The University of Education Schwäbisch Gmünd
Institute of Mathematics and Informatics
Department of Informatics

Suggested Enrichment Program

Student's Handouts

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2008

Handout 1

The Suggested Enrichment Program Outcomes

Dear student,

The following are the suggested enrichment program outcomes. Please, read them before receiving instruction:

Through the suggested enrichment program you will hopefully be able to use Cinderella to:

Outcome 1   Construct dynamic figures.

Outcome 2   Come up with many construction methods to construct dynamic configurations for a certain figure.

Outcome 3   Come up with many different and varied construction methods to construct dynamic configurations for a certain figure.

Outcome 4   Come up with novel and unusual methods to construct dynamic configurations for a certain figure.

Outcome 5   Produce many relevant responses (ideas, solutions, proofs, conjectures, and new formulated problems) toward a geometric problem or situation.

Outcome 6   Produce many different and varied relevant responses (ideas, solutions, proofs, conjectures, new formulated problems) toward a geometric problem or situation.

Outcome 7   Generate many unusual ("way out"), unique, clever responses or products toward a geometric problem or situation.

Outcome 8   Make new conjectures and relationships by recognizing your experience toward the aspects of the given problem or situation.

Outcome 9   Investigate the made conjectures and relationships in different situations and methods.

Outcome 10   Generate many different and varied proofs toward a geometric problem or situation.

Outcome 11   Generate many follow-up problems by redefining (modifying, adapting, expanding, or altering) a given geometric problem or situation.

Outcome 12   Apply different learning aspects of geometry (concepts, generalizations, and skills) in solving a geometric problem or situation.

Handout 2

Launching and Exploring Cinderella

In this session you will learn how to:

- Launch Cinderella
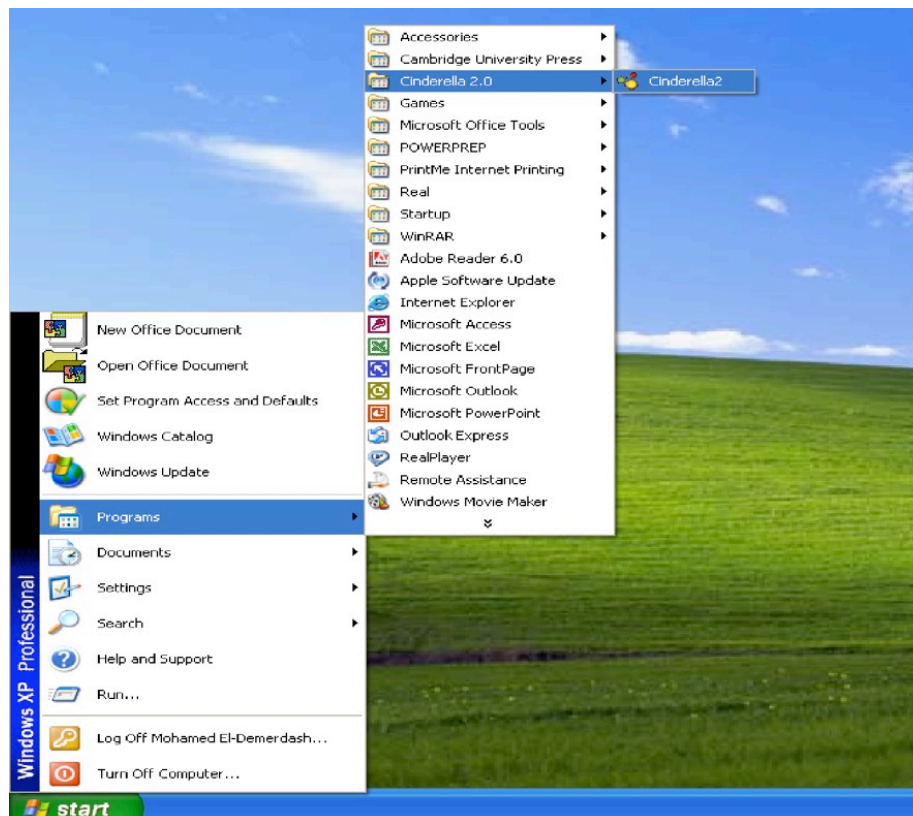- Explore Cinderella window
- Explore Cinderella menus

Student Activity: Launch Cinderella

To start Cinderella, It depends on where Cinderella installing folder is; however you may either:

- Double-click **Cinderella.2 shortcut** on the desktop, If it exists.

- Click **Start** button on the taskbar.
  Click **Programs**.
  Find and click **Cinderella. 2**

- Double-click a file created by Cinderella. Files that are created by Cinderella usually have the extension **".cdy"** and have icons similar to the icon shown below.

After a few moments, Cinderella will launch and be ready to work.

Exploring Cinderella Window

After you launch Cinderella, you will see a window, called **"Unnamed in (Euclidean View)"**. It looks similar to the figure shown below. The main window of Cinderella consists of seven major elements. Here are the main elements of the window in order from the top to the bottom.
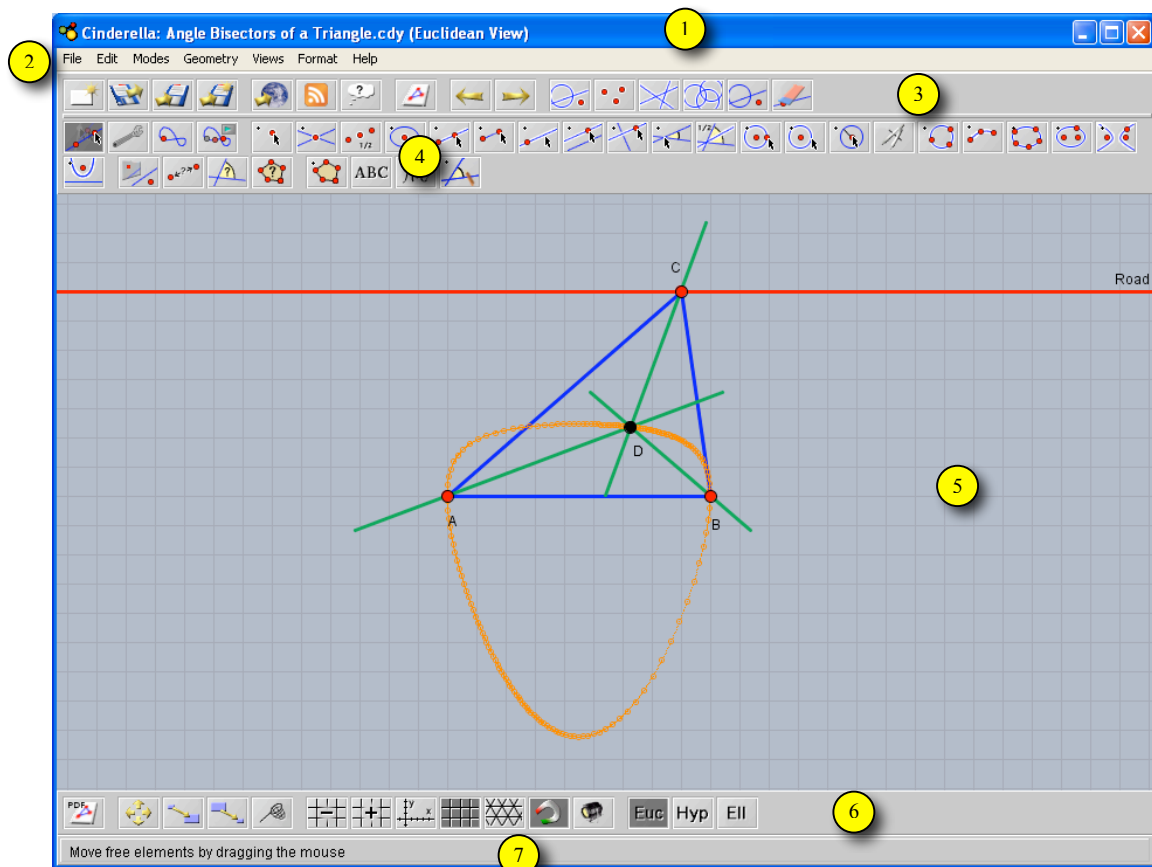

Figure shows a Cinderella window.

1. Title Bar

Here you will find the name of the program – Cinderella – and the current construction file name and its corresponding view as well. If you haven't named the construction file yet, you will see something like **"Unnamed in (Euclidean View)"**.

2. **Menu Bar**

   It contains the menus with the commands that control Cinderella. It comprises of seven menus, which are: **File, Edit, Modes, Geometry, Views, Format,** and **Help**. Click on a menu to pull it down. Select a command by clicking on it.

3. **Standard Toolbar**

   It contains buttons for basic/general commands such as **opening, saving, printing, exporting, undoing, redoing,** and **selecting**.

4. **Geometric Modes Toolbar**

   This toolbar contains tools for *all* geometric construction modes ranging from adding point to generating loci.

5. **Construction Area**

   This is the area where you can create and modify your geometric constructions such as points, straight lines, and circles. Here, you can also make your geometric explorations using Move mode.

6. **Specific-view Actions Toolbar**

   This toolbar contains buttons for **specific-view actions** such as **zooming in** and **out, translating, drawing coordinates axes, drawing rectangular** or **triangular grids,** and **showing hidden elements**.

7. **Message Bar**

   In this bar Cinderella tells you in which mode you are and what actions you should do.

Exploring Cinderella Menus

Cinderella menu bar comprises of 7 pull-down menus, which are: **File, Edit, Modes, Geometry, Views, Format,** and **Help** respectively. It should be mentioned here that *all* functions and facilities of Cinderella could be accessed through the main menus, whereas the toolbars only include the most important tools.

1. File Menu

The **File** menu contains a list of file-related commands, such as **New**, which creates a new Cinderella file, **Open** which opens or loads a Cinderella saved file, **Save** which saves the current Cinderella file, **Close Window** which closes the current Cinderella file, etc. Notice the combination next to some of the commands in the file menu. For instance, if you want to save a Cinderella file use the combination **Ctrl+S** (Control key and S key).

New	Ctrl+N
Open	Ctrl+O
Recent Constructions	▶
Save	Ctrl+S
Save as	Ctrl+Shift+S
Close Window	Ctrl+W
Edit Scripts	Ctrl+9
Open Exercise Editor	Ctrl+8
Export to HTML	Ctrl+E
Export Graphics to	▶
Print	Ctrl+P
Choose Toolbars	
Exit	Ctrl+Q

2. Edit Menu

This menu contains tools for **undoing, redoing,** and **copying** and **pasting** parts of construction. In addition, under this menu you can create **Macro-constructions** using the tool, **Create Tool from Selection**. It also contains several tools for selection that enables you either to **select all, select points, select lines, select conics,** or **deselect all**. Here you also get access to the **inspector,** a tool that can be used to edit the geometric elements within your construction.

|	
Undo	Ctrl+Z
Redo	Ctrl+Y
Copy	Ctrl+C
Paste	Ctrl+V
Create Tool from Selection	Ctrl+Shift+N
Delete Elements	Ctrl+Delete
Select all	Ctrl+A
Select points	Ctrl+Shift+P
Select lines	Ctrl+Shift+L
Select conics	Ctrl+Shift+C
Deselect all	Ctrl+Shift+A
Fetch	
Information	Ctrl+I

3. Modes Menu

The **Modes** menu contains a collection of construction tools for *all* geometric constructions ranging from adding point to generating loci. Most of these tools can be accessed via geometric modes toolbar.

✔ Move	Ctrl+M	
Redefine Point		
Point	▶	
Line	▶	Free Line
Circle	▶	Segment
Conic	▶	by two points Ctrl+L
Graphics	▶	Horizontal Line
Measure	▶	Vertical Line
Polygon	▶	Through Point
Transformation	▶	Parallel
Special	▶	Orthogonal
Simulation	▶	Fixed Angle
API	▶	Angular Bisector
		Polar of Point

4. Geometry Menu

One of the main features of Cinderella is that it supports different kinds of geometries. Here you can choose the kind of geometry you wish to work in (the default is **Euclidean Geometry**, but you can also work in **hyperbolic geometry** or **elliptic geometry**). It should be mentioned here that switching to another kind of geometry does affect the behavior of the geometric elements you will construct.
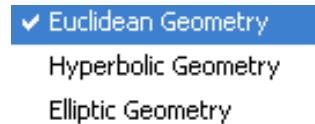
5. Views Menu

This menu enables you to open your constructions in different views (the default is **Euclidean View**, but you can also open your construction in **Hyperbolic View, Spherical View, Polar Euclidean View,** and **Polar Spherical View**). It also enables you to open the **Construction Text** (Cinderella special window that shows a detailed description for each element within your construction) as well as the **Information Window** that shows and reports non-trivial facts about your construction.

6. Format Menu

The **Format** menu enables you to choose the default format in which units and equations should be displayed.
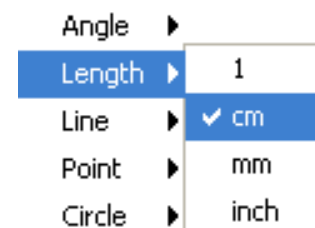
7. Help Menu.

The Help menu contains **Help on mode** that provides help for the current mode, **Cinderella complete Manual**, and references to online help, updates and licensing issues.

Handout 3

Basic Commands and Constructions (Modes) of Cinderella

In this session you will learn about:

- Cinderella basic commands
- Cinderella basic constructions (modes)

Cinderella Basic Commands

Open New Cinderella Window

To get a new construction window in Cinderella, do one of the following:

- From the **File** menu select **New**.
- Press the keyboard shortcut **Ctrl+N**.
- Click on the new button [ ] on the standard toolbar.

The New command opens a new, blank Cinderella window in Euclidean View for creating and modifying geometric constructions. In this new window, everything is reset to the default state.

Open/Load Cinderella Saved File

To open/load a Cinderella saved file, do one of the following:

- From **File** menu select **Open**.
- Press the keyboard shortcut **Ctrl+O**.
- Click on **Open** button [ ] on the standard toolbar.
- Double-click the Cinderella file icon; it could be similar to this icon [ ].

The open command opens a dialog box for opening an existing Cinderella file.

Save Construction

To save the current construction, do one of the following:

- From **File** menu, select **Save**.
- Press the keyboard shortcut **Ctrl+S**.
- Click on **Save** button [ ] on the standard toolbar.

The save command opens a dialog box that allow you to save the current Cinderella construction to a name that you specify.

Save Construction with New Name

To save the current construction with a new name, do one of the following:

- From **File** menu select **Save as**.
- Press the keyboard shortcut **Ctrl+Shift+S**.
- Click on **Save as** button on the standard toolbar.

The save as command opens a dialog box that allows you to save the current Cinderella construction to another name that you specify.

Create an Interactive Web Page

To create an interactive web page of the current construction, do one of the following:

- From **File** menu select **Export to HTML**.
- Press the keyboard shortcut **Ctrl+E.**
- Click on **Create an Interactive Web Page** button on the standard toolbar.

This action will open a dialog box that allows you to save the current Cinderella file as a web page.

Two **warnings** should be taken into consideration, while you are creating interactive web pages:

(1) The construction data has to be saved as Cinderella file with the extension **"cdy"** before you export it to HTML.

(2) The construction data has to be saved into the same directory your webpage will be resided in.

Undo

Undo command enables you to take one or more actions backward. You can undo as many backward actions as you want; however each click on the undo button takes you one action backward. The undoable actions are:

- Construction steps
- Movements
- Appearance changes
- Zooming, translating, and rotating views

- Deletion of elements

Redo

Redo command enables you to take one or more actions forward. Here you can also redo as many forward actions as you want.

Delete

Delete command is used to delete currently selected elements and other elements that depend on them.

Selection Commands

Under the Edit menu, there are several tools for selection that enable you either to select all elements, all points, all lines, or all conics and circles. *All* of these tools are also accessible via corresponding buttons on the standard toolbar.

Select All Elements

It is used to select all geometric elements in the construction.

Select All Points

It is used to select all points in the construction.

Select All Lines

It is used to select all lines in the construction.

Select All Conics

It is used to select all conics and circle in the construction.

Deselect Everything

It is used to clear the current selection in the construction.

Cinderella Basic Constructions (Modes)

Move Mode

The move mode is one of the most important tools that provide Cinderella with the dynamic behavior – the ability to move free elements and the whole constructions moves accordingly without destroying the configuration which is a very beneficial characteristic in exploring geometric relationships.

Generally, move mode has twofold functions that enable you to select and move elements around the construction area.
There are two types of points: **free/movable points** and **fixed points**.

Free points: these are not dependent on the elements of the construction and can be moved around the construction area freely and the rest of the construction moves/changes accordingly.

Fixed points: are points that are dependent on the position of other free elements of the construction and cannot be moved.

In the construction area, you can visually distinguish between the free and fixed points by their appearance: fixed points appear darker.

Moving Points

To move a free/movable point, move the mouse pointer over the point you want to move. Press the left mouse button. Hold it pressed and drag the mouse. The point follows the mouse pointer.

Selecting Elements

The move mode can also be used to select one or more geometric elements in the construction area. To select an element, just click over the element you want to select. By holding the shift key you can select several elements at the same time.

You can easily recognize the selected elements, since they are highlighted in all views. You may select elements for the following reasons:

- To individualize the appearance of geometric elements using the inspector which is available under the item menu **"Edit/Information".**

- To delete the selected elements using **"Delete"** action.

- To simultaneously move the selected elements.

Add a Point

Add a point mode construct a single new point by using a single press-drag-release sequence mouse input. Constructing a point can be described as follows:

- **Pressing** the left mouse button generates the point.

- **Dragging** the mouse while the left mouse button is pressed changes the position and definition of the point.

- **Releasing** the mouse button fixes the definition of the point.

The definition of the point depends on the position on which the mouse was released. In other words, if at the moment of release the mouse is …

- ➤ … over no element at all, then a free point is added and can be freely moved in "Move Mode".

- ➤ … over an existing element (line, circle, conic), then a semi free point is added on the existing element and can be moved along the existing element in "Move Mode".

- ➤ … over the intersection of two elements (line, circle, conic) ,then the intersection of these elements is added as a fixed point that can not be moved in "Move Mode".

- ➤ … over an existing point, then no point will be added.

Add a Line

Add a line constructs two points and a straight line joining them by using a single press-drag-release sequence mouse input. Constructing two points and a line joining them can be described as follows:

- **Pressing** the left mouse button generates the first point. The definition of this point depends on the position of the mouse when the button is pressed as explained earlier in **"Add a Point"**.

- **Dragging** the mouse while the left mouse button is pressed generates the line and the second point. The definition of the second also depends on the position of the mouse.

- **Releasing** the mouse button freezes the second point and ends up with the straight line that joins the two points.

Line through Point

Line through point mode constructs a line through a point with a certain slope so that when the point is moved, the slope of the line remains constant. However, in move mode it is also possible to select the line and change its slope. Constructing line through point can be described as follows:

- **Pressing** the left mouse button generates the point.

- **Dragging** the mouse while the left mouse button is pressed generates the line.

- **Releasing** the mouse button freezes and finishes the construction.

Add a Parallel

Add a parallel mode constructs a line through a point parallel to another line by using a single press-drag-release sequence mouse input. Constructing the parallel can be described as follows:

- **Move** the mouse pointer over the line you want to construct a parallel to it. Then **press** the left mouse button. This action generates the parallel line and a point, which the parallel line passes through it.

- **Drag** the mouse while the left mouse button is pressed. This action moves the parallel line and the generated point to the desired position.

- **Release** the mouse button. This action freezes the definition of the parallel line and the new point, and finishes the construction.

Add a Perpendicular

Add a perpendicular constructs a line through a point perpendicular to another line by a single press-drag-release sequence using the mouse. Constructing the perpendicular can be described as follows:

- **Move** the mouse pointer over the line you want to construct a perpendicular to it. Then **press** the left mouse button. This action generates the perpendicular line and a point, which the perpendicular line passes through it.

- **Drag** the mouse while the left mouse button is pressed. This action moves the perpendicular line and the generated point to the desired position.

- **Release** the mouse button. This action freezes the definition of the perpendicular line and the new point, and finishes the construction.

Add a Circle ![icon]

Add a circle mode constructs a circle given by its center and a point on its circumference by using a single press-drag-release sequence mouse input. Constructing a circle in this mode can be described as follows:

- **Pressing** the left mouse button generates the center of the circle.

- **Dragging** the mouse while the left mouse button is pressed generates the circle and the circumference point.

- **Releasing** the mouse button freezes the definition of the circumference point and finishes the construction.

Midpoint ![icon]

Midpoint mode constructs two points and the point that is the midway between them using a single press-drag-release sequence with the mouse. Constructing the midpoint can be described as follows:

- **Pressing** the left mouse button generates the first point.

- **Dragging** the mouse generates the second point and the midpoint as well.

- **Releasing** the mouse freezes the definition and finishes the construction.

Segment ![icon]

Segment mode constructs two points and a line segment joining them by using a single press-drag-release sequence mouse input. Constructing two points and a line segment joining them can be described as follows:

- **Pressing** the left mouse button generates the first point.

- **Dragging** the mouse while the left mouse button is pressed generates the second point and the line segment joining the two points. The definition of the second also depends on the position of the mouse.

- **Releasing** the mouse freezes the second point and ends up with the line segment line that joins the two points.

Student Activity:

Use Cinderella to come up with dynamic configurations for each of the following figures:

- Triangle
- Equilateral triangle
- Isosceles triangle
- Right-angled triangle

- Quadrilateral
- Trapezium
- Parallelogram
- Rectangle
- Rhombus
- Square

- Circle
- Tangent to a Circle

Handout 4

Dragging and Measuring Facilities of Cinderella

Cinderella has a wide range of facilities; among these facilities are the dragging and measuring facilities. In this activity, you will experience the dragging and measuring facilities of Cinderella to make and investigate new geometric conjectures.

Student Activity:

1. Launch Cinderella or open new Cinderella file.

2. Use Cinderella to construct any triangle. (Use **"Add Point"** tool [icon] to construct three points A, B, and C as three vertices of the triangle, then switch to **"Draw a Segment"** tool [icon] to join up the three points using a press-drag-release sequence with the mouse to end up with triangle ABC)

3. Construct the midpoints of the sides of the triangle. (Use **"Midpoint"** tool [icon] with the mouse press-drag-release sequences to bisect the three sides $\overline{AB}$, $\overline{BC}$, and $\overline{AC}$ at D, E, and F respectively)

4. Join the midpoints of the sides to get the four triangles: △ADF, △DBE, △EDF, and △CEF. (Use **"Draw a Segment"** tool [icon] to join the midpoints D, E, and F). Your construction should look like the figure shown below before you continue.
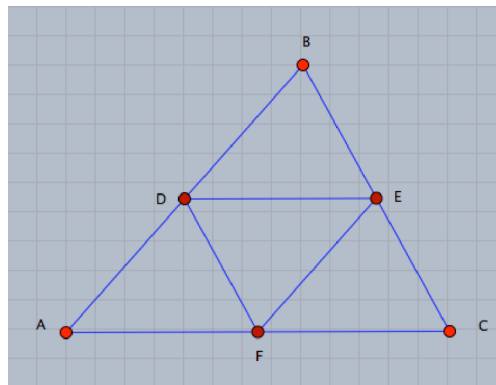
5. Switch to **"Move"** mode by pressing the button [icon] in the toolbar. Use Cinderella's dragging facility to drag free points (A, B, or C), visually observe the four triangles and try to make a conjecture about the area of the four triangles. In other words, what can you say about the area of the four triangles?

6. Using measuring facilities of Cinderella, the area of each triangle can be measured. For doing so, switch to the **"Define a Polygon"** mode by pressing the button in the toolbar, define the four triangles as polygons: Poly0, Poly1, Poly2, and Poly3, then switch to the **"Measure Area of a Polygon"** mode by pressing the button in the toolbar and just click inside each triangle (polygon) to get its area.

7. Use dragging to alter the triangle △ ABC and visually observe the area of the four triangles. What can you conclude about the area of the four triangles obtained by joining the midpoints of the sides of a triangle? Write down your conjecture in the form of mathematical theorems.

8. Produce a mathematical proof for the investigated conjecture.

9. Pose follow-up problems related to this geometric situation.

Handout 5

Automatic Proving Facilities of Cinderella

Cinderella has built-in automatic proving facilities that could be used to immediately check the correctness of your geometric conjectures. In this activity, you will see how to use these facilities to check the collinearity of the three points.

Student Activity:

1. Launch Cinderella or open new Cinderella window.

2. Switch to **"Circle by Radius"** mode using **"Modes"** menu or by pressing the button ⬤ in the toolbar.

3. Move the mouse pointer over the construction area. Use a press-drag-release sequence with the mouse to add a circle with centre A.
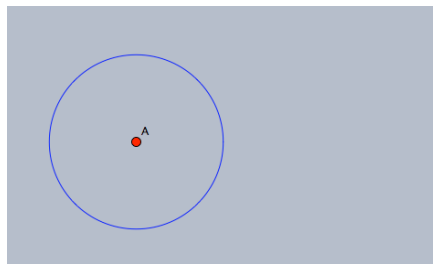

4. Add a second circle using the same mode such that the two circles intersect.
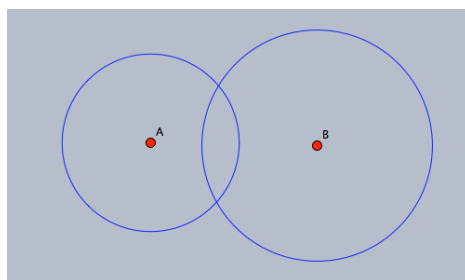
5. Generate the intersection points between the two circles, for doing so, switch to **"Intersection"** mode by pressing the button ⬤ in the toolbar, then select the two circles one at a time to generate their intersection points C and D. Your construction should look like the following figure before you continue.
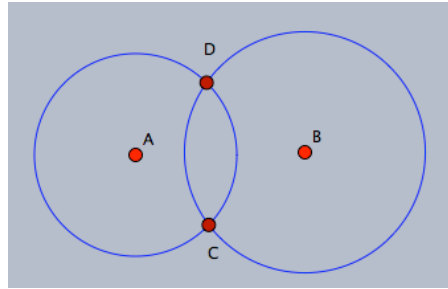
6. Switch to **"line by two points"** mode by choosing the menu item **"Modes/line/by two points"**, by pressing the keyboard shortcut **"Ctrl+L"**, or by pressing the button in the toolbar. Use a press-drag-release sequence with the mouse to add a line connecting the two points A and D.

7. Add another line connecting the two points D and B.

8. Switch to **"Intersection"** mode by pressing the button in the toolbar. Select Circle A and Line a to get the intersection point E.

9. Using the same mode, select Circle B and Line b to get the intersection point F.

10. Open **"Cinderella's inspector"** by choosing the menu item **"Edit/Information"**.

11. Select all lines by pressing the button .

12. Clip the two lines by choosing the clipping button on the inspector. After clipping the two lines to their endpoints your construction should look like the following figure.
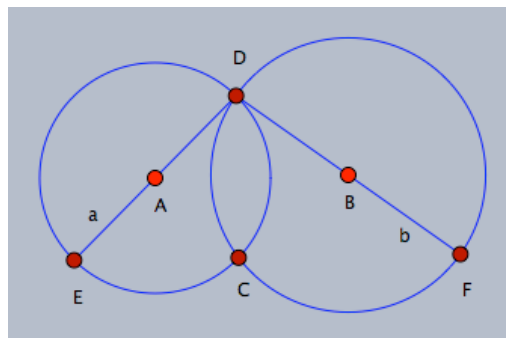
13. Use Cinderella's dragging facility to drag free elements in your construction and visually observe the behavior of the three points F, C, and E? What can you say about the three points F, C, and E in terms of collinearity? i.e. Are they collinear? Anyway make a conjecture about the collinearity of the three points and Cinderella will check it for you.

14. To check the correctness of the made conjecture about the collinearity of the three points, open Cinderella's information window by choosing the menu item **"View/Information Window"** or pressing the keyboard shortcut **"Ctrl+5"**. A console window pops up in which an automatic report about the configuration will appear. Now, switch to the **"Line, by two points"** mode by pressing the button to construct the line that connects the two points F and E, and then move the mouse pointer toward the point F press the left mouse button, hold it then drag the mouse over point E then release the mouse button. Notice the message that is given in the Cinderella Console Window, which indicates that point C lies on the connecting line of F and E.

15. Produce as many mathematical proofs as possible to prove the investigated conjecture.

16. Use different facilities of Cinderella to make up as many new conjectures as possible by elaborating – extending, modifying, or adapting – the conditions of the given situation.

Handout 6

Developing Macro-constructions

Cinderella has the ability to capsulate a sequence of construction commands into a new command/tool, which is called Macro-constructions. In this activity, you will experience how to use Macro-construction facilities to develop some geometric tools such as: perpendicular bisector and circum-center point of a triangle.

Student Activity: Developing a macro tool for perpendicular bisector.

1. Launch Cinderella or open new Cinderella window.

2. Switch to **"Circle by Two Points"** mode using **"Modes"** menu or by pressing the button in the toolbar. This mode allows you to construct a circle with two points one at the center and the other at the circumference of the circle.

3. Use a press-drag-release sequence with the mouse twice to construct two points A and B and two circles that use A and B as centers and B and A as point on the circle.
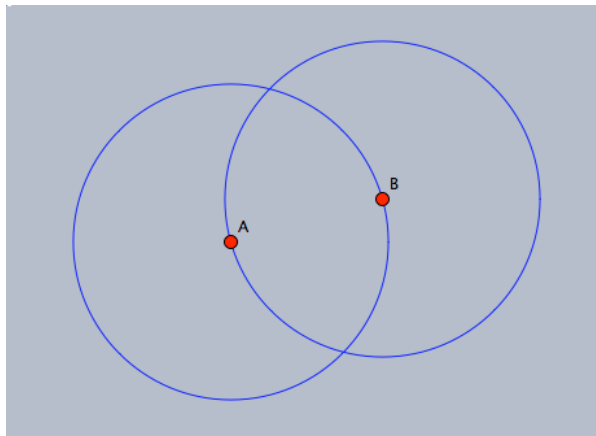

4. Generate the intersection points between the two circles at C and D, using the "Intersection" mode . Then, switch to "Add a Line" mode to construct to the perpendicular bisector of A and B.
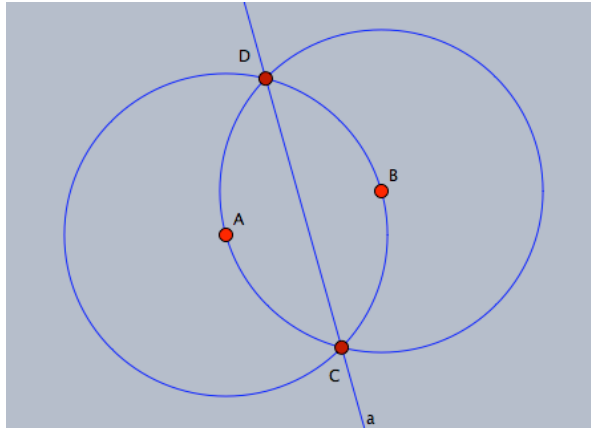
5. To define a macro you have to select the initial elements – here the two points A and B – and the final elements – here the line a. So, Switch to "Move" mode, and then use Shift key to select the two points A and B and the connecting line a.
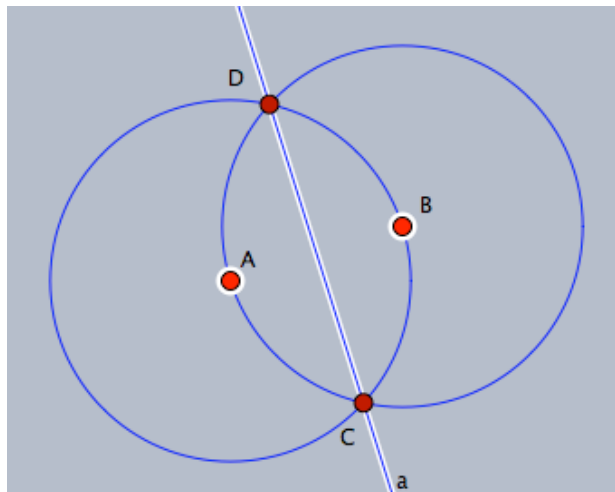

6. Now, the three selected elements, the two points A, B and the line a, which represent the initial and final elements, can be used to create a macro tool for the perpendicular bisector. For doing so, choose menu item **"Edit/Create Tool from Selection"** or press the keyboard shortcut **"Ctrl+Shift+N"**. A new window of two fields pops up that requires a name and a description for the new tool. Enter the name and the description for the new tool – Perpendicular Bisector and Create the Perpendicular Bisector are suggested to be a name and description for the new tool – then, click OK button to confirm the creation of the tool. The icon is created automatically and will be available in the toolbar.
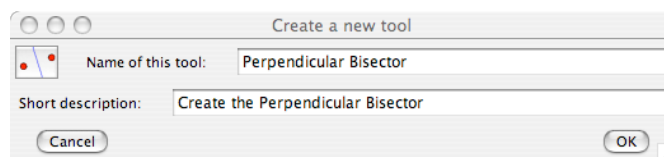
Student Activity: Developing a macro tool for circum-center point of a triangle.

In this activity, you will be guided to use the perpendicular bisector tool to construct the circum-center point of a triangle and develop a new macro tool for the circum-center point of a triangle as well.

1. In the last Cinderella window that contains the developed perpendicular bisector tool. Clean the construction area by selecting all elements using the item menu **"Edit/Select all"** or by clicking the button ⬭ or by pressing the keyboard shortcut **Ctrl+A**. Then, delete elements using the menu item **"Edit/Delete Elements"** or by clicking the button ✎ or pressing the keyboard shortcut **Ctrl+Delete**.

2. Construct a triangle ABC.

3. To construct the perpendicular bisectors for the triangle sides, click the developed perpendicular bisector tool button ⬭ three consecutive times this action will instantly paste the points A' and B'; A" and B"; A3 and B3 and the perpendicular bisector lines a', a" and a3.
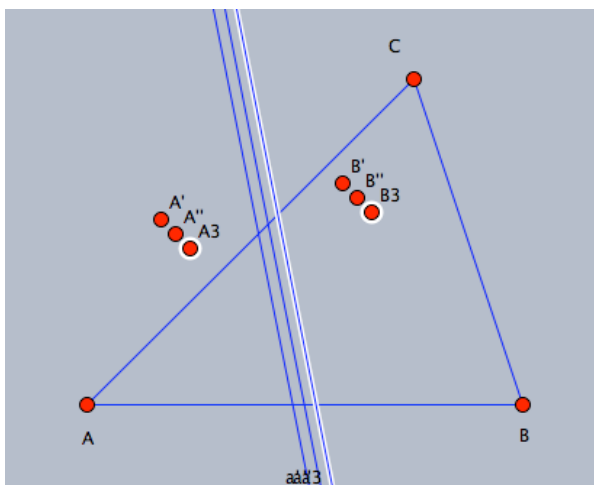
4. Switch to **"Redefine Point"** by using the menu item **" Modes/Redefine Point"** or by clicking the button 🔧 in the toolbar mode and then move A' to A, B to B', A" to B, B" to C, A3 to A, and B3 to C. That will end up with a configuration of a triangle and its side perpendicular bisectors.

5. Generate the intersection point of the perpendicular bisectors at D[1] to get the circum-center point of triangle ABC.

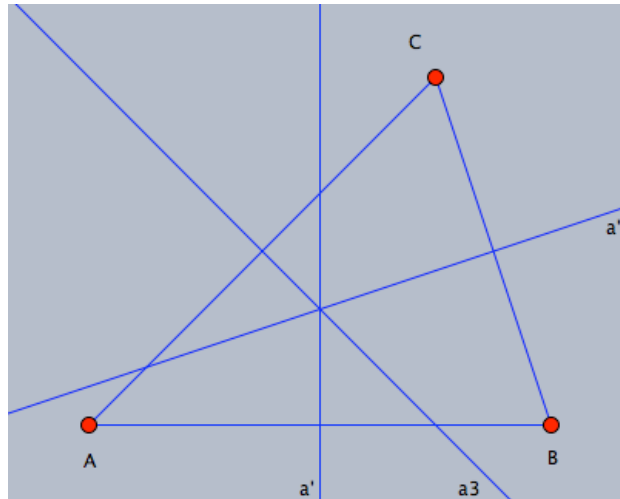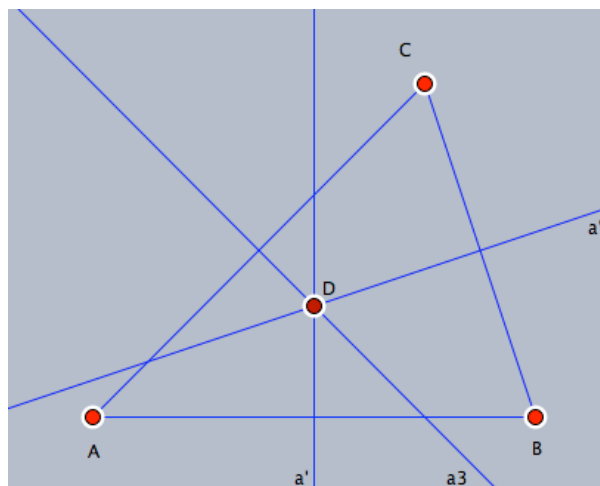6. Switch to "Move" mode, and use Shift key to select the points A, B, C as initial elements and D as final element for the macro.

7. After you select the initial and final elements of the macro, use **"Create Tool from Selection"** command from edit menu to develop a new macro tool for the circum-center point of a triangle, and give it a name and a description. A new icon for the circum-center point of a triangle will be created in the toolbar.

---

[1] Remark: The perpendicular bisectors of the sides of a triangle are concurrent. The automatic proving facilities of Cinderella can be used to show that, while you are generating the intersection point D.

Assignment project:

Use Cinderella to develop a macro tool for each of the following:

- In-center point of a triangle

- Orthocenter point of a triangle

- Center of mass or centroid point of a triangle

- Euler line of a triangle

Handout 7

Animating and Tracing Loci Facilities of Cinderella

In this activity, you will experience the use of animating and tracing loci facilities of Cinderella to discover and generate geometric loci.

Student Activity:

1. Construct a triangle ABC in a way that it is possible to move the point C along a straight line L, which is parallel to the base $\overline{AB}$.

2. Construct the three heights of the triangle ABC and generate their intersection point at D[2]. Your construction should look like the following figure.
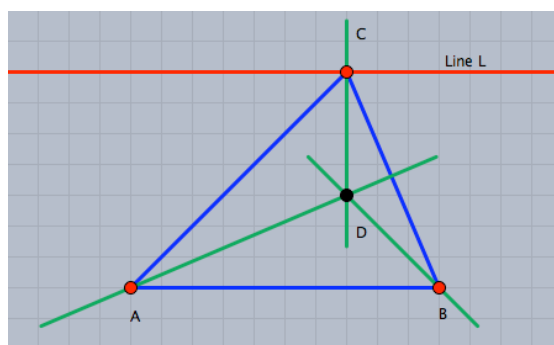
3. Move the point C along the straight line L, which is parallel to $\overline{AB}$, and observe the point D (the heights intersection point). Can you expect the locus of the point D, while the point C moves along the straight line L? In other words, which curve does the point D trace, while the point C moves along the straight line L? Make a conjecture?

4. The locus of the point D can be automatically generated using tracing a locus facility of Cinderella. For doing so, switch to **"Create a Locus"** mode by choosing the menu item **"Modes/special/loci"** or by clicking the button in the toolbar. Afterwards, to generate the locus, three objects should be defined: the moving element, which is the point C; the road, which is the straight line L; and the tracer, which is the point D (the heights' intersection point). So choose the point C, then the straight line L and finally choose the point D. Within a second the locus will be automatically generated. After the locus is generated your construction should look like the figure shown below.

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[2] Remark: The heights of a triangle are concurrent. The automatic proving facilities of Cinderella can be used to show that, while you are generating the intersection point D.
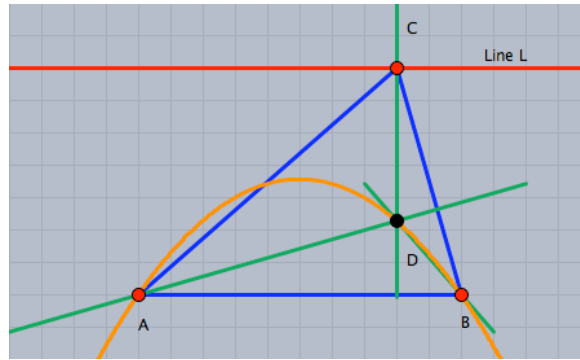
5. Switch to **"Move"** mode and experience the locus when you move the point C along the line L.

6. Moreover, Cinderella has powerful animation facilities that can automatically move the point C along the line for you, and you do not have to move the point by your self. To generate an animation for the point C along the straight line L, switch to **"Animation"** mode by choosing the menu item **"Modes/Special/Animate"** or by clicking the button in the toolbar. Then, two elements should be defined: the moving element, which is the point C and the road, which is the straight line L. So select the point C then the straight line L. After you have defined the animation an animation control panel with three buttons and a speed slide pops up in the lower left corner of the window.

7. Use the animation buttons with the speed slide to experience the locus of the point D when the point C is automatically moved along the straight line L.

8. Use Cinderella to elaborate the given situation by altering its conditions to discover and generate other geometric loci related to triangle.

   For example: the situation can be elaborated to discover and generate the locus of the medians intersection point of a triangle when a triangle vertex moves along a straight line. In this case, as shown in the figure below, the locus of the medians intersection point is a straight line, which is parallel to the road straight line.
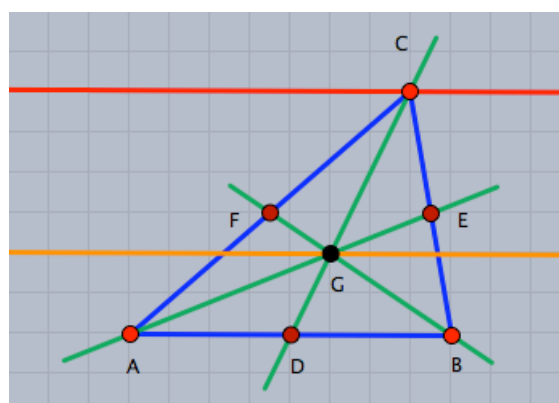
Handout 8

Midpoints of the Sides of a Quadrilateral

Student Activity:

Use Cinderella to construct any quadrilateral. Construct the midpoints of each side. Connect the midpoints of the adjacent sides.

Make a conjecture about the obtained figure. i.e. what is the figure formed by joining the midpoints of the adjacent sides of a quadrilateral?

Use Cinderella objects and tools to investigate the conjecture.

State your conjecture in the form of mathematical theorems.

Can you figure out a mathematical proof for this conjecture?

Can you pose some follow-up problems related to the original problem?

Handout 9

Angular Bisectors of a Parallelogram

Student Activity:

Use Cinderella to construct a parallelogram. Construct the angular bisectors of the interior angles of the parallelogram. Generate the four intersection points of the angular bisectors.

Make a conjecture about the obtained figure. i.e. What is the figure formed by joining the four intersection points the angular bisectors of the interior angles of parallelogram?

Use Cinderella objects and tools to investigate the conjecture.

State your conjecture in the form of mathematical theorems.

Can you figure out a mathematical proof for this conjecture?

Can you pose some follow-up problems related to the original problem?

Handout 10

Constructing a Parallelogram

Student Activity:

1. Write down as many generalizations (theorems, definitions, properties, and corollaries) as you can that are related to the parallelogram.

   For example: A parallelogram is a quadrilateral, in which each two opposite sides are parallel.

   (We shall want you to discuss your responses with the rest of the group, so please write them on OHP transparency).

2. Think about which of these generalizations can be used to construct a parallelogram using Cinderella. Come up with as many different and various methods as you can to construct a parallelogram using Cinderella. In each construction method, you should:

- List the construction algorithm.

- Explain the theoretical background of the construction algorithm.

- Justify the construction algorithm order.

3. How can the different methods of construction be classified?

   Classification criteria:

Handout 11

Constructing a Rhombus

Student Activity:

1. Write down as many generalizations (theorems, definitions, properties, and corollaries) as you can that are related to the rhombus.

    For example: A rhombus is a parallelogram, in which two adjacent sides are equal in length.

    (We shall want you to discuss your responses with the rest of the group, so please write them on OHP transparency).

2. Think about which of these generalizations can be used to construct a rhombus using Cinderella. Come up with as many different and various methods as you can to construct a rhombus using Cinderella. In each construction method, you should:

- List the construction algorithm.

- Explain the theoretical background of the construction algorithm.

- Justify the construction algorithm order.

3. How can the different methods of construction be classified?

Classification criteria:

Handout 12

Constructing a Rectangle

Student Activity:

1. Write down as many generalizations (theorems, definitions, properties, and corollaries) as you can that are related to the rectangle.

   For example: A rectangle is a parallelogram with a right angle.

   (We shall want you to discuss your responses with the rest of the group, so please write them on OHP transparency).

2. Think about which of these generalizations can be used to construct a rectangle using Cinderella. Come up with as many different and various methods as you can to construct a rectangle using Cinderella. In each construction method, you should:

- List the construction algorithm.

- Explain the theoretical background of the construction algorithm.

- Justify the construction algorithm order.

3. How can the different methods of construction be classified?

Classification criteria:

Handout 13

Constructing a Square

Student Activity:

1. Write down as many generalizations (theorems, definitions, properties, and corollaries) as you can that are related to the square.

    For example: A square is a parallelogram with a right angle and two adjacent sides equal in length.

    (We shall want you to discuss your responses with the rest of the group, so please write them on OHP transparency).

2. Think about which of these generalizations can be used to construct a square using Cinderella. Come up with as many different and various methods as you can to construct a square using Cinderella. In each construction method, you should:

- List the construction algorithm.

- Explain the theoretical background of the construction algorithm.

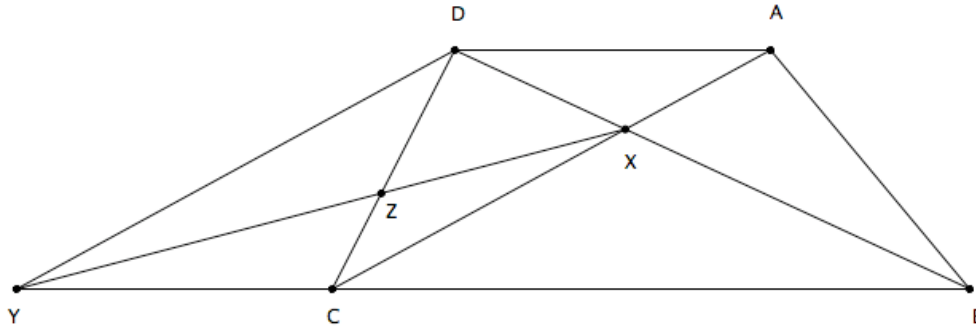- Justify the construction algorithm order.

3. How can the different methods of construction be classified?

Classification criteria:

Handout 14

Posing Geometric Problems

Student Activity:

In the figure above, ABCD is a trapezium whose parallel sides are $\overline{AD}$ and $\overline{BC}$. X is the point where the diagonals intersect. $\overrightarrow{DY}$ is drawn as $\overrightarrow{DY} \parallel \overrightarrow{AC}$ and cuts $\overline{BC}$ at Y.

Use different facilities of Cinderella – constructing, dragging, measuring, and calculating facilities – to **pose** as many various and different **geometric problems** as possible, which could be answered either in direct or indirect ways based on the given information.

Handout 15

Finding Geometric Relationships

Student Activity:

In the opposite figure, AF = BE, $\overline{FH}$ ∥ $\overline{EG}$ ∥ $\overline{BC}$, and $\overline{GD}$ ∥ $\overline{AB}$.

Use different facilities of Cinderella – constructing, dragging, measuring, and calculating facilities – to **find** as many various and different **geometric relationships** as possible, which could be deduced in direct or indirect ways based on the given information.