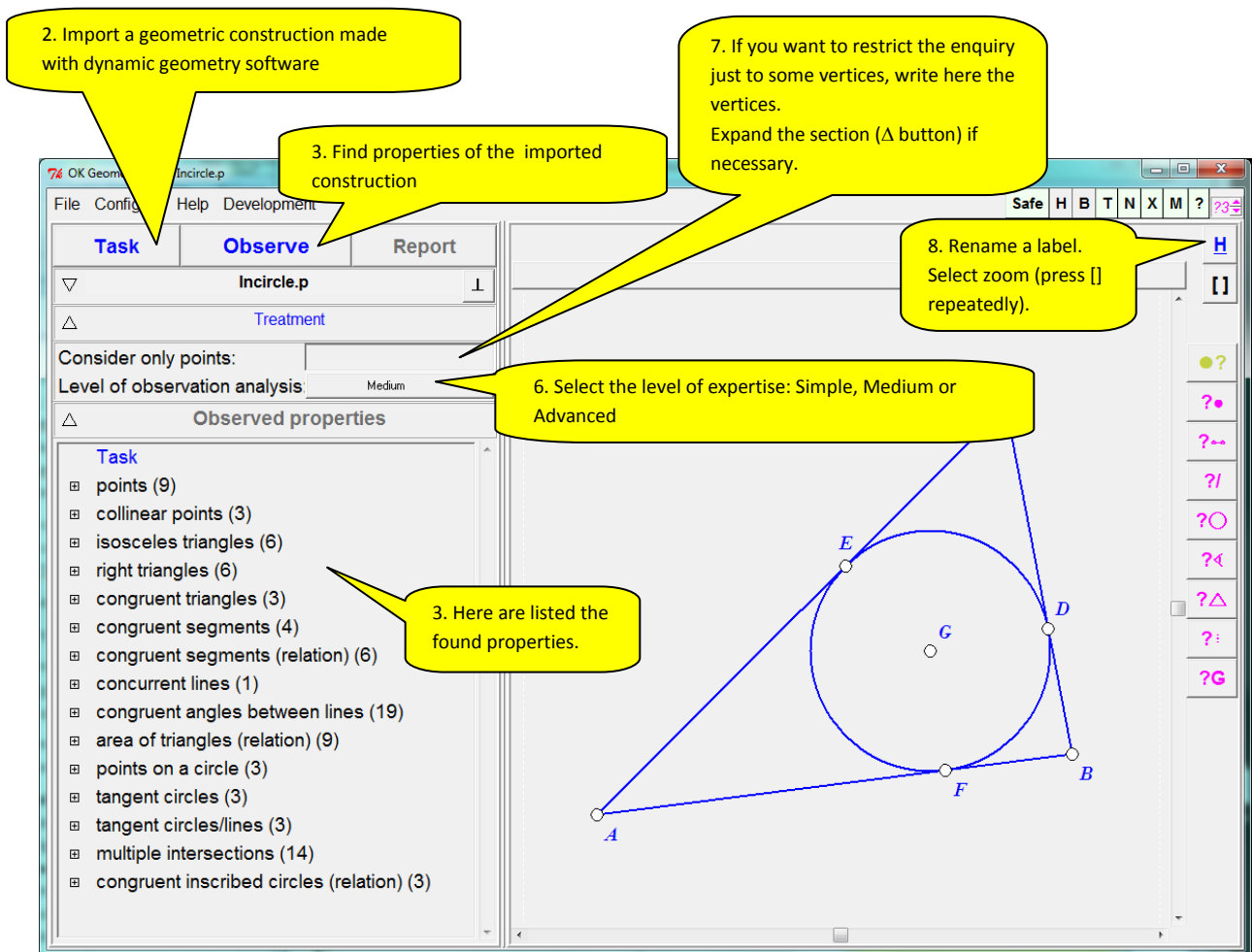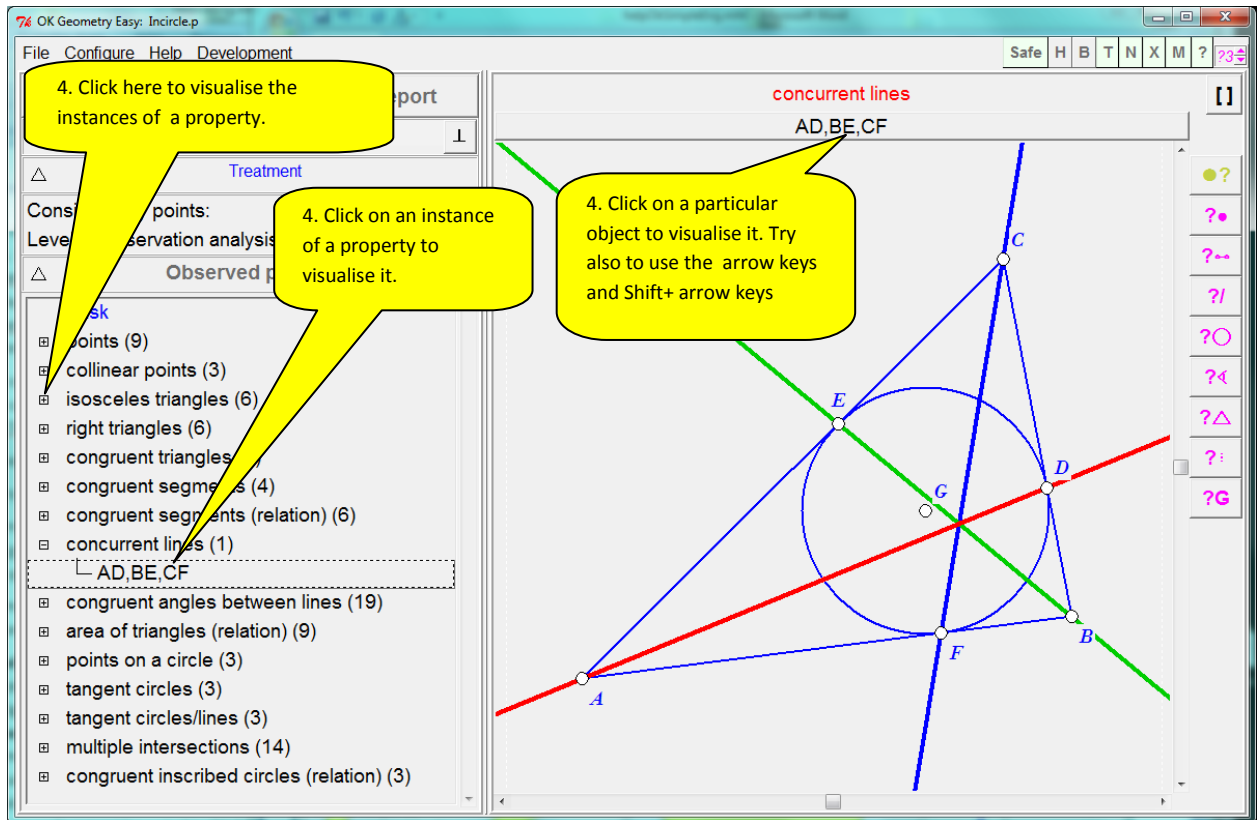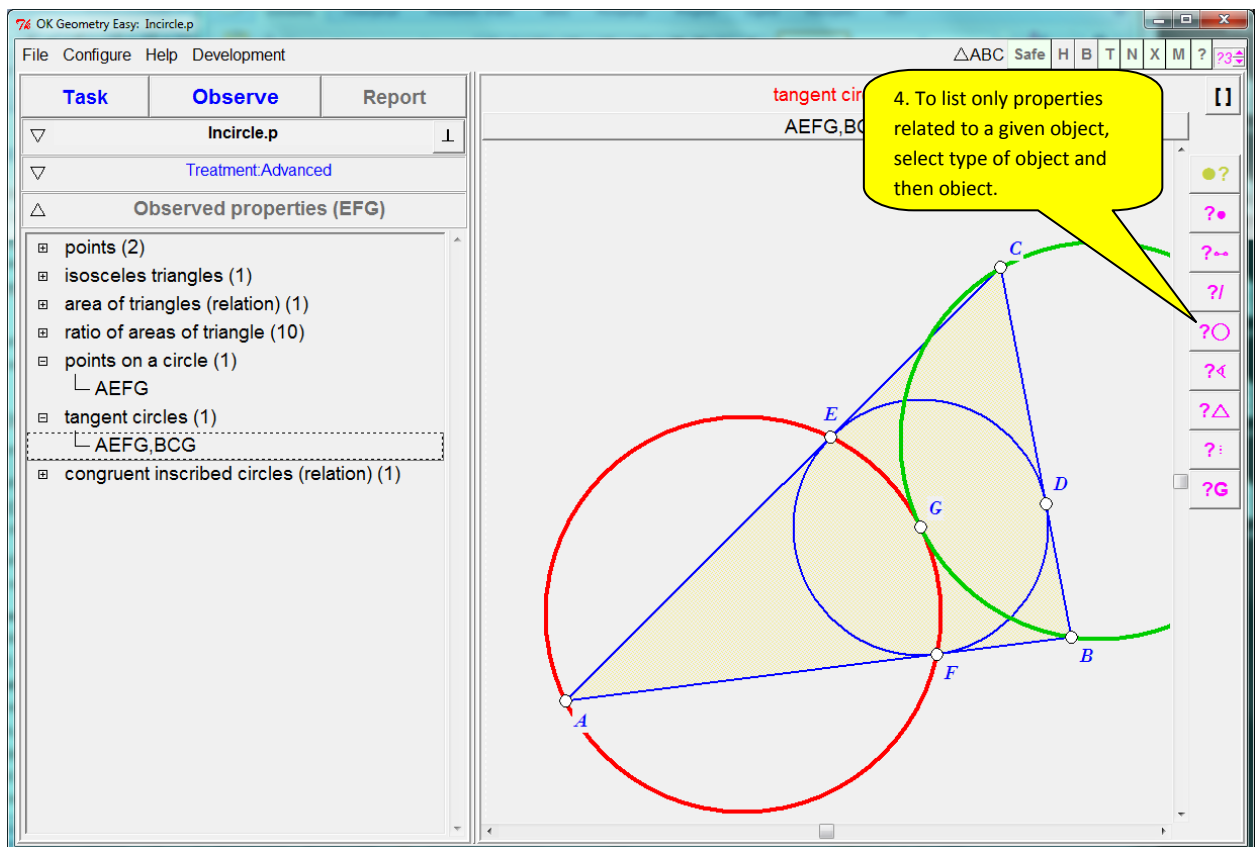

Figure 2

Figure 3

Figure 4

2.3   Understanding the properties

OK Geometry imports and displays many elements from constructions made with various dynamic geometry software (GeoGebra, Cinderella, Cabri, Sketchometry, C.a.R., JGEX). When analysing geometric constructions OK Geometry considers:

- all **displayed labelled points**;
- all displayed lines, circles, and other objects;
- all lines (displayed or not) passing through any two **displayed labelled points**;
- all circles (displayed or not) passing through any three **displayed labelled points**;
- all conics (displayed or not) passing through any five **displayed labelled points**;
- specific objects (displayed or not) .

Special care should be taken to properly label the points in a construction. Remember:

1. **Point labels usually consist of a letter, optionally followed by apostrophes, numerals or other letters. The same label cannot be used for different points.** Thus the labels of points should be like: A, B, A', B'', A1, B12, AB . There is no need to label all displayed points in a geometric construction, label just the relevant ones, each with a different label.
2. **A reasonable number of points to consider in a construction is 4-12.** The number of spotted patterns, in general, rapidly increases with the number of considered points in a construction. An excessive number of considered points may result in an unmanageable collection of properties and unclear visual representation. During the analysis it is possible to exclude some labelled points from being considered (either by specifying the labels to be considered, see 2.2.7).
3. **At any time you can within OK Geometry change, hide, delete or add labels for points.** Right click on the right pane and follow the menu commands.
4. **OK Geometry considers only acute and right angles between lines.** Properties are thus often stated in the form that something holds for *some angles or their supplementary angles*. The reader has to find out where to take into consideration the angles and where the supplementary angles. In the Figure 5 (right) OK Geometry, for example, notes the ratio 1:2 between the two displayed angles (∠BCA and ∠BDA) or their supplementary angles. In fact, the ratio 1:2 is between the angle ∠BCA (green colour) and supplement of ∠BDA (supplement of the angle indicated by red colour).
5. **OK Geometry does not warn of trivial cases of congruency of angles (angles related to pairs of parallel lines, angles formed by two crossing lines).** In fact, a pair of parallel lines would produce an immense number of congruent angles. Thus, when considering the spotted properties one should check if there are parallel lines and be aware of the congruency of angles defined by parallel lines and lines that cross them. In the trapezium (Figure 5 left), for example, OK Geometry does not list the fact that the angles ∠DEA and ∠BEC or ∠DCA and ∠CAB are congruent.

It is important to choose well, which points to mark and label in a geometric construction. In general, try to mark all points that you find to be potentially relevant to your investigation. In common tasks it is quite straightforward which points to mark and label. However, especially when solving harder problems, a good choice of points to label is also a matter of good intuition (more precisely: of an extensive and well organised knowledge base).
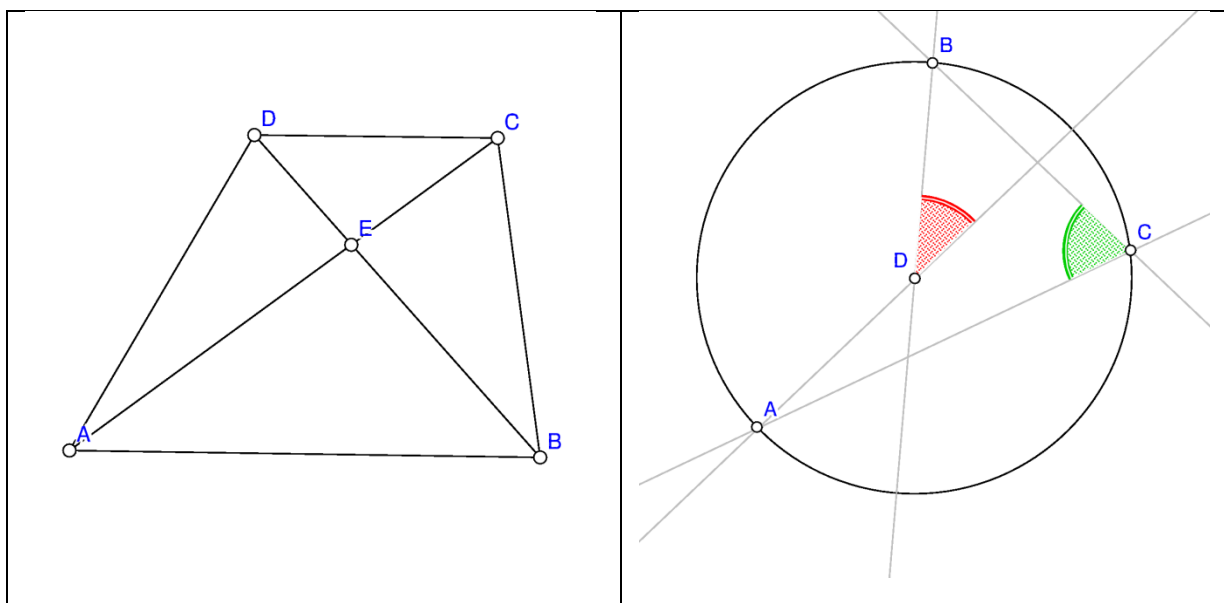
Figure 5

2.4 Presentation of properties

With OK Geometry (Easy mode) you can present information or proofs prepared with OK Geometry (Basic mode).

2.5 Organising a proof

OK Geometry (Easy mode) is designed also **for organising a given set of properties into a proof**. Students that still learn the concept of a proof and students that find difficult proving geometry facts will benefit if someone (e.g. their teacher, using OK Geometry in basic mode) had previously selected the facts to be used in a proof. In this way the student can focus on the construction of the proof by properly sequencing the properties and supplying deductive arguments. In the Examples directory you can find some simple exercises of this kind, e.g. Trapezium1.pro. Note that the exercises are prepared with OK Geometry (not in Easy mode) and stored in files with .pro ending.

To work out a prepared task of this kind (e.g. Trapezium1.pro) follow these steps:

1. Press the button **Task** in the main menu bar (Figure 6) to select and read a task, in our example the file Trapezium1.pro. (Such tasks can be previously prepared by the teacher with OK Geometry, but not in the Easy mode.) On the left pane you can see the task and the numbered observed facts. On the right pane you can see their respective iconic representations.
2. Try to find relations among the shown facts, i.e. which fact follows from which facts. Usually this is done by moving around (dragging) the icons (drag by pointing the icon and pressing the left button of the mouse). You can change the size of icons and elements of icons (e.g. labels) with the sliders on the lower left of the window. (see Figure 5).
3. You can change the order of icons by dragging the properties in several ways:

- Right click on the icon and use the command *Change icon number*.
- Select the property and use the - or + keyboard key to move the active property up or down the list.
- Drag the property on the left pane to a desired position.
- Use the < and > buttons on the command bar on the left.

4. Double click a description on the left pane or on an icon on the right pane. In the form that appears (Figure 7) write an explanation, e.g. why does the represented property follow from the previous facts in the list. In the text you can mark paragraphs as Claims, Arguments, Definitions (right click on the paragraph). Use the # symbol to refer to another property: e.g. #3 refers to the property and icon number 3. Note that it is possible to comment the relation directly on the left pane.

5. Additional commands are available with a right click on an icon. You can also use the command bar on the left to move among icons, to maximise an icon, to use special characters, etc.

6. When all properties are commented and the proof is worked out, you can obtain a report. Press the Report button (Figure 8) and follow the instructions. You will get a HTML file with your proof. You can read and edit this file with common text editors.
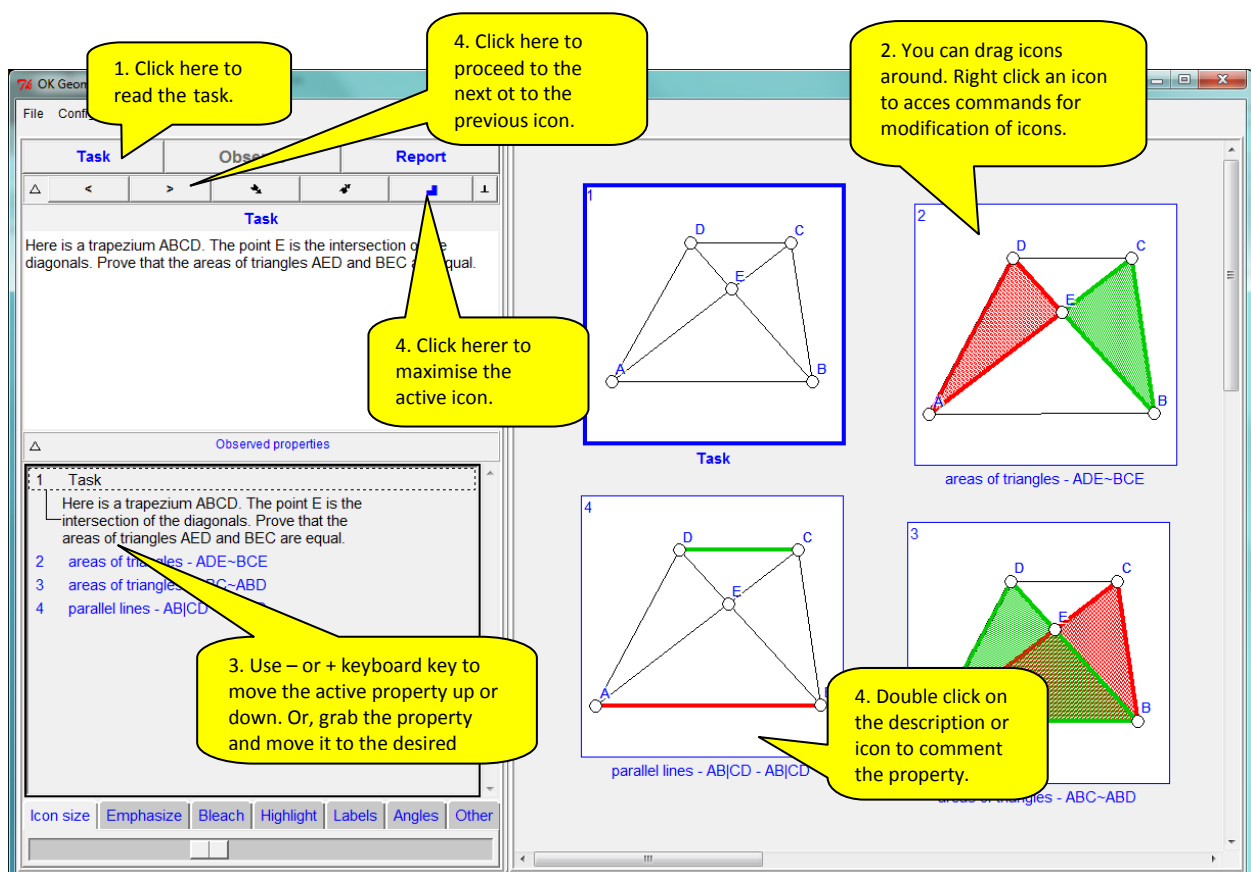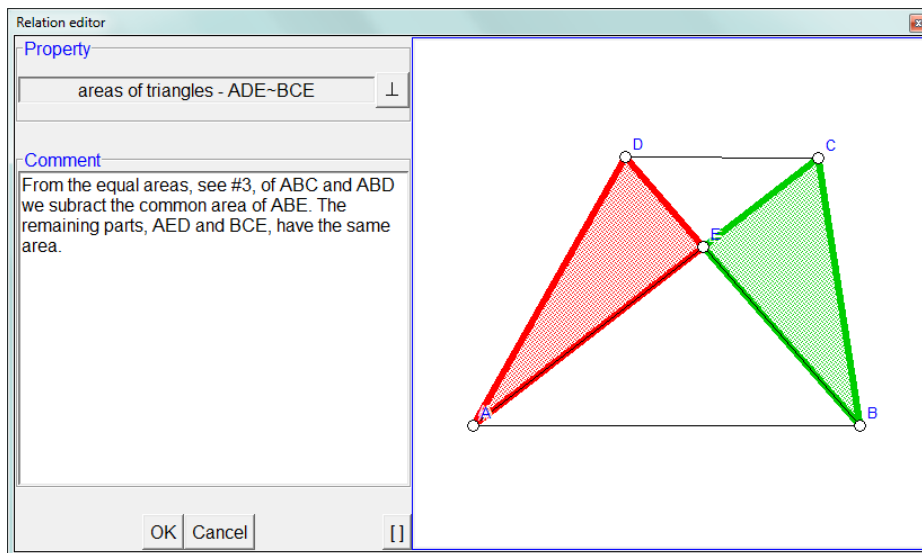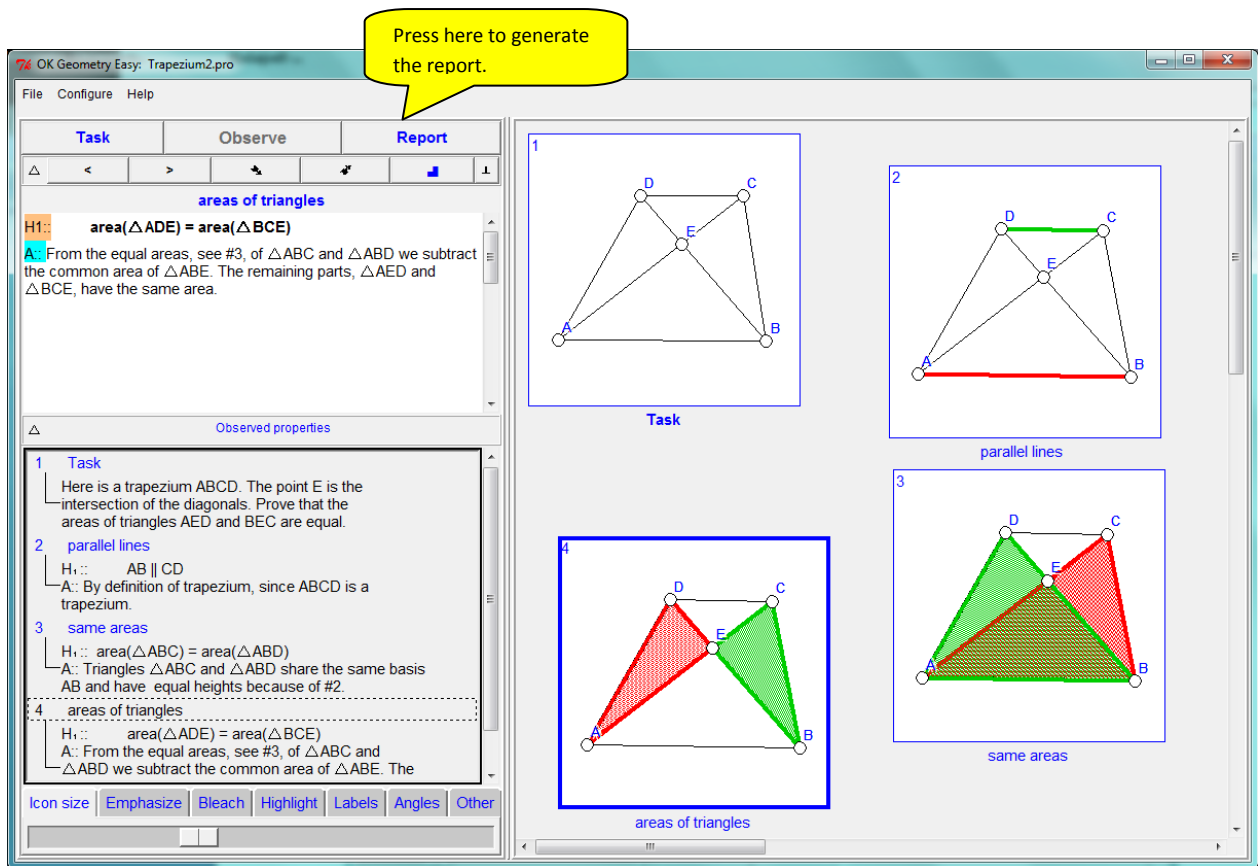

Figure 6

Figure 7

Figure 8

Note:

- OK Geometry Easy **does not** check the correctness of the proof.
- Steps 2-4 can be repeated in any order.
- You can save your work using the *File|Save project* command in the main menu.
- This section describes only the basics of writing up simplified proofs. More details are in the documentation of OK Geometry Basic.

2.6 Making a report of a proof

Note that before producing reports a Postscript interpreter should be installed[1].

OK Geometry can produce various styles of reports (paragraph form with pictures in or above text, two column form, etc.) in various type formats (htm, doc, pdf). We present here how to make a two column proof in HTM format.

To obtain the report press the **Report** button in the main menu bar (Figure 8). First, you will be asked for the name of the file to be generated – in our case choose a file name with htm file ending. In the form that appears afterward specify the desired modalities of the report to be generated – in our case choose Two column with icons structure of the report.
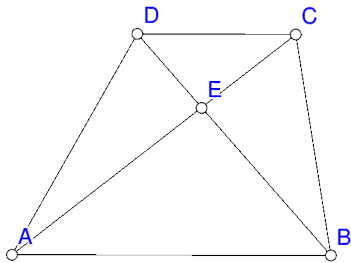
Once the HTML report is generated, you can modify it with a HTML editor or with an appropriate word processor.

Here is how a final report might look like:

Author: Zlatan Magajna (Mon Jul 11 18:10:14 2016)
Source: C:\ Users\ Zlatan\ zm\ Proj\ GeoOkApp\ OkExamples\ Trapezium2.pro
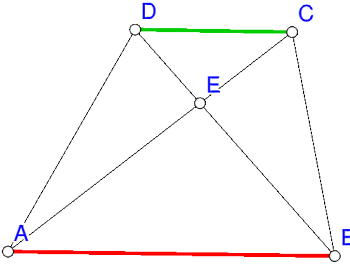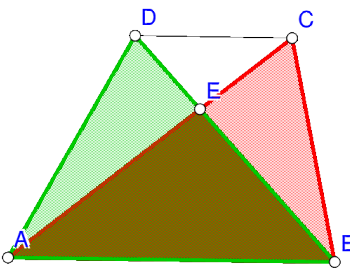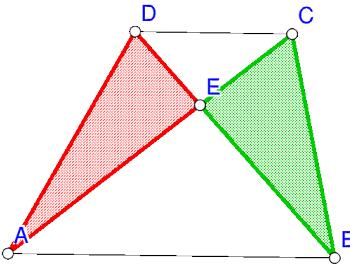
A Trapezium Task

1 Task

Here is a trapezium ABCD. The point E is the intersection of the diagonals. Prove that the areas of triangles AED and BEC are equal.

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[1]A postscript interpreter in needed also for some other operations (e.g. to copy displayed constructions or to include them in reports). The Ghostscript GPL Release, a free postscript interpreter, is available at http://www.ghostscript.com/download/gsdnld.html.

	2 parallel lines	Argument 1
	2 parallel lines **Claim 1** $$AB \parallel CD$$	**Argument 1** By definition of trapezium, since ABCD is a trapezium.
	3 same areas **Claim 1** $\text{area}(\triangle ABC) = \text{area}(\triangle ABD)$	**Argument 1** Triangles $\triangle ABC$ and $\triangle ABD$ share the same basis AB and have equal heights because of #2.
	4 areas of triangles **Claim 1** $\text{area}(\triangle ADE) = \text{area}(\triangle BCE)$	**Argument 1** From the equal areas, see #3, of $\triangle ABC$ and $\triangle ABD$ we subtract the common area of $\triangle ABE$. The remaining parts, $\triangle AED$ and $\triangle BCE$, have the same area.

2.7 Other modes of OK Geometry (Basic and Plus mode)

The Basic mode of OK Geometry offers several additional possibilities for working out and analysing planar geometric constructions. Students who like to study such objects and the teachers that like to explore or produce deductive tasks for their students may benefit from it. In the Basic mode of OK Geometry one can:

- Make new dynamic constructions and edit imported constructions.
- Make advanced and implicit constructions, e.g. construct a circle that is tangent to three given circles or determine a point that satisfies a minimisation criterion.

- Select the properties to be taken into consideration in the analysis of constructions.
- Efficiently search among the detected observed facts.
- Collect the properties to be used for further elaboration (e.g. in a proof).

There is also a Plus mode of OK Geometry. This mode allows observation of very specific properties of planar constructions (e.g. Kimberling centres) and is aimed for the specialists in triangle geometry.