

Maxwell Introduction

ENGS 120

Maxwell is a collection of field simulators, including 2D and 3D, and electrostatic, magnetostatic, conduction, and eddy-current solutions. This introduction will walk you through using it for an electrostatic problem.






1. Starting up a new project:

- a. Log on to a PC. You can use the public “thayer” account or your own account.
- b. Start Maxwell from the Ansoft item on the start menu (Start:Ansoft:Maxwell). You will get a menu of buttons across your screen.



Click on PROJECTS to open a project file manager. You can use this to manage project files or project directories. Probably you'll want to create your own project directory so you can keep track of your work, so...

- c. Click “Add...” under Project Directories. You'll need to enter an alias, and an actual name for the directory (choose make new directory—otherwise you'll just create a new alias for the main directory, which gets confusing fast). Now, back in the project manger, click on that new directory. The project list above is now the projects in that directory (but there aren't any yet, so it's empty).
 - d. So add a project by clicking “New...”. You'll need a name, and you get to select 2D or 3D. 2D is much faster to run, and much easier to use, so choose it if you possibly can get away with it.
 - e. Now if you select your new project name in the list of projects, the right hand window will let you do stuff with it, like write notes (a good idea—it is easy to forget which project is which a month later) or open it and start working on it (click “open”).
 - f. Now you have started the main field simulator program.
2. Field Simulator. The right hand side has a picture of your project (nothing yet), and the left hand side has a list, in order, of the steps you need to go through. Starting at the top,
- a. Choose a type of analysis. Electrostatic is what we'll start with.
 - b. Choose a coordinate system, Cartesian (XY) or cylindrical (RZ).
 - c. “Define Model” is where you draw what you want to simulate. So choose “draw model”.
 - d. **Draw Model.** This is a big step. Choosing this invokes a drawing program with a set of drawing tools across the left, and menus across the top. Most tools are also under the menus—the tools on the left are just shortcuts.
 - i. The first step is to choose units: Model: Drawing Units. Note that you can choose different options for rescaling when you change units, but if you choose the units you want to start with, you don't have to worry about that.
 - ii. A good next step would be to set the drawing size, although you can always change it later. Notice that the numbers are in the units you chose in the last step.
 - iii. Now it is safe to start drawing. You can pick a rectangle or circle from the tools at the left, or from a wider range of options under “object”. Use the left mouse button to draw something. When you are done, you get a menu to choose the color and name. It is worth choosing a name you can remember because you may later assign properties, etc. by name.
 - iv. You could be done now, but you may want the following drawing tricks:

3. Getting help is always a good trick. The rightmost menu invokes a help viewer with a pretty good index. You can also invoke it from the bottom of the main field simulator window.
4. To put in exact dimensions, you can directly enter coordinates at the bottom left of the screen. Typing in two numbers and hitting enter is the same as clicking on that point.
5. Some modes, such as “measure”  stay on until you click the right mouse button. If nothing works and the buttons on the left are all inactive, you are doing some operation you need to finish. The bottom of the screen has some text you’re unlikely to notice unless you are looking for it telling you what the mouse buttons do in the current mode.
6. You can zoom in and out with the icons on the left    or under Window: Change View.
7. You can select objects by clicking, and copy and paste (under edit). The  button is useful to deselect all objects before selecting more. (It’s easy to select an object to delete and then discover the hard way that the last thing you worked on was still selected too.)
8. Window: Grid is useful to set the grid spacing to something that lets you position your objects’ corners exactly on grid points. If that doesn’t work, drawing something approximate and then using the “Reshape” menu with manual coordinate entry is a good strategy.
 - i. When you’ve completed your drawing, save and exit the “2D Modeler” drawing program.
- b. Back to the Field Simulator. Now that you’ve defined the model, that step is checked off, and “**Setup Materials...**”¹ is now enabled. Click “Setup Materials...”. You will get a new panel in which you can choose existing materials, define new materials, and assign these to objects. For example, you could:
 - i. Chose Material: Add (left, middle). Now the bottom right has a menu to fill out with the electrostatic properties of a new material. Give it a name and some numbers, and click enter to add it to the list of materials.
 - ii. Now assign materials to objects. Highlight one or more objects in the list of objects, and a material in the list of materials. (You can click on the picture of the object if you forget the name, or just try a few and see which highlights the object you want...)
 - iii. Save and exit.
- c. Next step is “**Setup Boundaries/Sources...**” This gives you another panel, which is perhaps the most confusing. It is used both to establish boundary conditions (needed at all four edges of the drawing, at least), and sources. Let’s start with sources.
 - i. Select an object that will be a source (a known voltage or charge). Look under the “edit” menu. If you choose “Edit>Select:Object:By Clicking” you can then click on the object. Sounds simple, but the strange thing is that you aren’t finished selecting until you click the right button to tell it so. (If you happened to look at the bottom of the window it would tell you so, but I often forget to look there.) Now your object should be highlighted.

¹ Note that this should be “Set Up Materials”, because “setup” is a noun whereas “set up” is a verb.

- ii. Now assign it a source. “Assign:Source”, then either “Solid” or “Sheet.” The two are equivalent for voltage, but for charge, “Solid” assigns a total charge to a conductor and the charge distribution will be computed as part of the field solution, whereas “Sheet” allows you to create a fixed charge density on a surface (you must use “Select Edge” rather than “Select Object” for this last option). Enter a value, and a selection for charge or voltage. Entering a name can be useful, and you may want to change the color so you can visually keep track of what sources you’ve assigned.
 - iii. Assign boundary conditions to the edges of the region and anywhere else you want to add them. Select an edge, or all four at once (Hint: click just inside the edge, because if you click even a hair outside, the click won’t register, since you are clicking outside the drawing). A “balloon” boundary attempts to simulate space extending to infinity and is often the best choice. We’ll talk about using symmetry boundaries in class. There are two kinds of balloons available, charge or voltage, to make the charge at infinity match the charge in the problem space, or to make the potential at infinity zero. Save and exit the Boundary/Source Manager.
- d. If someday you run a large company, you will learn about “Setup Executive Parameters,” but for now we’ll skip that.
 - e. **Setup Solution: Options.** (“Variables” is for automatically varying parameters. We won’t use that for now). Probably you won’t want to change anything here just now but it’s good to know about. You can:
 - i. Manually draw a mesh of points at which it calculates the field. Normally however, it will make a rough mesh and refine it adaptively as needed, but the percentage indicated (15% default).
 - ii. Set the percent error it targets.
 - iii. Set the number of passes (e.g., you might go back and increase this if you want it to try a few more iterations).
 - f. **Solve!** Just tell it to go. If it is taking a while, you might want to monitor convergence or the “Profile” in the upper right window, as it repeatedly refines the mesh to get a good solution. It will tell you when the “Solution is complete”. If you get errors, check your boundaries and sources. You are likely trying to solve something that does not make physical sense. Note that “Convergence” includes total field energy (for a one meter deep extension of what you’ve drawn), so you may get the information you need from that. If not, on to the post processor.
 - g. **“Post Process.”** You need to decide what you want to know about the solution, and display it with the post processor.
 - i. First step is probably to plot some field lines, just to see if you got what you wanted. Do “Post:Plot” to get the basic plotting menu. Voltage contour plots are the default, and probably a good idea. You can select a color for the plot, or say yes to “Spectrum” to get a color-coded plot.
 - ii. If the plot you got is good, you may be done, but if you don’t like the scaling or something, go to “Post:Plane” and choose the type of plot you are using. Now you’ll get a full menu of options for it. For example, I wanted to rescale the plot to cover a different range of voltages that I got enough lines to see what was going on in the region of interest. As you add plots you get a new scale in the upper left, but sometimes the old one is on top of the new one. You can move the scales around with your mouse.
 - iii. You can use “Window:Refresh” to clear the window for a new plot or “Window:Zoom” to zoom in, although you must replot or redisplay the plot after zooming.

- iv. To print a plot, go back to the very first toolbar window that opens when you first start Maxwell. (It is probably underneath many other windows on your screen.)



Clicking the "print" icon will open a screen-grabber utility. Select "Grab Screen" and then select the area to print: click on one corner, and complete the outline with a second click. You can now use the file menu of the screen grabber to print the file or save a bitmap image.

- v. The real power of the post-processor is in the calculator. Not only can it give you numerical values, but it can also let you calculate new things to plot. But that is a subject for another handout.