

## 2D GEOMETRY BASICS WITH SVOFFICE 2009

---

Presented by: Dr. Murray Fredlund, President of SoilVision Systems Ltd.

### Introduction

Hi, my name is Murray Fredlund. Welcome to the session 2D Geometry Basics within the *SVOffice 2009 Next Generation* geotechnical software suite.

### An Overview

- CAD Drawing Space – overview
- Working with the Grid – turn on the grid and enter objects
- Drawing tools – basic drawing tools such as moving objects & deleting points
- Geometry Objects Definitions – basic building blocks to create models
- Entering Geometry – how to
- Editing Objects – how to
- 2D Geometry Concept – basic concepts
- Creating a Mesh – creating a mesh with your model

The CAD drawing space is central to the entry of new numerical models. The help can be perused for a complete description of the workspace of the CAD control. This presentation is going to focus on the aspects of the drawing space which can be utilized for the entry of geometry in the numerical model.

### Useful Components

This slide shows an overview of the components which are useful for a person entering geometry into a numerical model.

1. Command control toolbar to flip between 2D and 3D view. Most 3D models are still created on a 2D plane and then extruding them in the 2D plane.
2. Drawing menu which contains functionality for drawing objects on the CAD control.
3. Geometry portion of the Model menu. This contains all of the functionality a person could make use of to draw graphic objects.
4. Current region that the user is working on.
5. Current surface that has been selected.
6. Grid Selector. Tool for entering model geometry in a reasonable factor. Specifying a grid size that represents the minimum accuracy the user cares about.
7. Snapping Selectors. Tool for entering model geometry in a reasonable factor. Specifying a grid size that represents the minimum accuracy the user cares about.

### Working with the Grid

When you are working with the grid, it is important to make best use of the grid when drawing a numerical model. Doing so will greatly help in the stability and robustness of the numerical model because regions must exactly match each other. If there is too much accuracy you can have problems with regions overlapping or not quite butting up against each other properly and then the overall quality of the numerical model suffers. A well-chosen grid size makes it easy to draw geometry on the screen. The user will be prompted to select the grid size everytime a numerical model is created. The grid may be adjusted under the Options/Settings menu. Grids

always align with the model origin at zero:zero. Approximately 1-5% of your World Coordinate Range is a good place to start.

### **Useful CAD Tools**

Overall there are a number of CAD drawing tools that are implemented by SVOOffice 2009 to simplify drawing of your geometry. It is possible to snap to object points, which is useful if you are drawing a region that touches another region. If you select the point and hold the CTRL key you can move that single point of a region to a new point. You can also select a single point and delete by hitting the DELETE key. Moving entire objects can be accomplished by selecting the point, holding the SHIFT key and moving the mouse.

### **Entering Geometry**

The basic building blocks for the geometry of a numerical model are illustrated in this figure. There are regions (mid-level) and any region can have an infinite number of shapes (closed polygons, circles, polyline). Regions can have groupings of Shapes. The default of the program is to put one shape per region (1:1 correlation). This can be changed using other features in the program. Material Properties are always associated with Regions (not Shapes). If the user has a group of shapes, they can be associated with a Region and then a single Material Property can be applied to that Region.

It's good for the user to consider how many regions will comprise a model when they first design it and their placement. This will determine how Material Properties are linked into Regions. SVOOffice supports overlapping regions in all of the software packages. This simplifies the entry of certain models because the requirements for geometry input are relaxed and makes meshing and design of your models much easier. For example, an earth dam with a core region is made possible by this overlapping regions feature. Without it, the earth dam shape must be drawn up and over the core.

Which shapes overlap others is controlled by the Regions dialog. Regions with an order higher overlap the previous ones.

Cut-outs are also possible in SVOOffice. You can create void regions which are useful for modeling tunnels or drainage pipes. They are done by entering two shapes on one region and then specifying one shape to be dominant and be the primary region. Subsequent shapes (non-dominant) are considered void regions by the solver.

Example: Earth dam model – A circle has been drawn on the same region as the other brown material. Shape one (the original shape) is selected as dominant. Therefore the second shape is considered to void the previous shape in that area. You can apply boundary conditions to that shape and treat it as an internal void region.

All geometry can be entered within the context of the current World Coordinate System and the Model System. Geometry can be entered in a variety of ways.

- Drawing using CAD tools
- Cutting and pasting from other software
- Manually Typing in coordinates
- Importing geometry from an AutoCad DXF file

- Importing from ESRI shape file

All related functions for getting geometry into the software are found in the Model/Geometry menu. Once a geometry object is entered, the user can then edit the properties of that object. They can double-click on that object (or click once with the mouse and right-click) and select the desired function from the menu list.

## Regions

The basic concept is that the region is one of the basic building blocks of the numerical model. In the example there are three regions and each region is made up of a closed polygon, polygon or polyline. If the user enters a polyline that is not closed, the software will automatically close it for them. This is part of the SVOOffice continuous-closed regions. A region is very similar to a layer in AutoCAD and may contain a number of geometric shapes. Features, flux sections, text and line art may also be associated with regions.

Some of the important concepts with Regions:

- Each material can only be assigned one material property.
- Regions may contain cut-outs of void sections
- Boundary conditions may be applied to any shape edge within a region
- Features must be drawn as to be internal to the geometry.

All regions need to form a continuum. In the example provided there are two regions (light and dark orange). Their polygons are linked by two shared points. These points must match up between regions. There are automatic algorithms that automatically detect when regions are close and the software then assists to make these points exactly match.

## Generating the Mesh

Once the numerical model has been successfully created, it must be meshed. This happens during the solution process in the SVOOffice software. The focus of the software is primarily on the concept of the numerical model. The philosophy of our company is to allow the numerical modeler to focus on the concept they are trying to represent and not the numerical process itself (the meshing of the finite element algorithm). The algorithm utilizes a proprietary mesh generation algorithm. The details may be found in the related Theory manual for the related product.

There are a number of common issues that people encounter when they are creating the model and subsequently generating the mesh.

1. Overlapping regions – if region points overlap each other an area of ambiguity is created for the mesher. The mesher cannot resolve which region dominates when regions overlap.
2. Too many boundary points – importing regions from AutoCAD can result in too many points around the edge of a region. This causes the mesh to be unnecessarily dense and it makes it difficult to create regions adjacent to the region because all points must be met. Points can be deleted.

3. Geometry objects too close together – If a feature line in the model comes too close to the edge of the model a dense mesh is created which can unnecessarily lengthen the solution for the model.
4. Non-matching adjacent region points – Our software now has advanced algorithms to assist the user when regions are close.

In conclusion, our presentation has covered common issues with geometry creation.

*<End of transcript>*

For more information on SVOOffice 2009 products, feel free to contact us directly at (306) 477-3324, or download our student version from [www.soilvision.com](http://www.soilvision.com) and try it out for yourself!