GeometryEditor Crash Course

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GeometryEditor

- Previously called *GeoSVG*
- A Dynamic Geometry System to explore mathematical concepts
- A Web-based system
  - No software installation required
- (for developers) A package for building more sophisticated Web applications that need mathematical drawing support
  - GeoSite, BBS, DMAD and so on...

Working Environment

- Purely based on HTML, SVG, and javascript
- Full Features (menu, toolbar, the graphical area, and interaction between SVG and HTML) work
  - on Firefox on all platforms
  - on Windows IE with ASV
  - on Opera (partially tested)
- Only graphical area works
  - on Mac Safari with ASV
  - on Netscape on all platforms with ASV

What a manipulative looks like

- Menu & Toolbar
  - An author needs to customize what menu items and toolbar buttons to be available to users
- Graphical area (canvas)
  - An author can add objects to the canvas
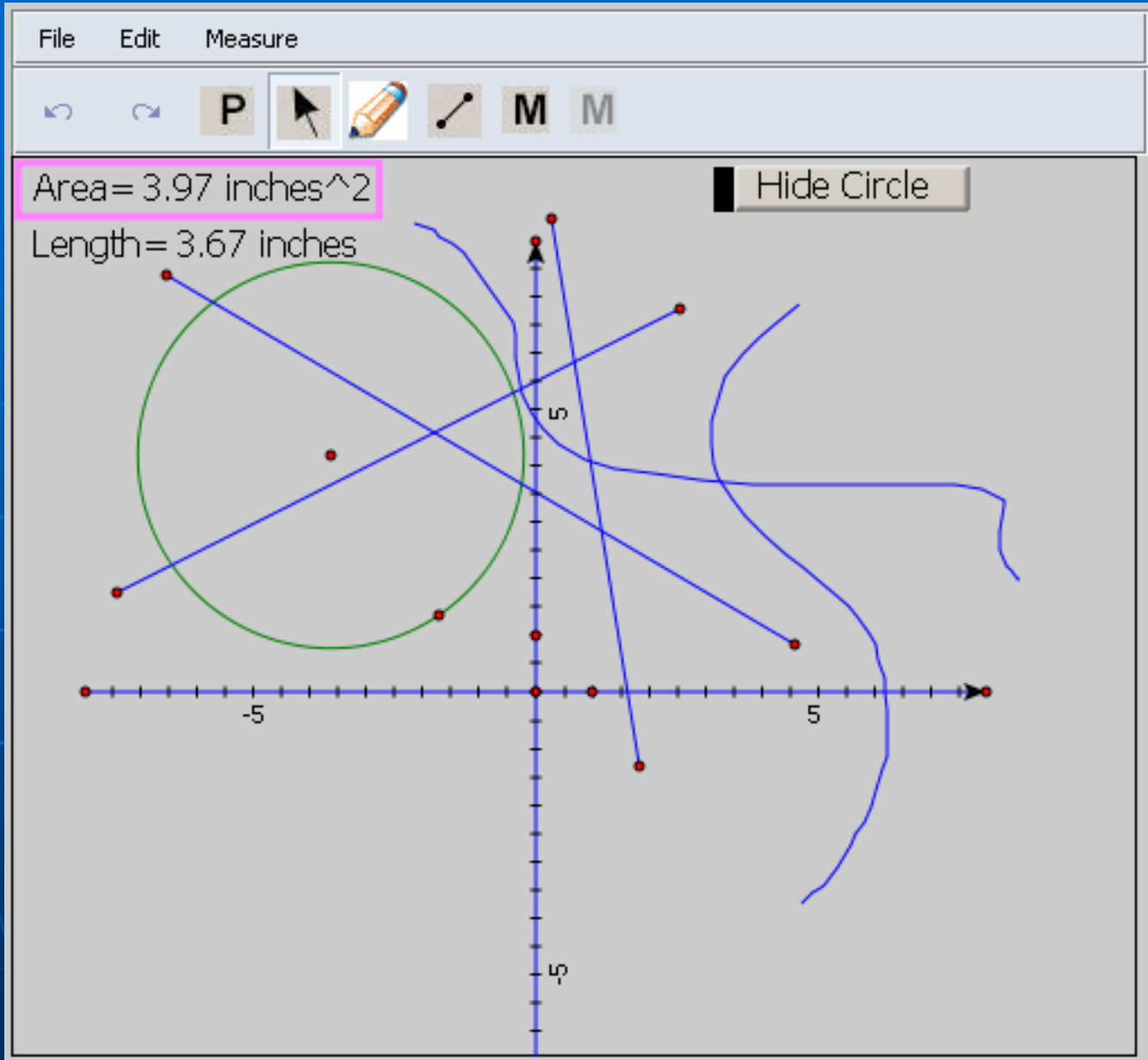
What a manipulative looks like

Objects you can author

- Implemented
  - Point
  - Line/ray/segment
  - Circle
  - Polygon
  - Scratch
  - Coordinate System
  - Function graph
  - Locus
  - Plain text
  - User input
  - Button
  - Measurement
- To be implemented
  - Vector, regular polygon, arc and conics
  - Slide bar

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

Length Segment k1 = 2.59 inches

$f1(x) = x*x - 6*x + 9$

k1

Plain Text

Hide Objects

5

5

Objects you can author

Menu Introduction:
Draw Menu

- Once a drawing tool in the Draw menu is selected, you can create objects by clicking and moving the mouse
  - Select or move object(s)
  - Pencil
  - Free Point
  - Line/Ray/Segment
  - Compass Circle
  - Macro
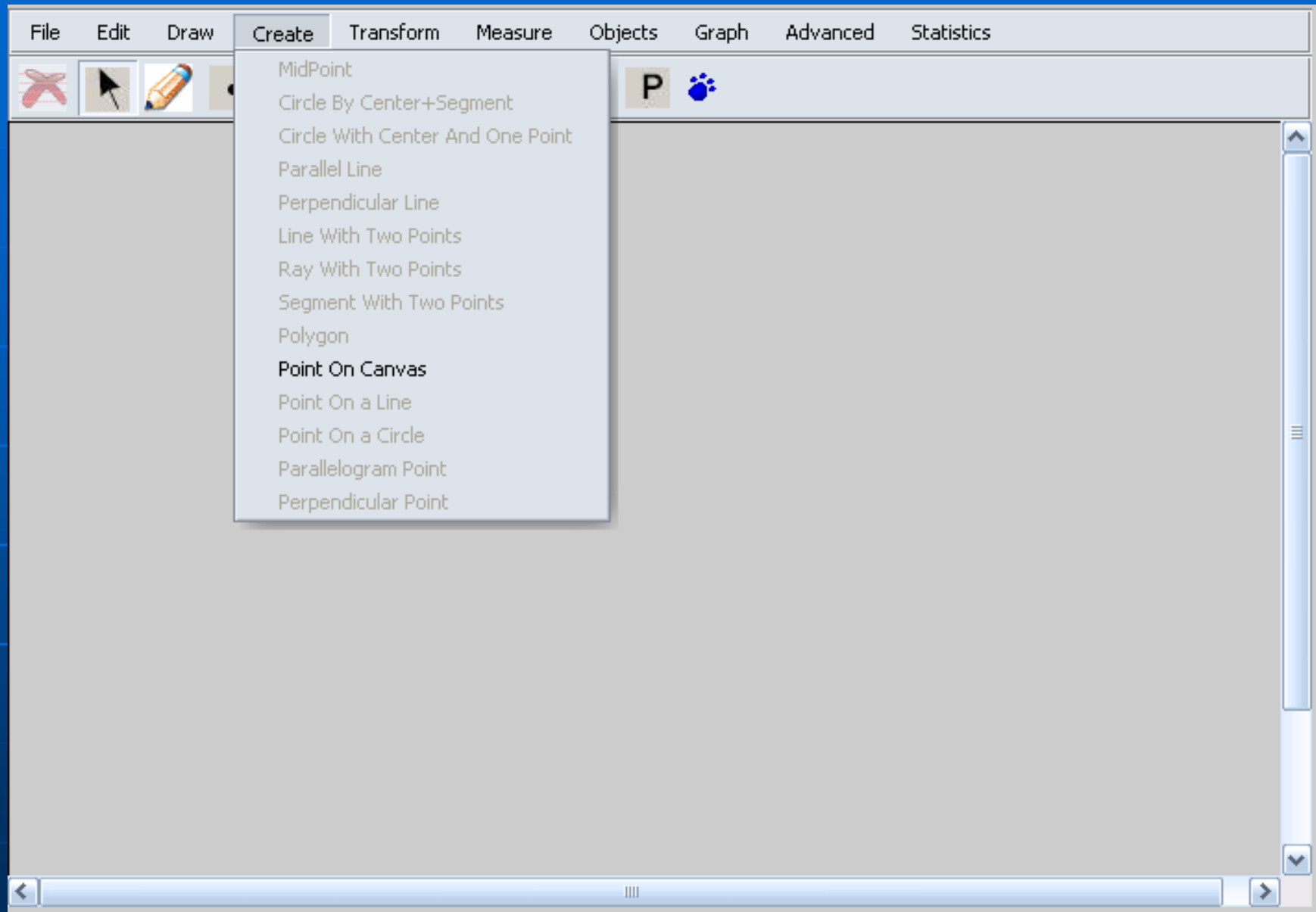
File	Edit	Draw	Create	Transform	Measure	Objects	Graph	Advanced	Statistics

Select or Move object(s)
Pencil
Free Point
Line
Ray
Segment
Compass Circle
Macro ▶
New Macro
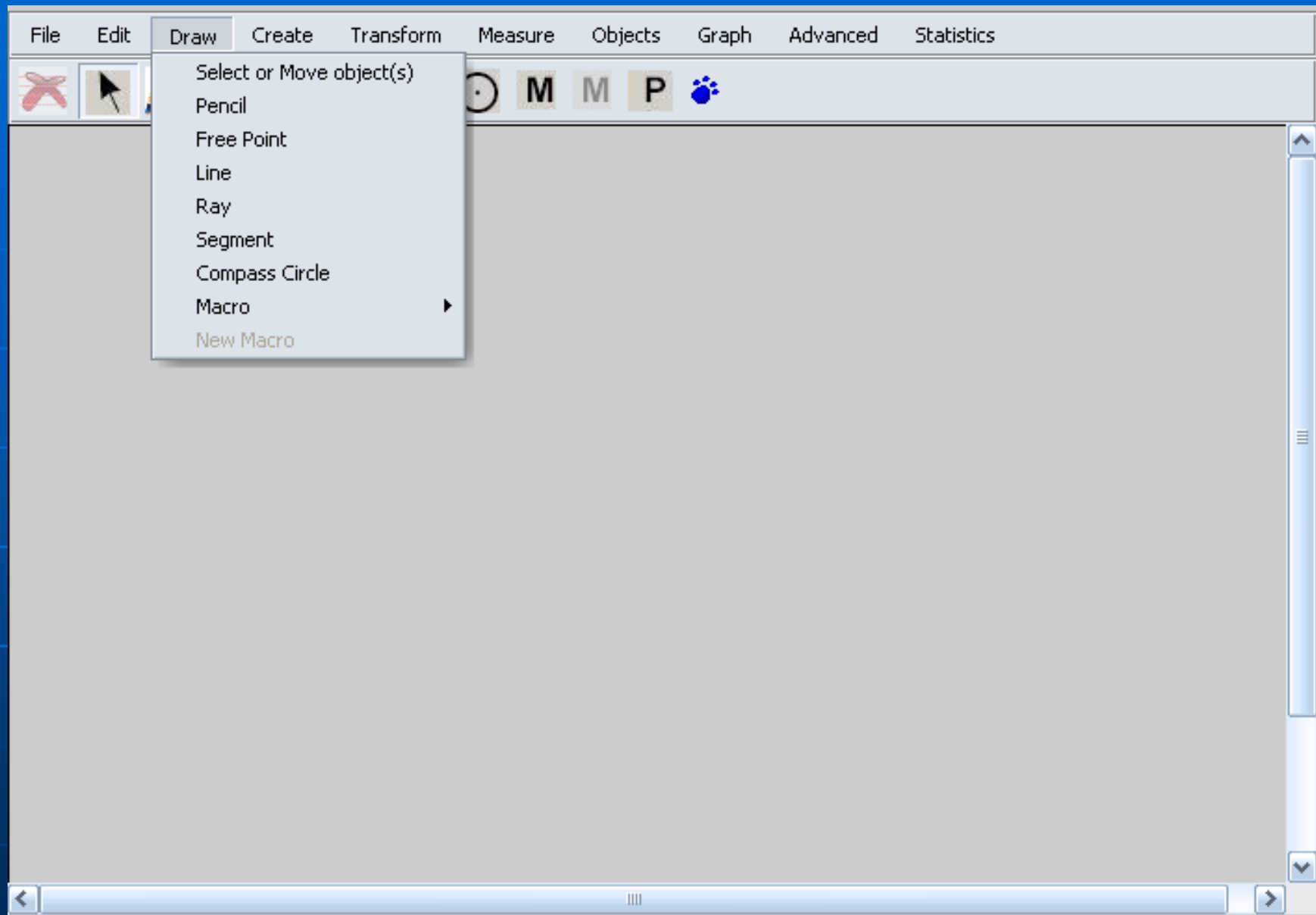
Draw Menu

Draw Menu:
Macro Support

- Grouping several steps as one new tool
- Objects involved with a macro are divided into
  - Givens
    - Selected by a user from an object on the canvas
    - Automatically generated
    - Associated with an object on the canvas (to be finished)
  - Results
    - Descendents of the givens
- A macro can come from a data string or a URL
- A macro can be saved with a manipulative
- Examples

Menu Introduction:
Create Menu

- With some objects selected, you can define a construction, in which one or more new objects will be created.
  - MidPoint of a segment
  - Circle by a center and a segment
  - Parallel/Perpendicular line
  - Polygon
  - Point on a line/circle/canvas
  - Perpendicular Point (the foot of the altitude, or perpendicular foot)
  - Parallelogram Point

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

MidPoint
Circle By Center+Segment
Circle With Center And One Point
Parallel Line
Perpendicular Line
Line With Two Points
Ray With Two Points
Segment With Two Points
Polygon
Point On Canvas
Point On a Line
Point On a Circle
Parallelogram Point
Perpendicular Point

Create Menu

Things you need to know:
Two types of operations

- Select an operation from the menu or toolbar, and then begin to draw on the canvas

- Select one or more objects, and then go to the menu or toolbar to apply an operation to it (them)
  - Sometimes, the operation may invoke a dialog

Things you need to know:
Menu and Toolbar Enabling and Disabling

- Menu items and toolbar buttons are enabled or disabled automatically based on the objects selected and the current system status

Things you need to know:
The property dialog

- To inspect the relations among objects via the parents/children relation
- To see how an object was named and labeled by the system, or to label it yourself
- To customize properties of an object
- To check if your construction is correct
- To study how a manipulative was created
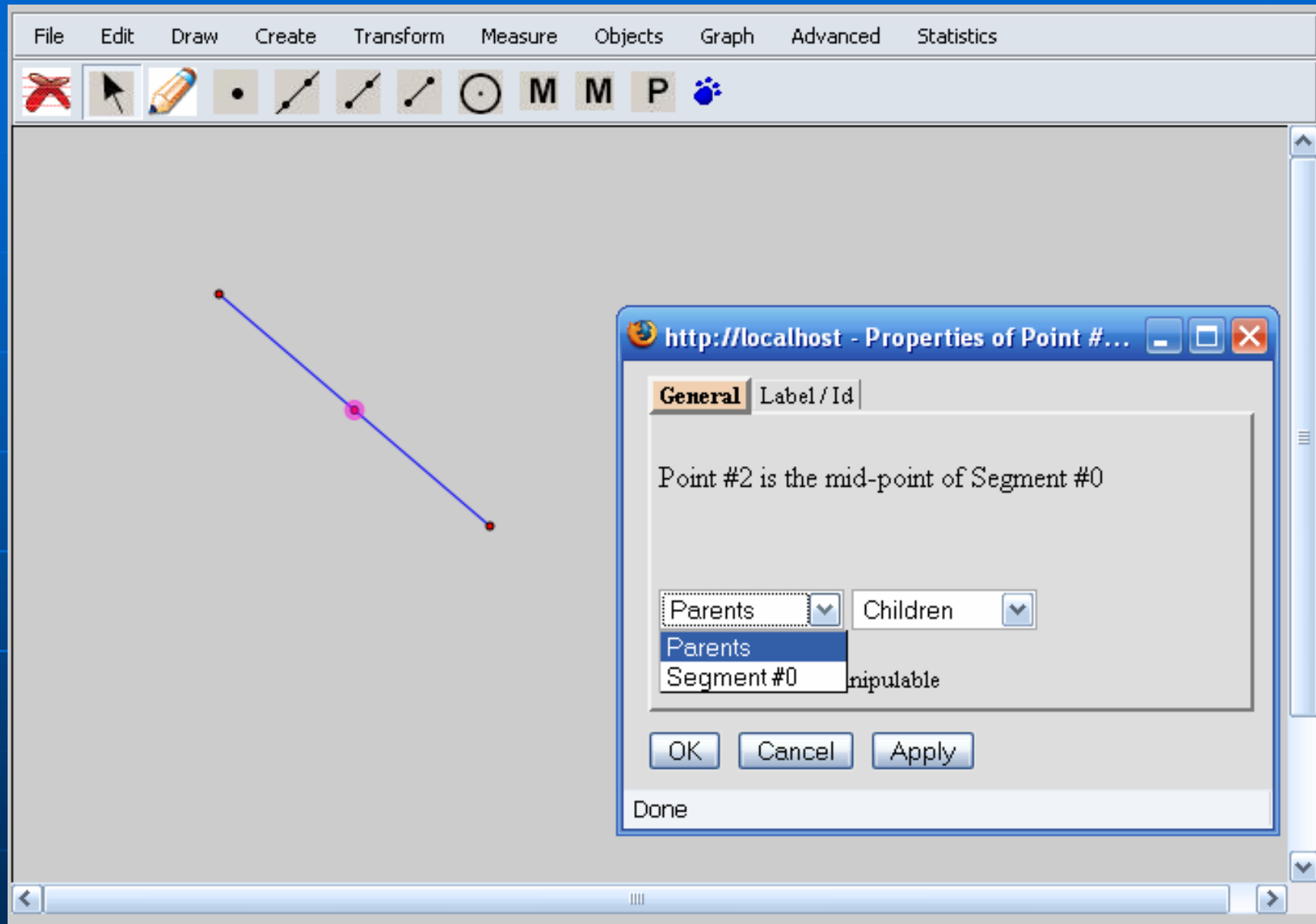
Property Dialog – to inspect relations among objects
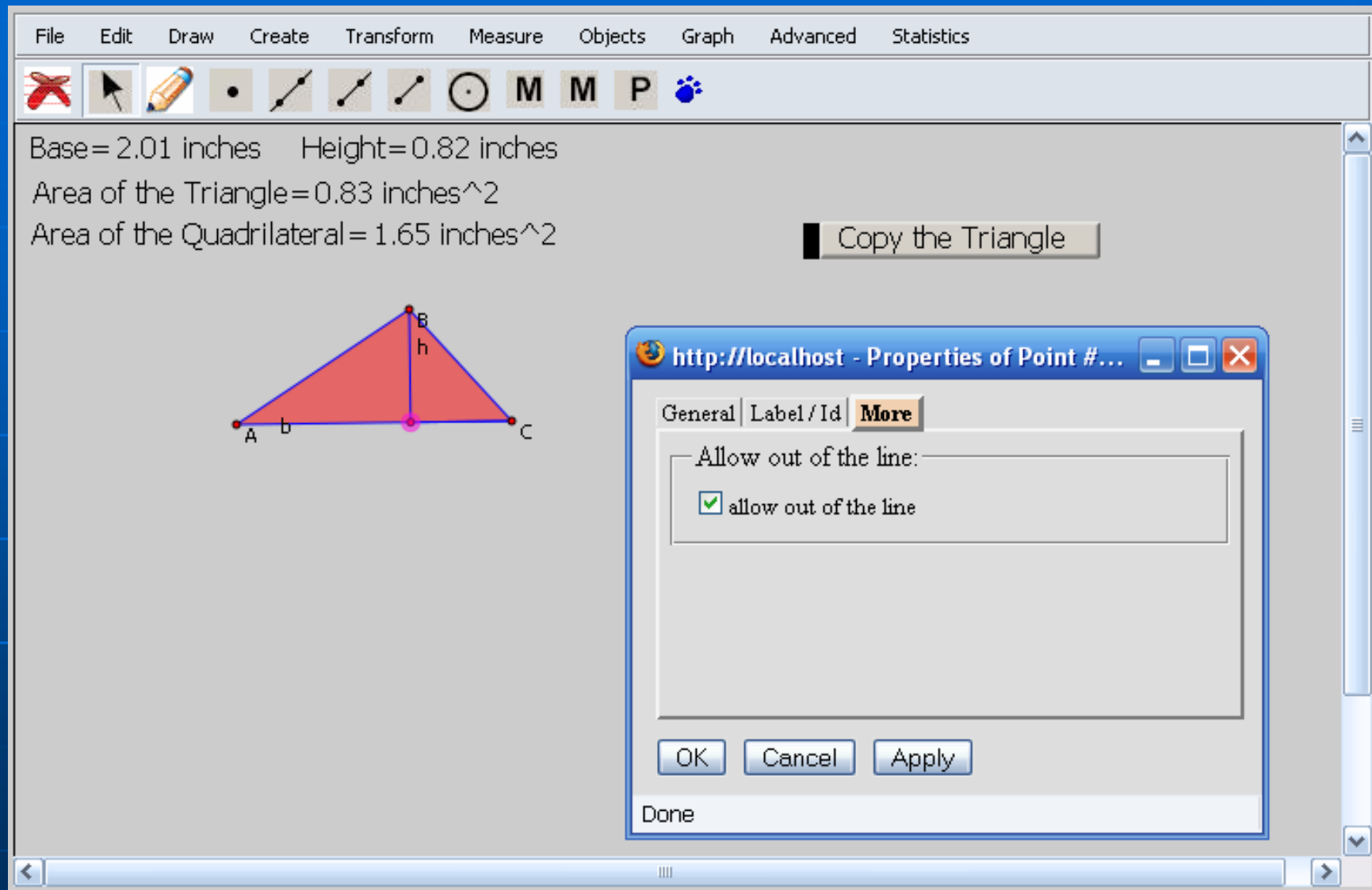
Property Dialog – to customize properties of an object

Things you need to know:
Naming and labeling of objects

- **Naming**
  - The name of an object is used whenever a description of the object is needed
    - In the property dialog shown in the previous slide
    - In an mathematical expression
  - An object is usually named in this way: *object type* plus *object label*
    - If an object has not been labeled, an object will be named like "Circle #3", "Polygon #2". The index numbers are assigned to objects of the same type in their creation order

Things you need to know:
Naming and labeling of objects (cont.)

- Labeling
  - You can label the object yourself.
  - If an object has not been labeled, when the object is measured, a label will be automatically assigned.
    - For example, labels of circles will be assigned as $c1$, $c2$, and so on

Menu Introduction:
Measure Menu

- **Measurements**
  - Line length, and slope
  - Circle radius, diameter, circumference, and area
  - Polygon perimeter, and area
  - Distance between a point and a point/line/circle
  - Angle
  - Coordinates, abscissa, and ordinate

File　Edit　Draw　Create　Transform　**Measure**　Objects　Graph　Advanced　Statistics

Line Length
Line Slope
Circle Radius
Circle Diameter
Circle Circumference
Circle Area
Distance
Polygon Area
Polygon Perimeter
Angle
Coordinates
Abscissa
Ordinate
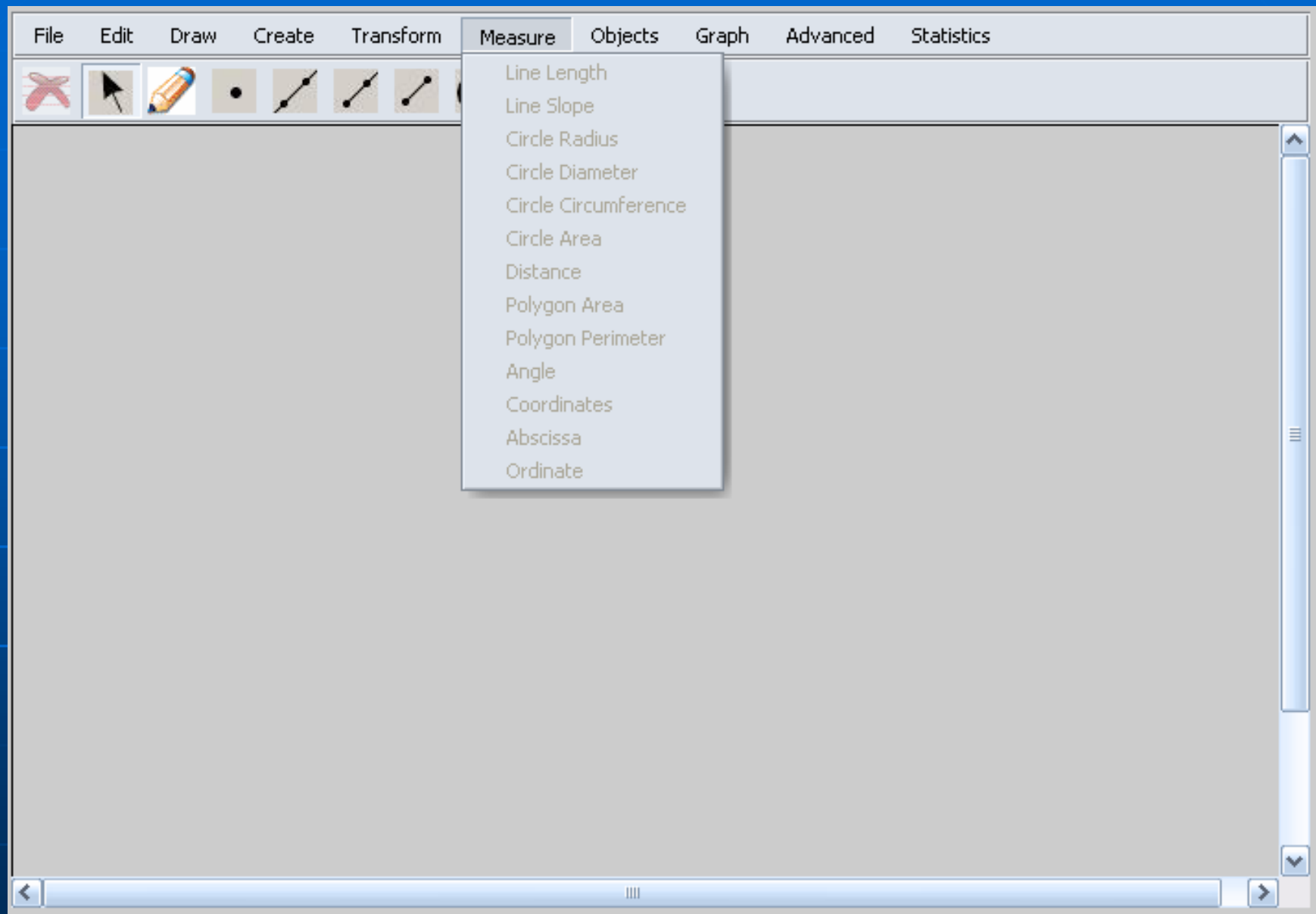
Measure Menu

Menu Introduction:
Transform Menu

- **Possible transformations**
  - Translation
    - x-y direction translation
    - Polar (angle/distance) translation
    - Vector translation
  - Rotation around a center
  - Reflection about a mirror
  - Dilation about a center
- Most of the transformation operations will invoke a dialog, which will invoke the calculator
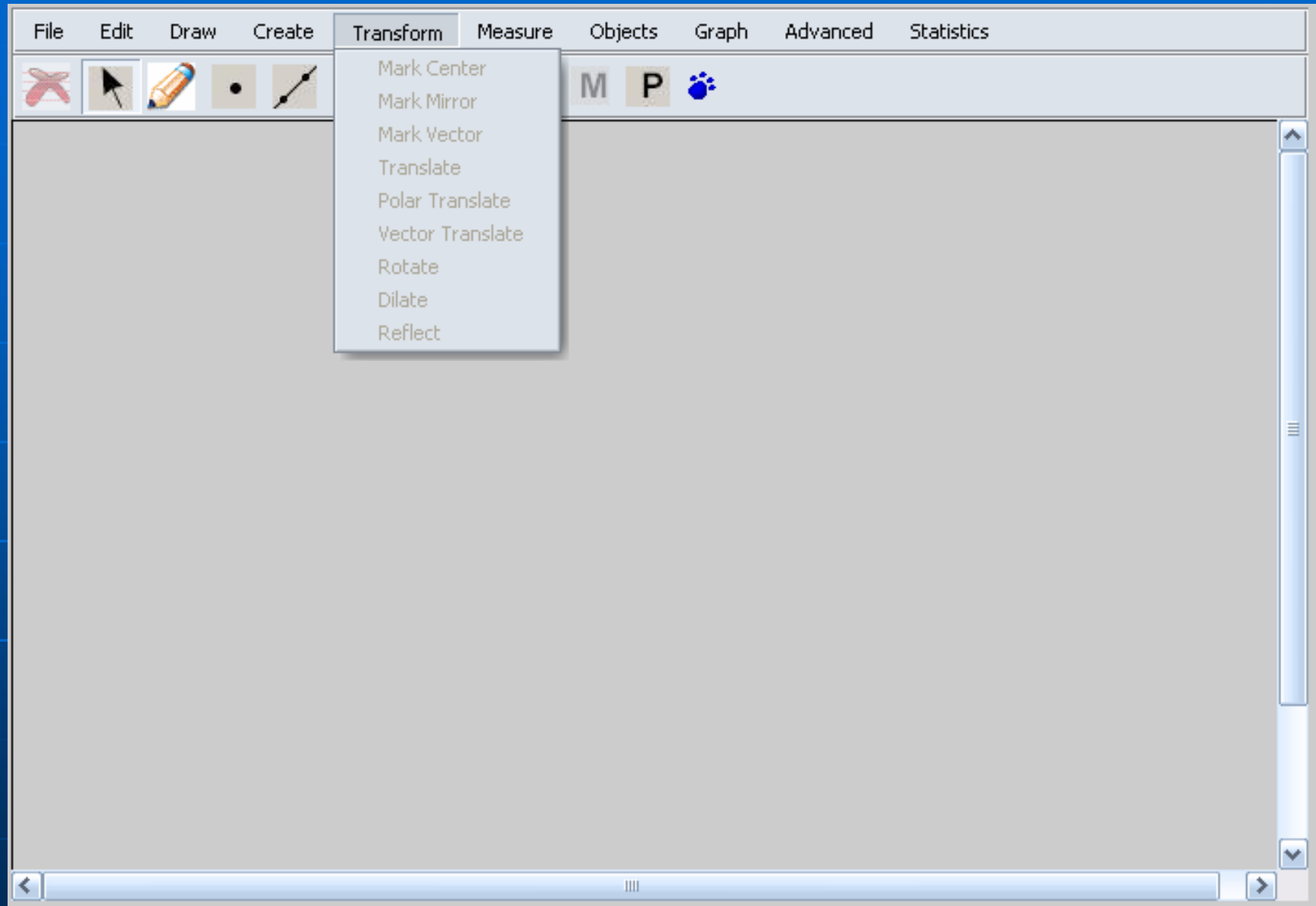
Transform Menu

Dialogs invoked by dilation

Result after the dilation

Property of the dilated triangle

Things you need to know:
The dynamic calculator

- The dynamic calculator can be used to
  - define a function
  - define a calculation
  - set numeric properties of objects
    - Depth of an iteration
    - Coordinates of a point
    - Unit length of an axis
    - Properties in a transformation
    - Dilation factor of a synchronized copy

Calculator for defining a function

Calculator for setting the depth of an iteration

Things you need to know:
The dynamic calculator (cont.)

- The calculator can form very meaningful expression by referring to the names or labels of objects

- An expression is unit sensitive
  - 9cm+3inches will give you 10.18inches
  - Distance units: cm/inches/pixels
  - Angle units: radians/degrees

- By clicking an object on the canvas, an author can insert the object into the expression

Things you need to know:
The dynamic calculator (cont.)

- An expression is entered in infix format, and it will be parsed and evaluated immediately. Invalid expression won't be allowed.

- The expression for a numeric property of an object can be changed even after the object is created.

Things you need to know:
The dynamic calculator (cont.)

- The calculator provides lots of built-in functions
  - *sin*, *cos*, *tan*, *abs*, *sqrt*, *log*, *ln*, *arcsin*, *arccos*, and *arctan*
  - *max*, *min*, *avg*, and *sum* of a sequence of numbers
  - *sgn*, *fac*, *round,* and *trunc*
  - *pick* that is similar to the "? :" operator
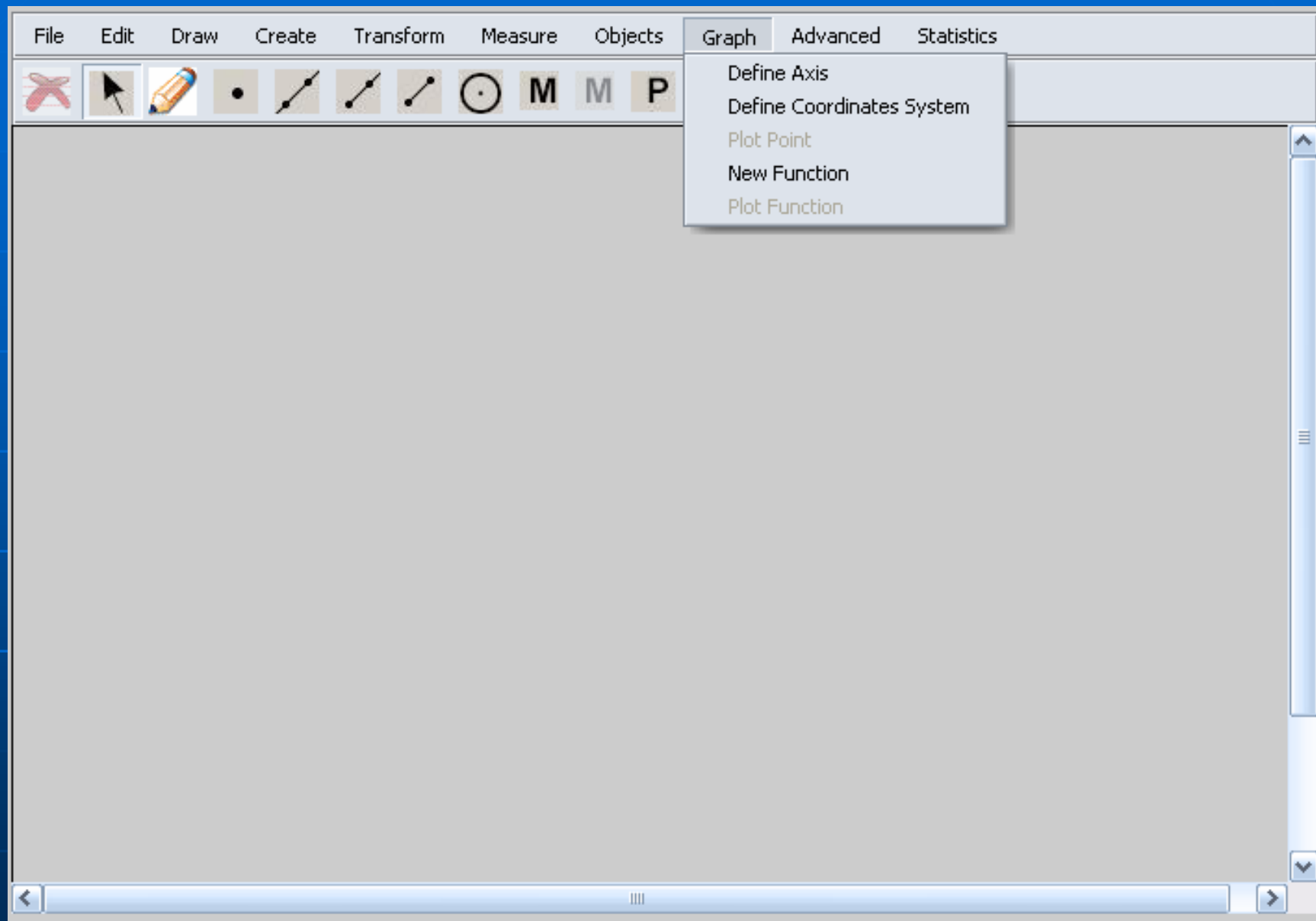- The calculator can handle boolean expressions

Things you need to know:
Interaction between the canvas and a dialog

- Some dialogs expect the user to click an object on the canvas as an input
  - Calculator as you have seen already
  - Synchronized copy dialog
  - Iteration dialog

Menu Introduction:

Graph Menu

- Coordinate system
- Point plotting
- Function definition and plotting

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

Define Axis
Define Coordinates System
Plot Point
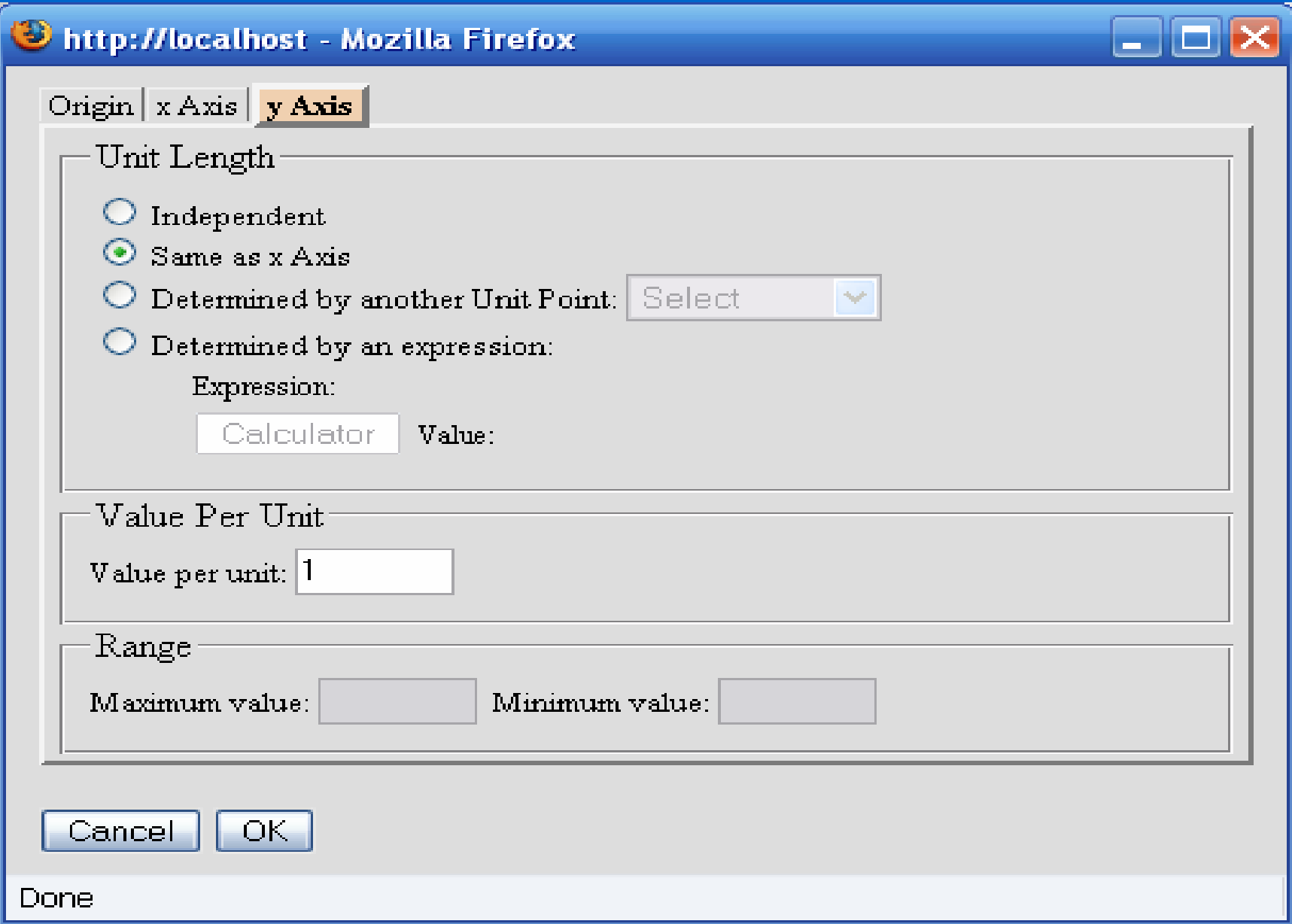New Function
Plot Function

Graph Menu

Graph Menu:
Coordinate System

- Usually, you just click OK in the dialog to create a new coordinate system

- You can also
  - Configure the unit length of an axis controlled by another axis in another coordinate system
  - Specify value per unit
  - Specify the range of an axis
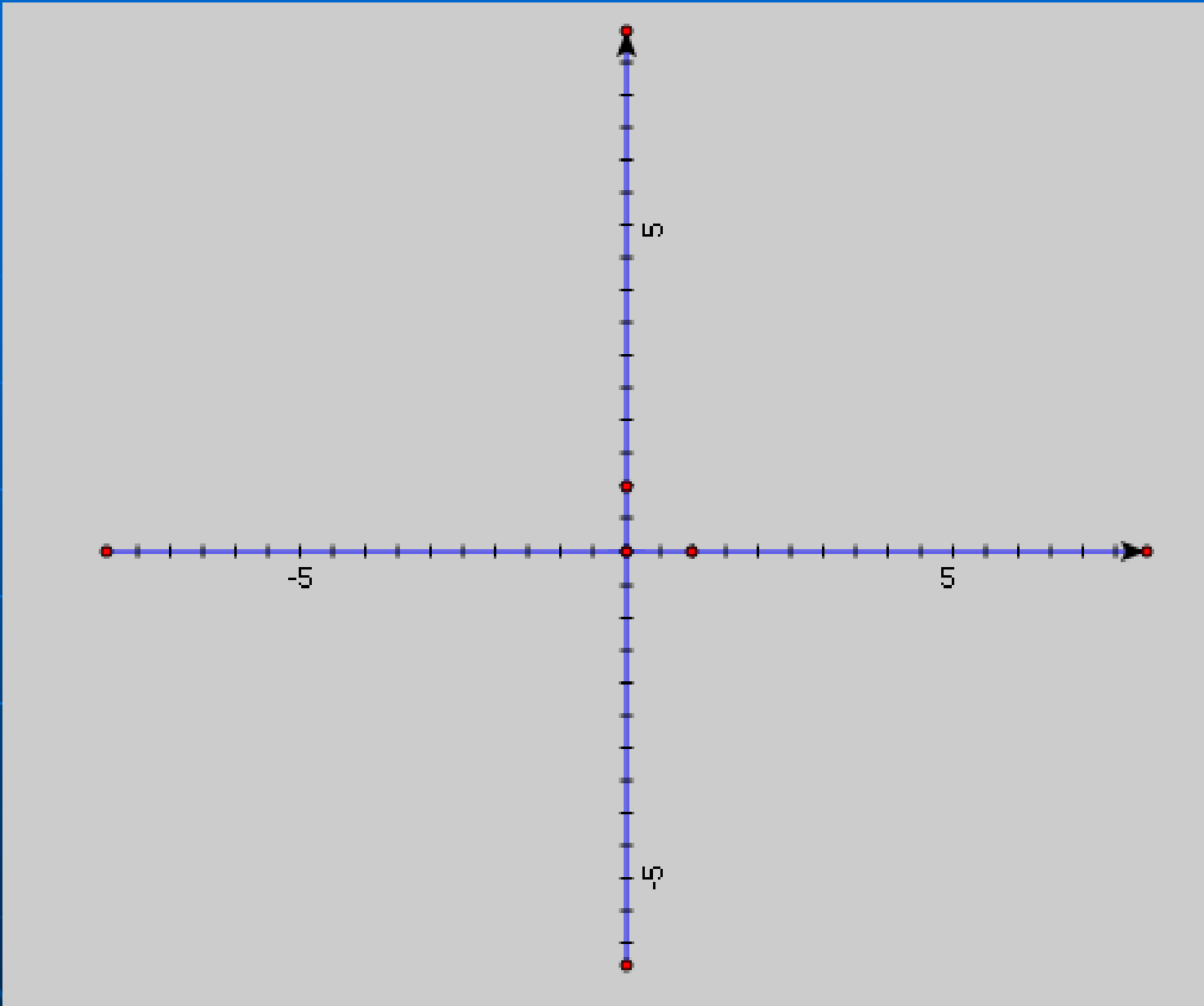
A coordinate system

The coordinate system dialog

Menu Introduction:
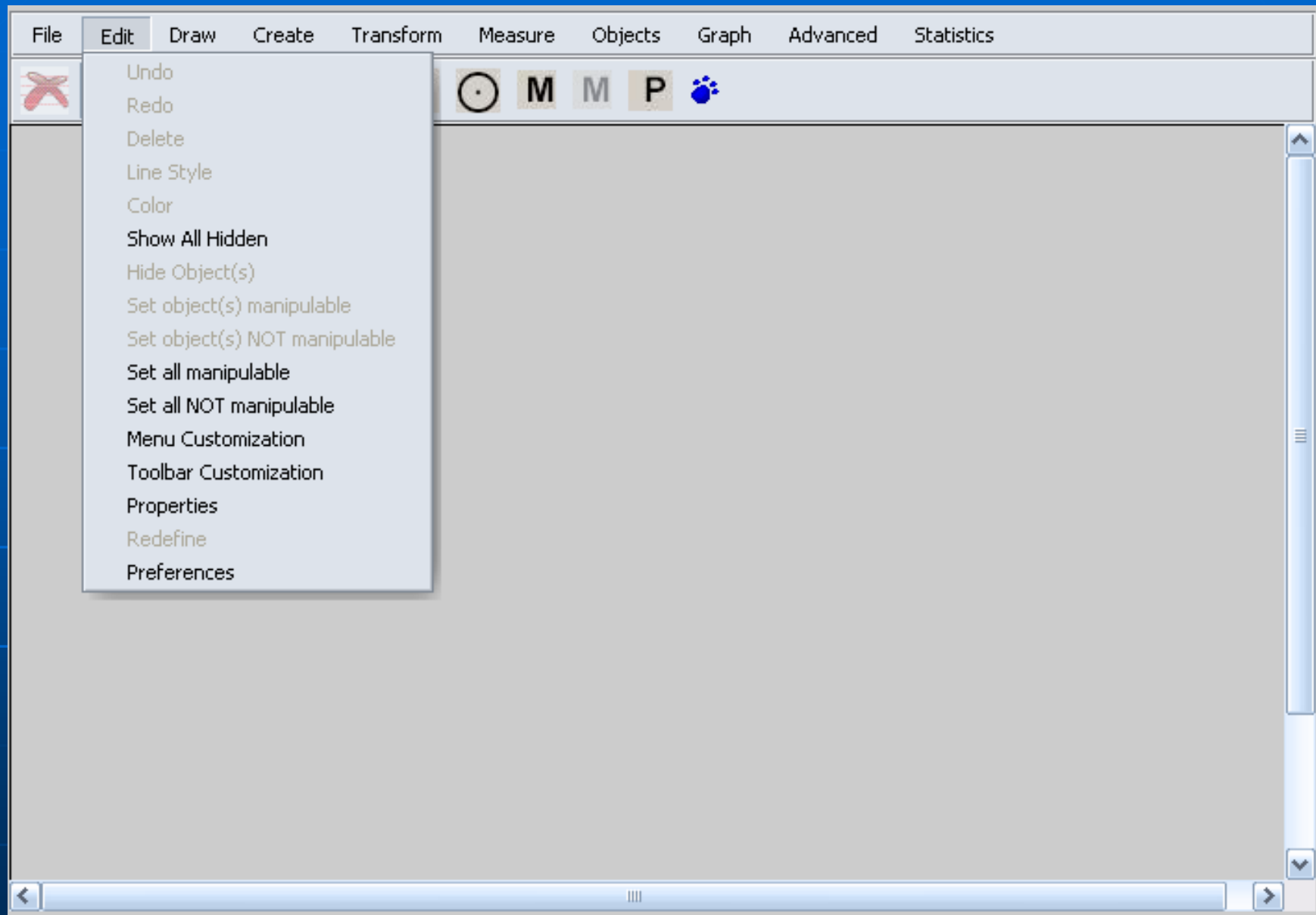
Edit Menu

- Undo/Redo/Delete
  - Unlimited undo and redo for
    - Object(s) creation
    - Object(s) deletion
    - Object(s) movement
    - And some other operations
- Properties
  - Properties of an object
- Redefine ***
- Preferences
  - Global properties of a manipulative
- Menu Customization/Toolbar Customization

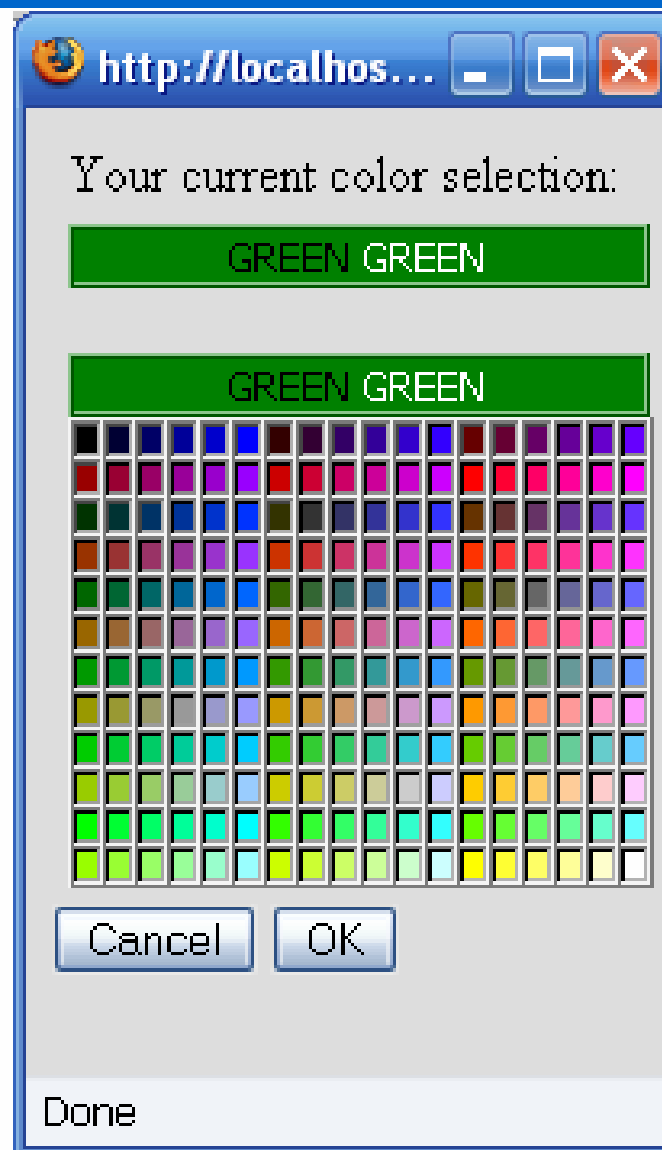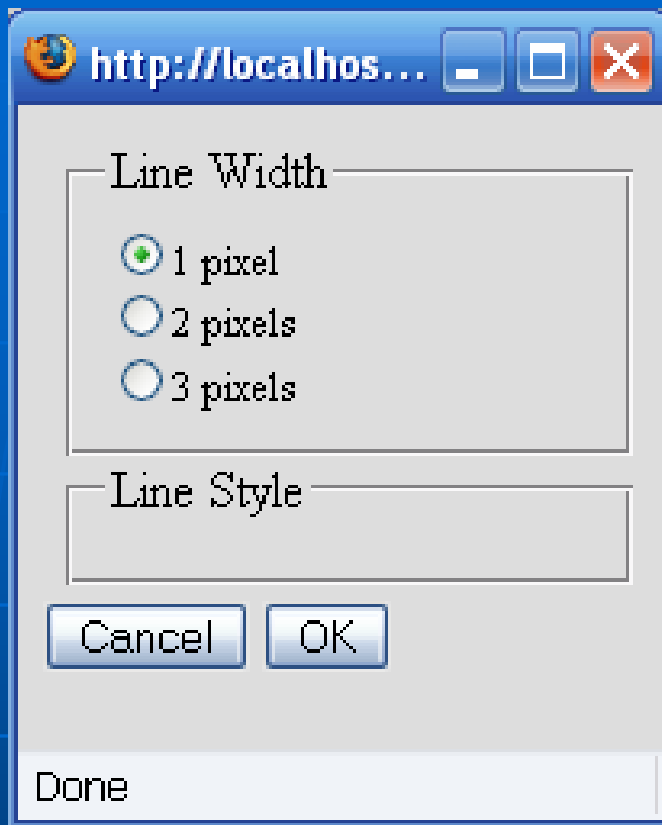# *Menu Introduction:*

Edit Menu (cont.)

- Line style dialog
  - for setting the style of a geometric object
- Color palette
  - for setting the color of a geometric object
- Show/hide object(s)
- Set object(s) manipulable or NOT manipulable

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

Undo
Redo
Delete
Line Style
Color
Show All Hidden
Hide Object(s)
Set object(s) manipulable
Set object(s) NOT manipulable
Set all manipulable
Set all NOT manipulable
Menu Customization
Toolbar Customization
Properties
Redefine
Preferences

Edit Menu

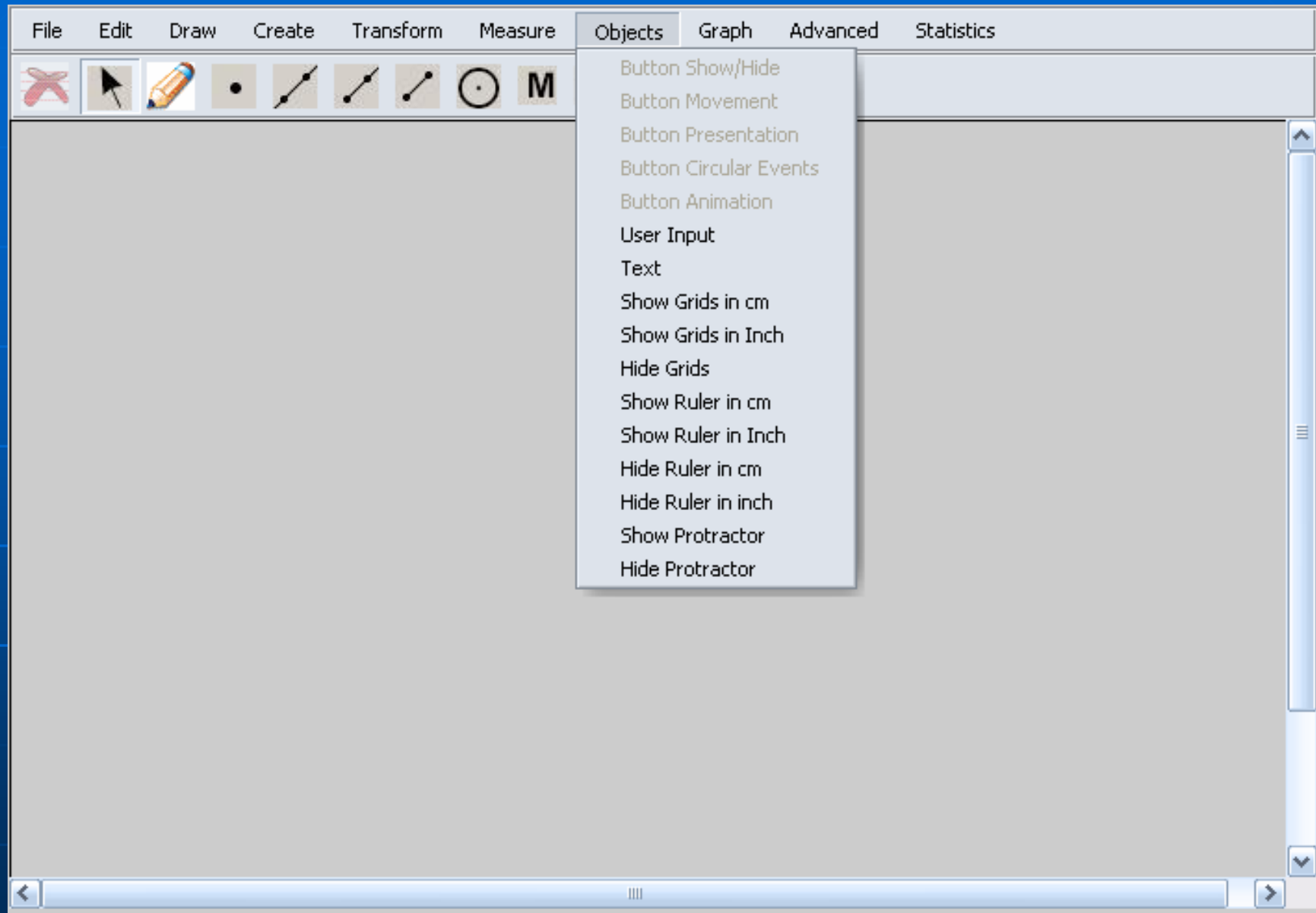**Line Style Dialog and Color Palette**

The preferences dialog

Menu Introduction:
Objects Menu

- Action button control
  - Show/Hide
  - Movement
  - Presentation
  - Circulation Events
  - Animation
- User input control
- Text block
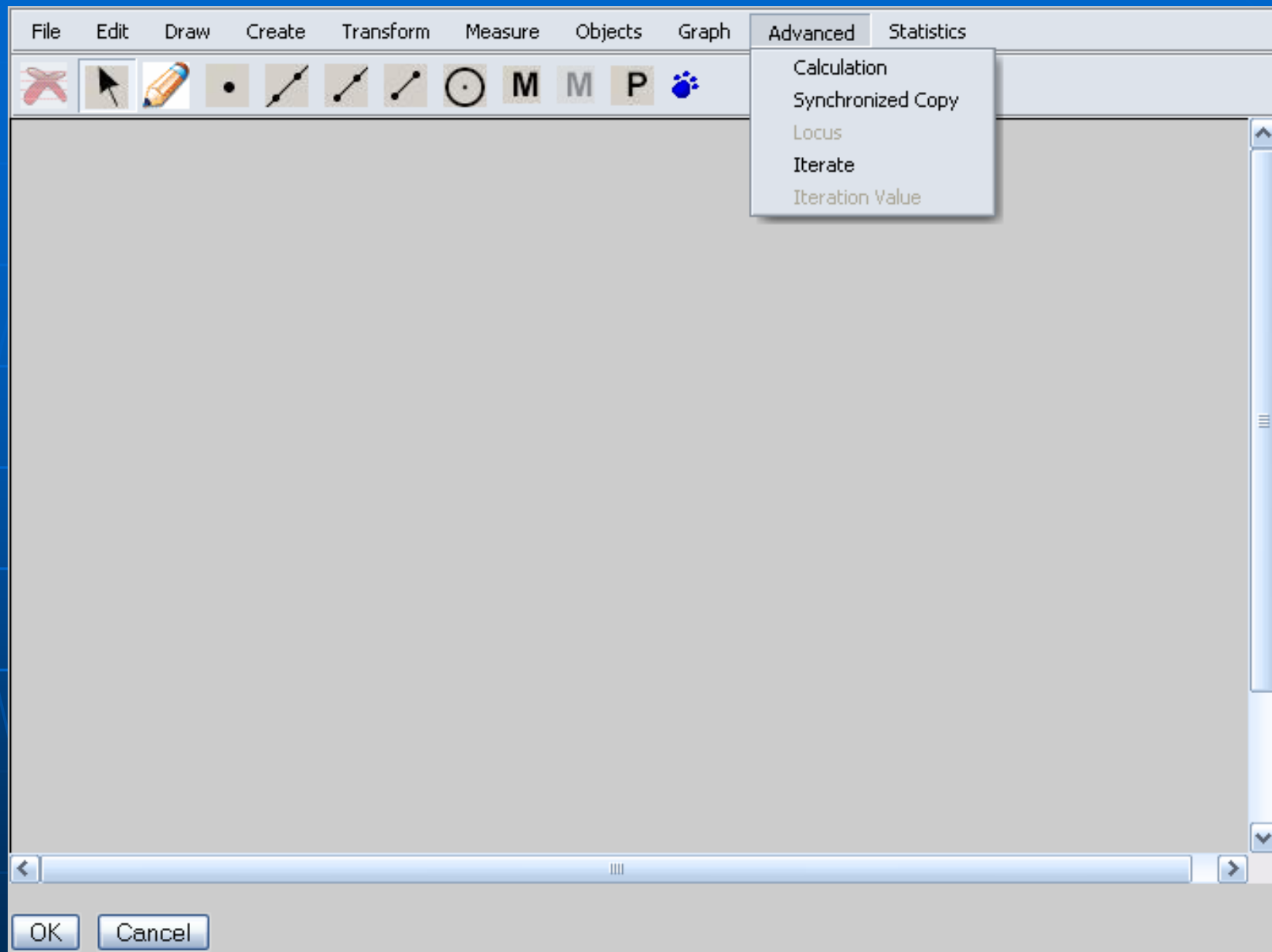- Rulers, protractor, and grids

File Edit Draw Create Transform Measure Objects Graph Advanced Statistics

Button Show/Hide
Button Movement
Button Presentation
Button Circular Events
Button Animation
User Input
Text
Show Grids in cm
Show Grids in Inch
Hide Grids
Show Ruler in cm
Show Ruler in Inch
Hide Ruler in cm
Hide Ruler in inch
Show Protractor
Hide Protractor

Objects Menu

Menu Introduction:

Advanced Menu

- Advanced constructions
  - Calculation
  - Synchronized Copy
  - Locus
  - Iteration
- They are advanced either because
  - the mathematics or the logic behind is sophisticated, or
  - the dialog assisting authoring is quite complex

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

Calculation
Synchronized Copy
Locus
Iterate
Iteration Value

OK   Cancel

Advanced Menu

Advanced Menu:
Calculation

- Calculation
  - The calculator will be invoked to define an expression in terms of other calculations, measurements, and user input controls
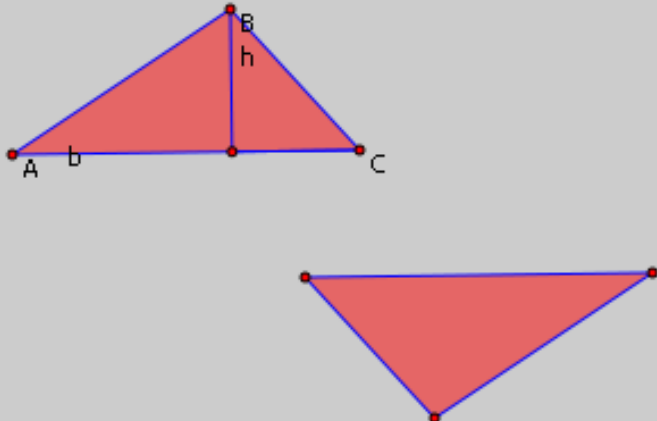
Advanced Menu:
Synchronized Copy

- Synchronized copy dialog
  - The mathematical relations among copied objects are always the same as the source objects

One triangle is a synchronized copy of another triangle
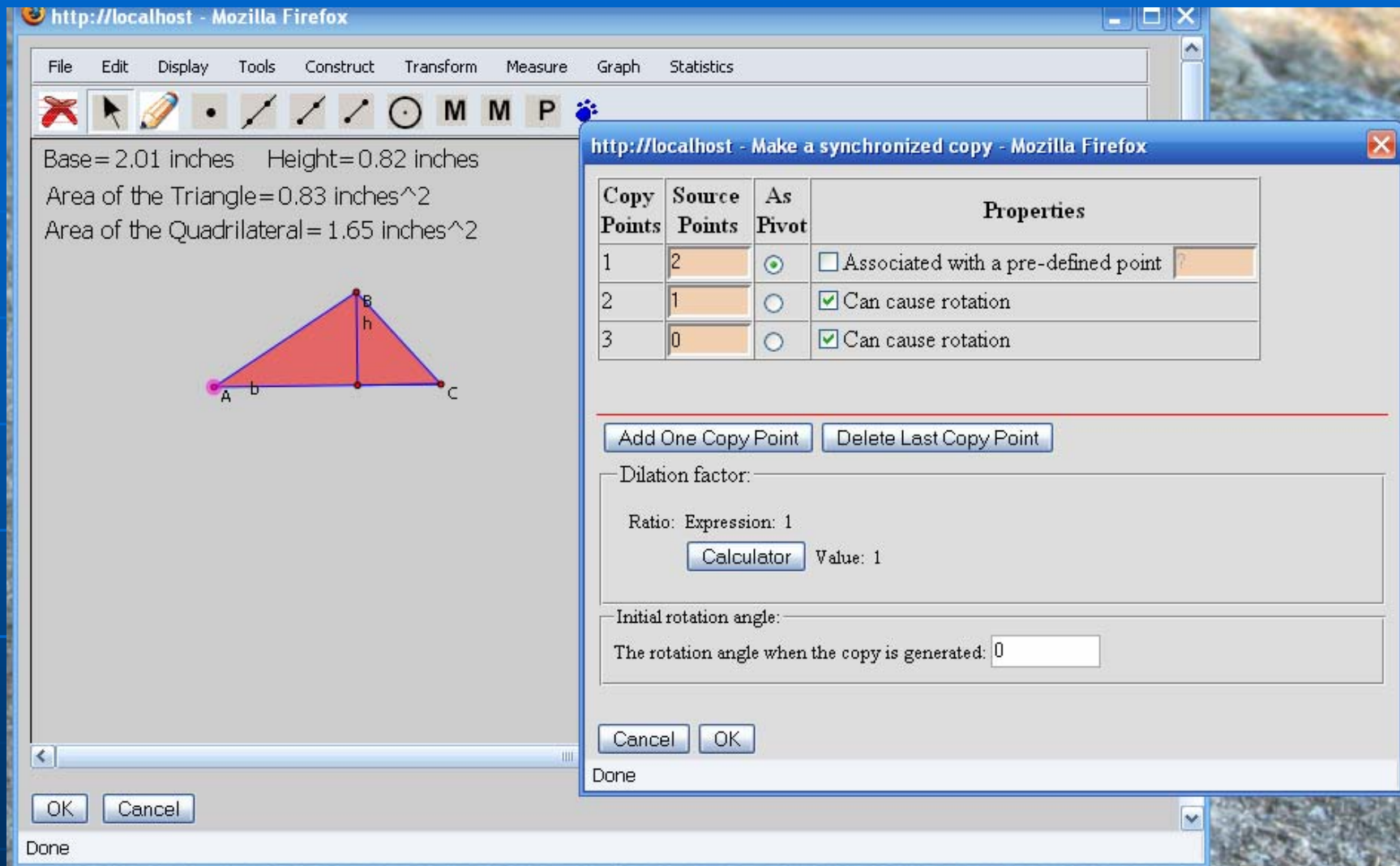
The dialog for making a synchronized copy
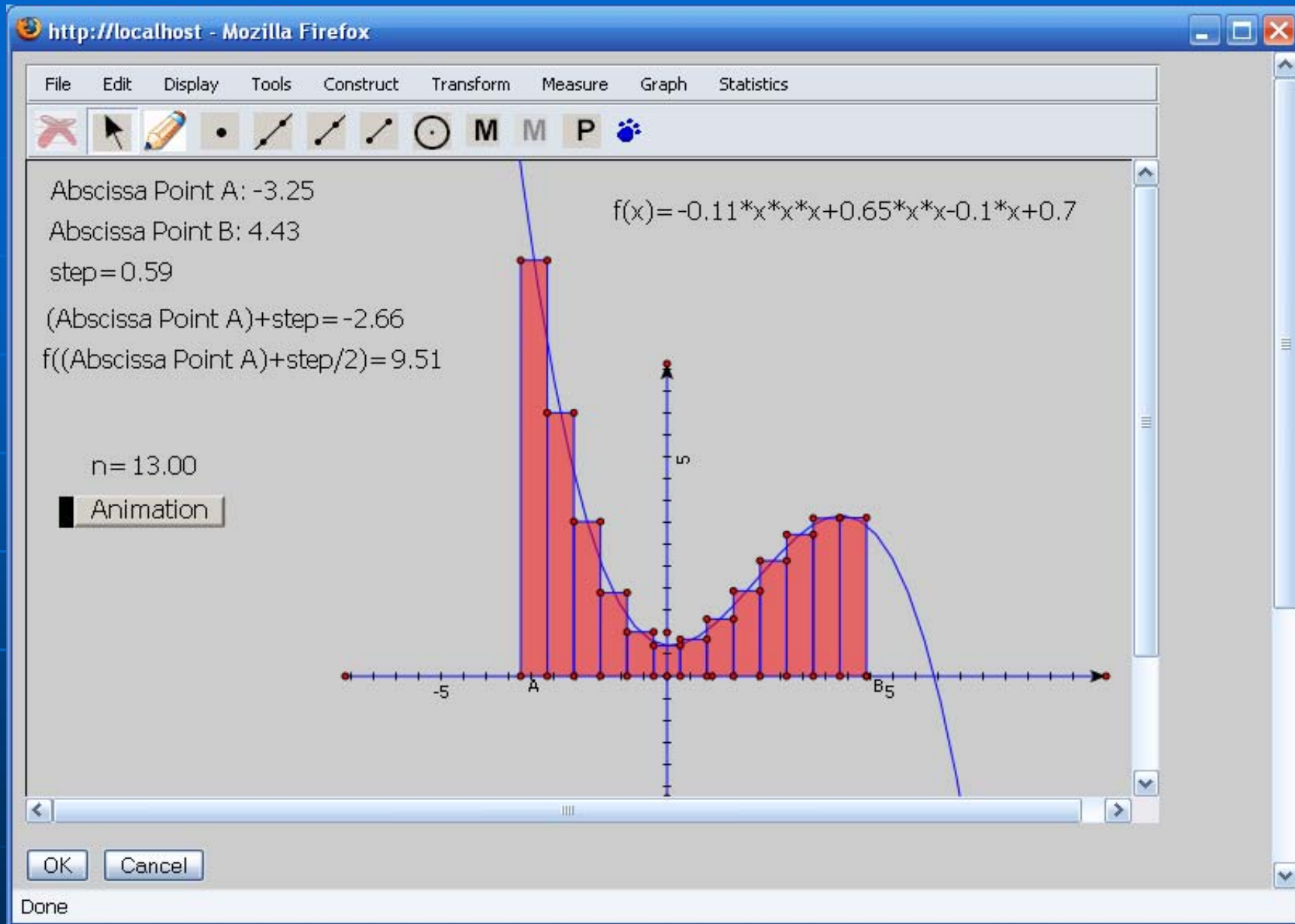
Advanced Menu:
Iteration

- An iteration rule must be specified
  - How a pre-image object is mapped to an image object (Point A mapped to mid-point C)
- The descendents structure under the pre-image object will be duplicated for the image object (point C takes the place of point A, and the whole descendents tree will be generated for point C)
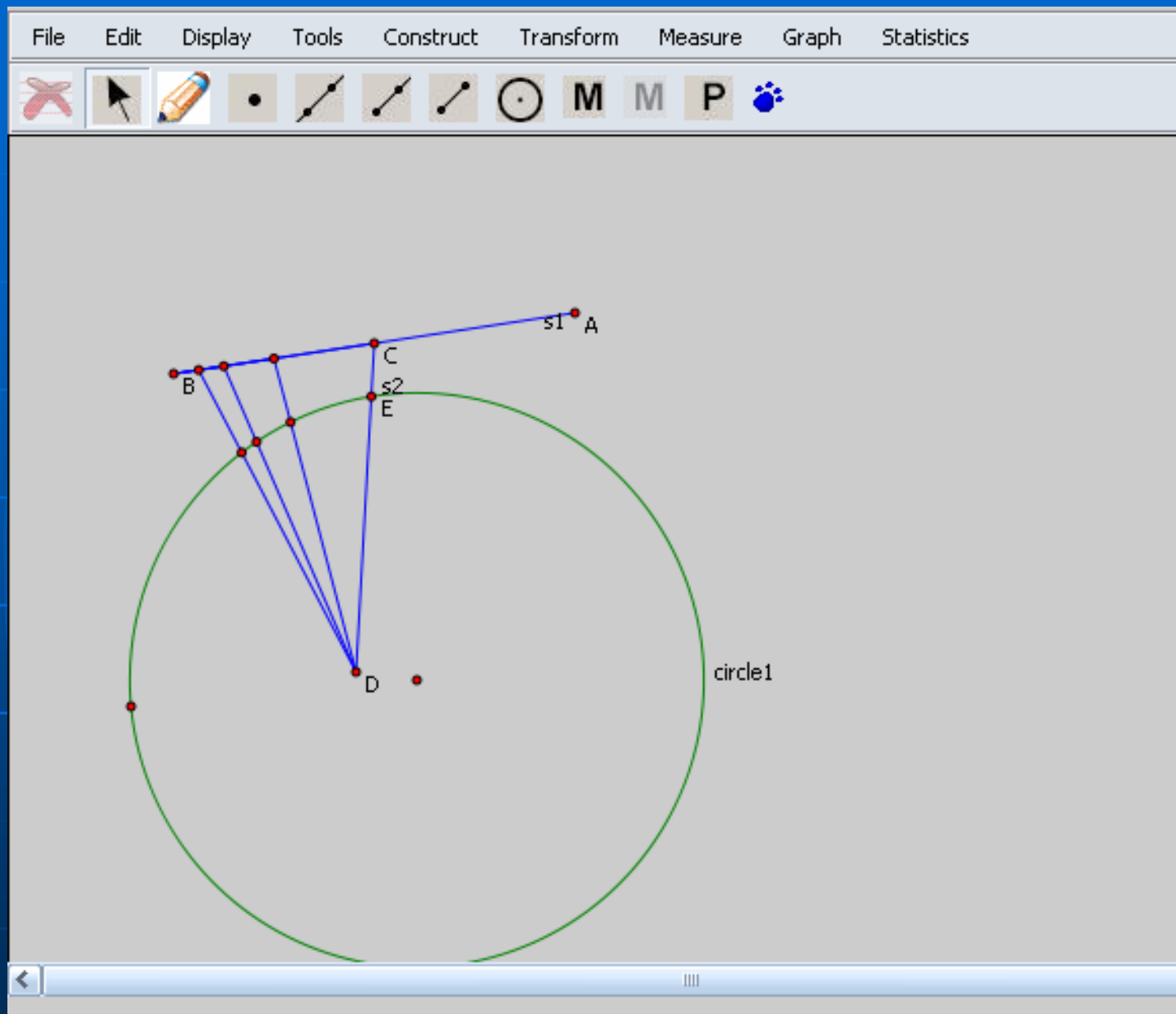
A simple iteration example: point A mapped to mid-point C
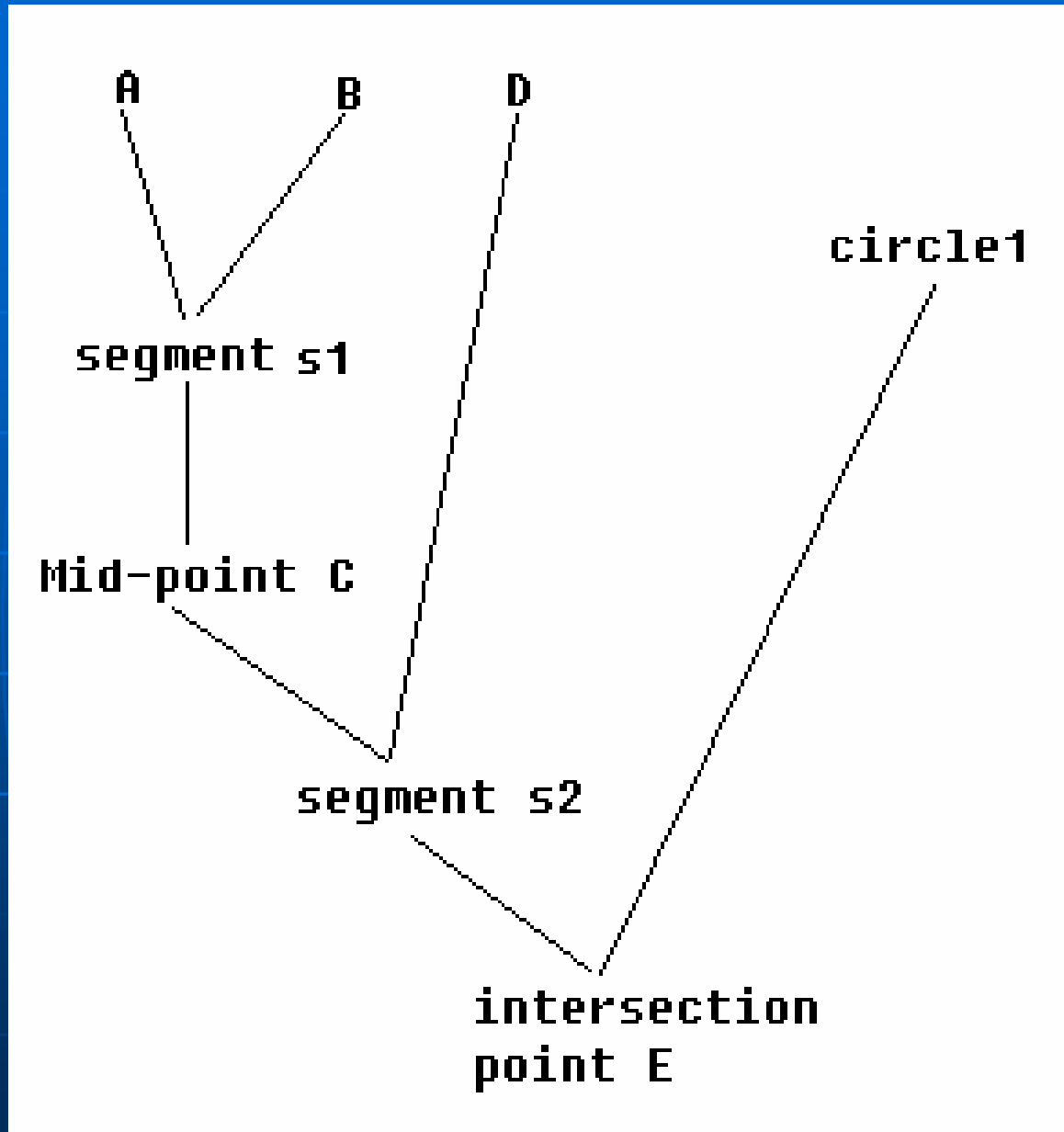
The dependency tree of the objects in the previous slide

A complicated iteration example

Advanced Menu:
Locus

- Mathematically, a locus is a collection of points which share a property. (Wikipedia)
- Three components
  - Driver
  - Path: that the driver will move along
  - Driven: must be a descendent of the driver
- Visually, a locus is a collection of all the locations the driven goes through
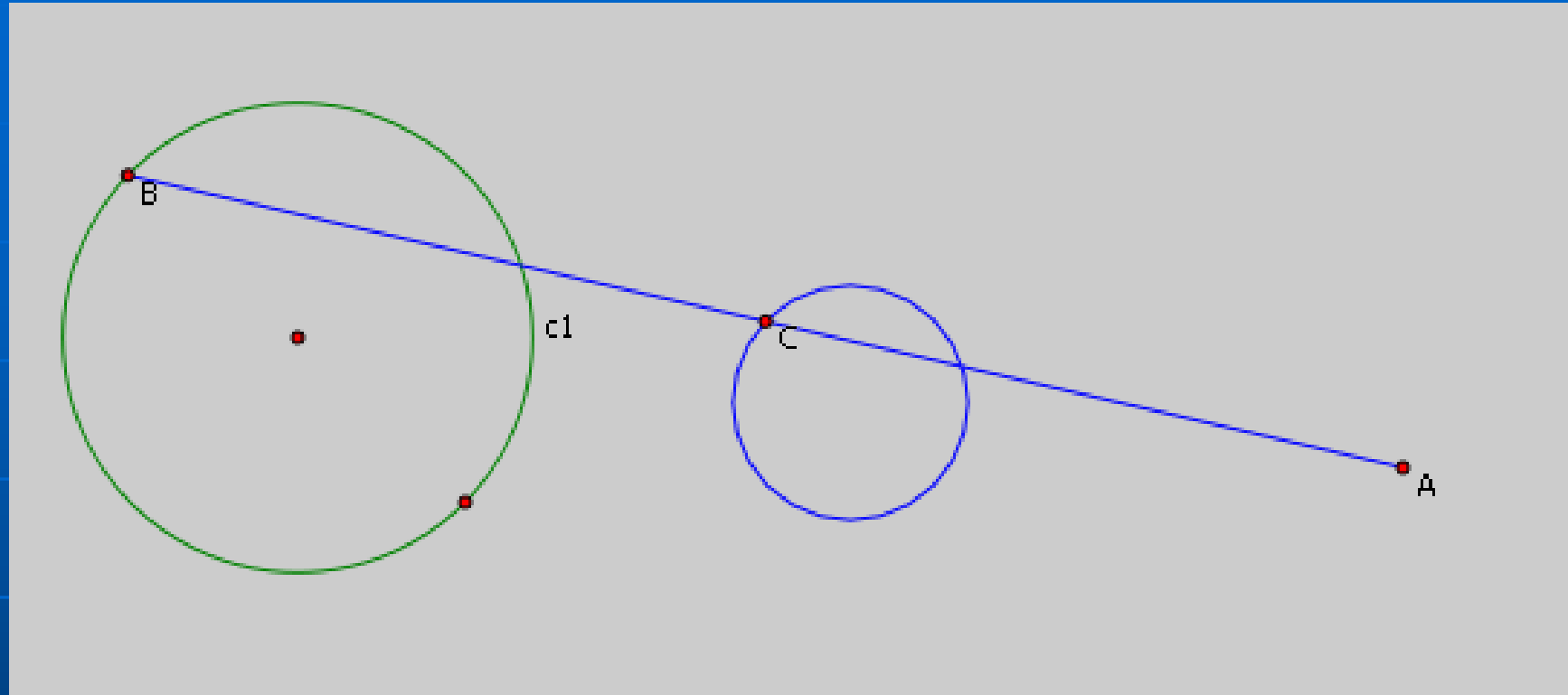
A simple locus example: C is the mid-point of segment AB, and B is on the circle c1. When point B moves around c1, the trace of C forms a locus
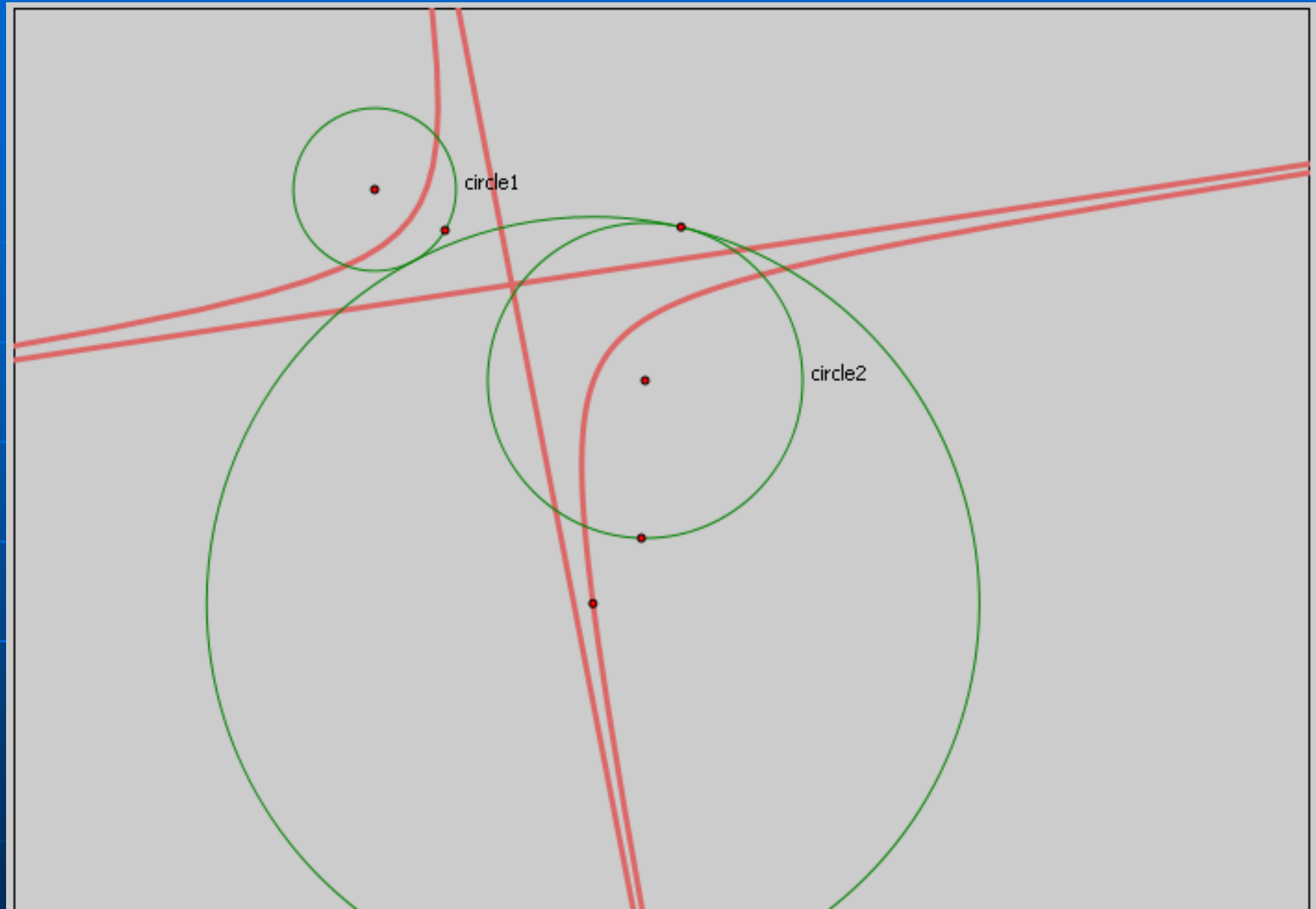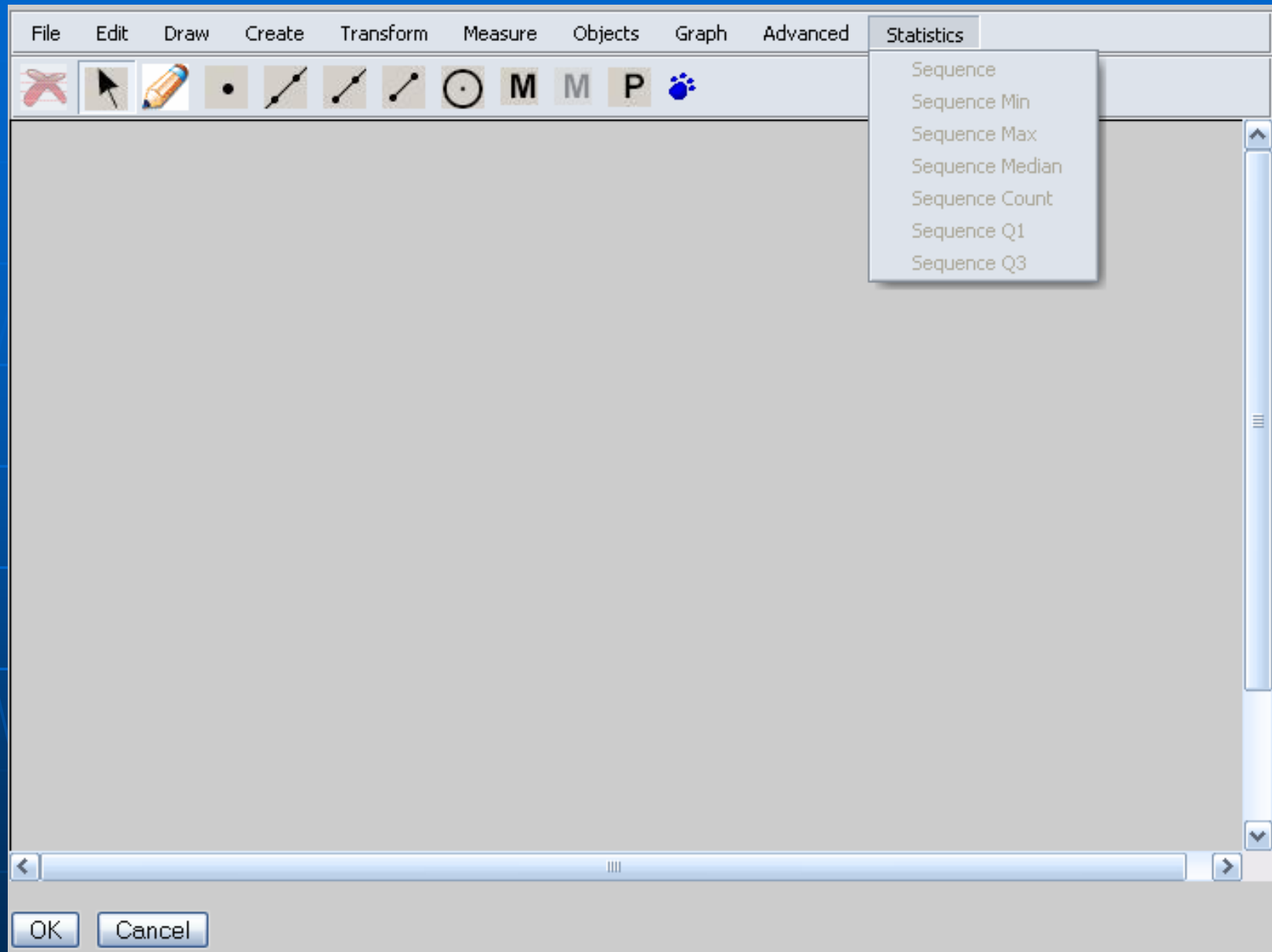
A locus example: the locus of the center of the circle tangent to two circles

Menu Introduction:

Statistics Menu

- Basic statistics supports
  - Min/Max, Median, Q1/Q3, and Count of a sequence of measurements of user inputs

File   Edit   Draw   Create   Transform   Measure   Objects   Graph   Advanced   Statistics

Sequence
Sequence Min
Sequence Max
Sequence Median
Sequence Count
Sequence Q1
Sequence Q3

M   M   P

OK   Cancel

Statistics Menu

Things you need to know:
Menu and Toolbar Customization

- Each menu item functionality can also be put on the toolbar
- The menu and toolbar can be customizable
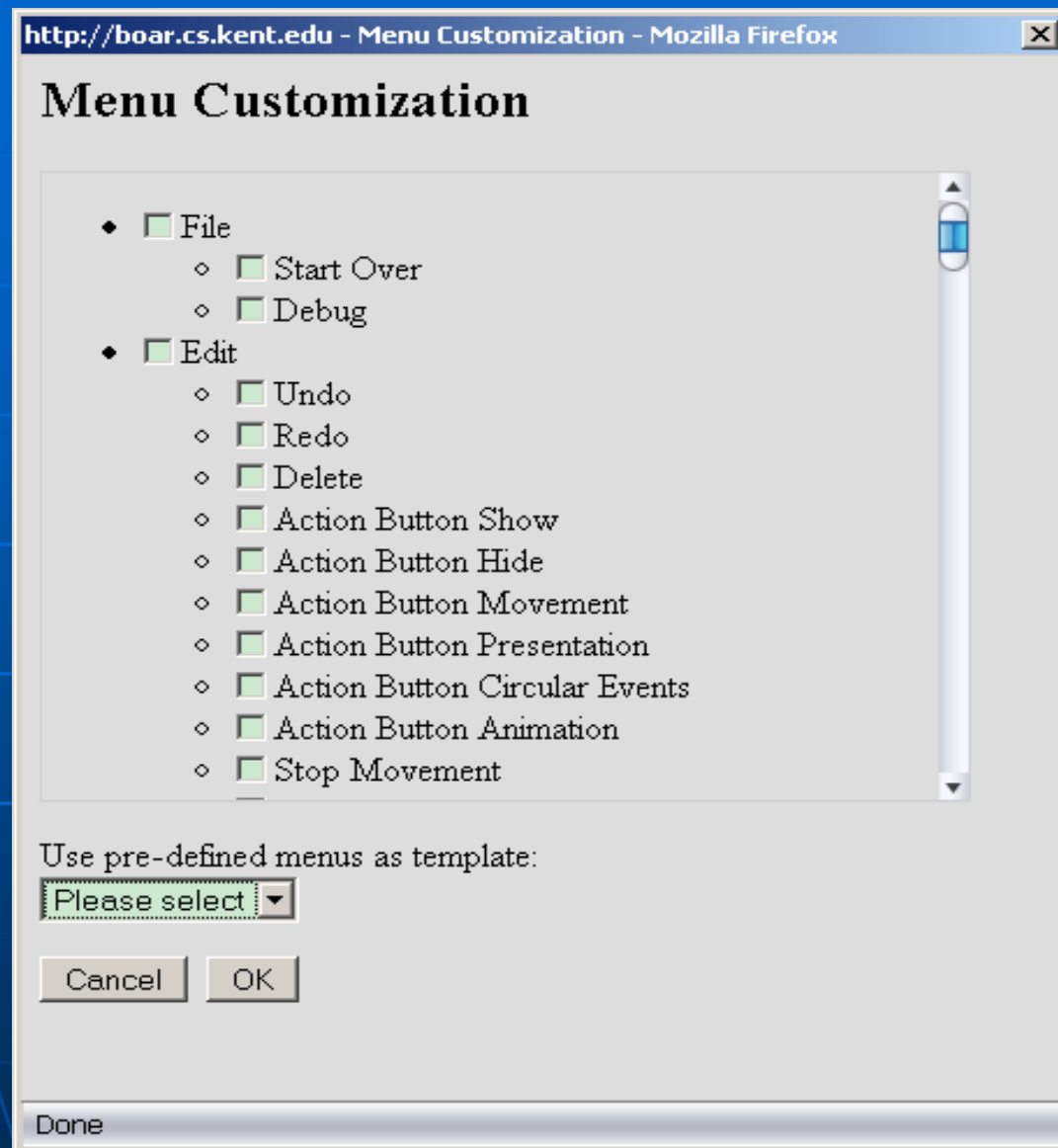
Menu Customization Dialog

Status of GeometryEditor

- More features need to be finished, however,
- The first trial version can be announced once a simple user account management is done on the GeoSite
- A progress table
  - http://www.cs.kent.edu/~xlai/geosite/GeometryEditor/doc/2007/tasks.html
  - although it can be understood only by me
- User manual and training materials needed

Features to be finished

- Envelops
- Arcs
- Conics
- Integration of MathML into the calculator
- Dialog showing construction steps
- Dialog showing macro properties
- Dialog for filtering iterated objects
- Tabulated data for an iteration
- Iterations for multiple mappings
- Some other small features

System Composition

- Graphical core (jsmin-ed)
  - 240KB, 16,000 lines of codes, 110 classes
- GeometryEditor.js: a layer between the graphical core and a client Web application
  - 50KB, 2,000 lines of codes
- Around 30 types of dialogs and their related Javascript files
- Open source libraries used:
  - Dynarch.com DHTML menus (50KB integrated into GeometryEditor.js)
  - FCKeditor (used in GeoSite)

Thank you!