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
Length Segment $k_1 = 2.59$ inches
$f_1(x) = x^2 - 6x + 9$
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
Draw Menu

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

- 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
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 $c_1$, $c_2$, 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
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

Length Segment $k_1 = 1.42$ inches

Length Segment $k_2 = 2.14$ inches
Property of the dilated triangle

Length Segment $k_1 = 1.42$ inches
Length Segment $k_2 = 2.14$ inches

Ratio: Expression: $(\text{Length Segment } k_1)/(\text{Length Segment } k_2)$
Calculator: Value: 0.66
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

f_1(x) = x^2
f_3(x) = -x^2 + 1
f_5(x) = \text{MAX}(f_1(x), f_3(x))
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
  - $\sin$, $\cos$, $\tan$, $\text{abs}$, $\sqrt{\text{r}}$, $\log$, $\ln$, $\arcsin$, $\arccos$, and $\arctan$
  - $\text{max}$, $\text{min}$, $\text{avg}$, and $\text{sum}$ of a sequence of numbers
  - $\text{sgn}$, $\text{fac}$, $\text{round}$, and $\text{trunc}$
  - $\text{pick}$ 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
Graph Menu

- Define Axis
- Define Coordinates System
- Plot Point
- New Function
- Plot Function
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

- **Origin**
  - **x Axis**
  - **y Axis**

- **Unit Length**
  - Independent
  - Same as x Axis
  - Determined by another Unit Point: Select
  - Determined by an expression:
    - Expression: [Calculator]
    - Value:

- **Value Per Unit**
  - Value per unit: 1

- **Range**
  - Maximum value:
  - Minimum value:
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
Line Style Dialog and Color Palette
The preferences dialog

Units

<table>
<thead>
<tr>
<th>Units</th>
<th>Precision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle:</td>
<td>degrees</td>
</tr>
<tr>
<td>Distance:</td>
<td>inches</td>
</tr>
<tr>
<td>Other (Slope, Radio ...)</td>
<td>hundredths</td>
</tr>
</tbody>
</table>

Cancel  OK

Done
Menu Introduction:

*Objects Menu*

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

Calculation

- Calculation
  - The calculator will be invoked to define an expression in terms of other calculations, measurements, and user input controls.
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

Base = 2.01 inches  Height = 0.82 inches
Area of the Triangle = 0.83 inches^2
Area of the Quadrilateral = 1.65 inches^2
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

Abscissa Point A: -3.25
Abscissa Point B: 4.43
step = 0.59
(Abscissa Point A) + step = -2.66
f((Abscissa Point A) + step/2) = 9.51

n = 13.00

A complicated iteration example
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 descendant 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
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

- File
  - Start Over
  - Debug
- Edit
  - Undo
  - Redo
  - Delete
  - Action Button Show
  - Action Button Hide
  - Action Button Movement
  - Action Button Presentation
  - Action Button Circular Events
  - Action Button Animation
  - Stop Movement

Use pre-defined menus as template:

[Please select]

[Cancel] [OK]

Done
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
  - 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](http://www.dynarch.com) (50KB integrated into GeometryEditor.js)
  - [FCKeditor](http://www.fckeditor.net) (used in GeoSite)
Thank you!