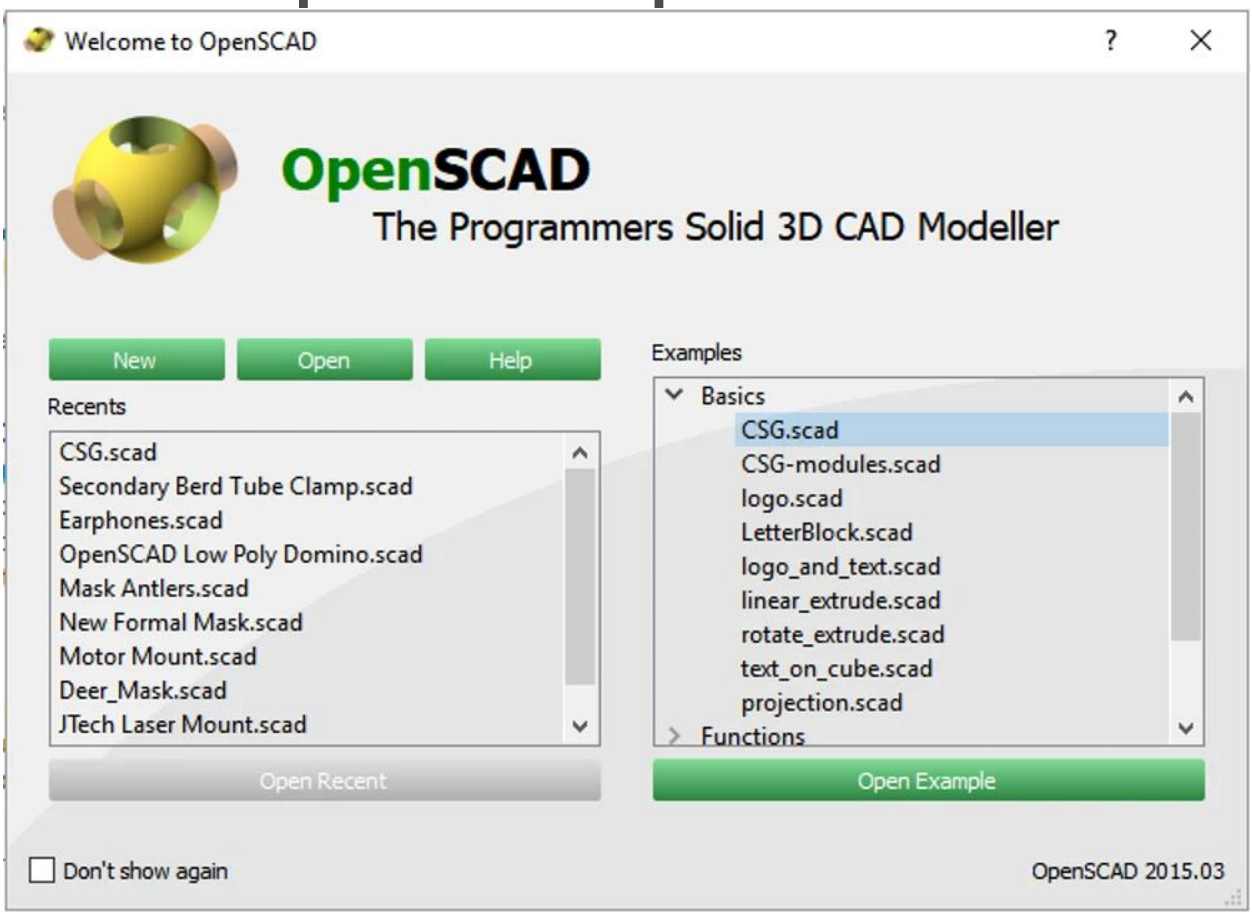
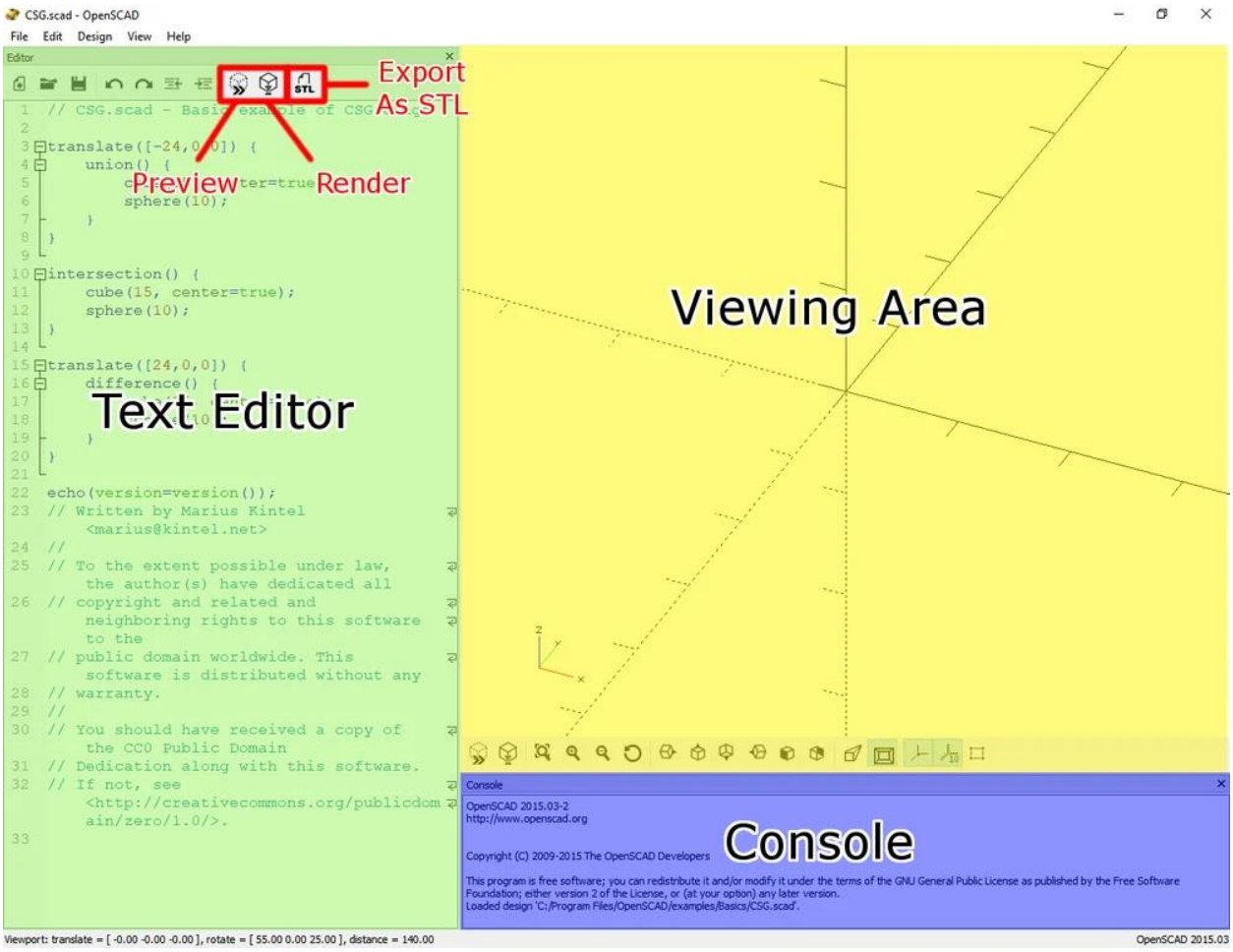
1b. The OpenSCAD Splash Screen



2a. The OpenSCAD Interface: The Text Editor

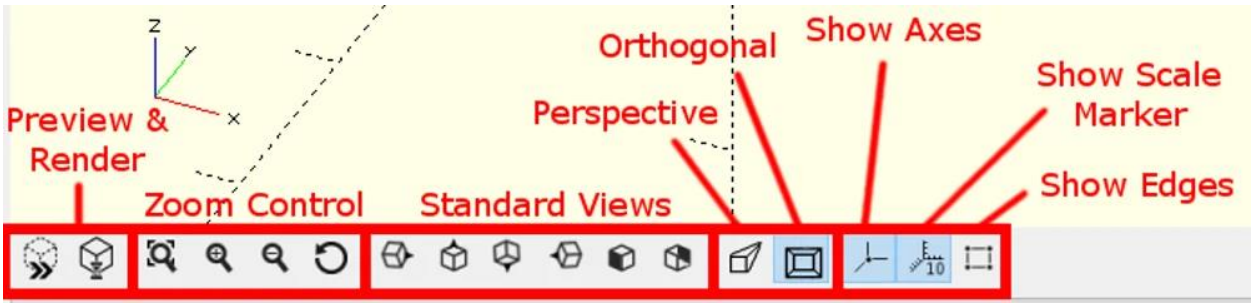
In the Examples box, go to Basics > CSG.scad, then click “Open Example” to open the simple CSG example file.



Let's begin by checking out the basic sections of an OpenSCAD window. The interface of OpenSCAD is very simple, consisting of only the **Text Editor**, the **Viewing Area** and the **Console**. Code is entered using the Editor, and the resulting model is shown in the Viewing Area. Most of the buttons in the Editor are pretty self-explanatory (New, Open, Save, etc.). The interesting ones are the Preview, Render and Export as STL buttons.

Hitting **Preview** will generate a quick model in the Viewing Area. This quick model shows the general idea of what the model will look like, but it's not the final calculated 3D model. Pressing **Render** tells OpenSCAD to calculate the final 3D model, which shows you the exact readout but takes longer to generate than a preview. After a model is rendered, **Export as STL** will open up a window to save your model as an STL.

2b. The OpenSCAD Interface: The Viewing Area

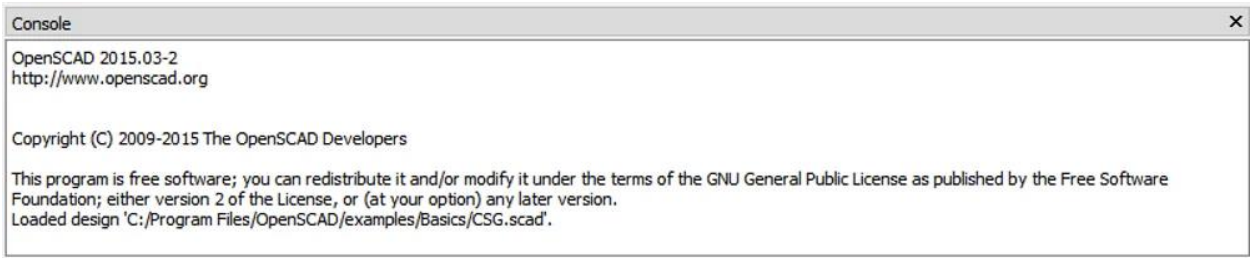


The Viewing Area displays the 3D model. The Preview and Render buttons are the same as in the Editor. The two middle clusters of buttons control the "camera" in the Viewer: the left-hand ones allow you to zoom or reset the view, and the right-hand ones snap the camera to standard views.

The last cluster of buttons include the Perspective/Orthogonal buttons, the Show Axes and Show Scale Marker buttons, and the Show Edges button. Switching between Orthogonal and Perspective changes whether the model is shown isometrically or with perspective. (The Orthogonal view is usually better for making mechanical models and Perspective is better for decorative models).

2c. The OpenSCAD Interface: The Console

The Console appears below the Viewing Area, and shows technical information regarding calculated models. It also shows a record of when you save or export a model, and displays the readout from **echo()** statements. Those who aren't concerned with the under-the-hood technical calculations needn't worry about the Console.



Objects, Actions, Operators and Variables

Every model constructed by OpenSCAD is built from a combination of **Objects**. Objects are primitive shapes like cubes, cylinders and spheres, and form the backbone of every model. Objects are created by **Actions** and modified by **Operators**, with **Variables** and **Comments** further enhancing the code.

- **Actions** are used to create objects or define variables. For example, Cube(), Cylinder() and Sphere() are actions that create their corresponding primitive Objects.
- **Operators** modify Objects. There are lots of different Operators, and they are used to change many different properties of an Object, such as its size or position.
- **Variables** contain values such as numbers, strings (i.e. text), vectors and lists. The information stored in variables can be used by Actions, Operators or other variables. (Variables will be discussed a little later in this OpenSCAD tutorial, in Section 5.)
- **Comments** are used to provide extra information to anyone reading the code. They're usually used to provide general information about the code (like the original author and publishing date) and explain the logic and reasoning behind particular lines. Comments do not affect Objects and are effectively ignored when OpenSCAD interprets and renders the code.

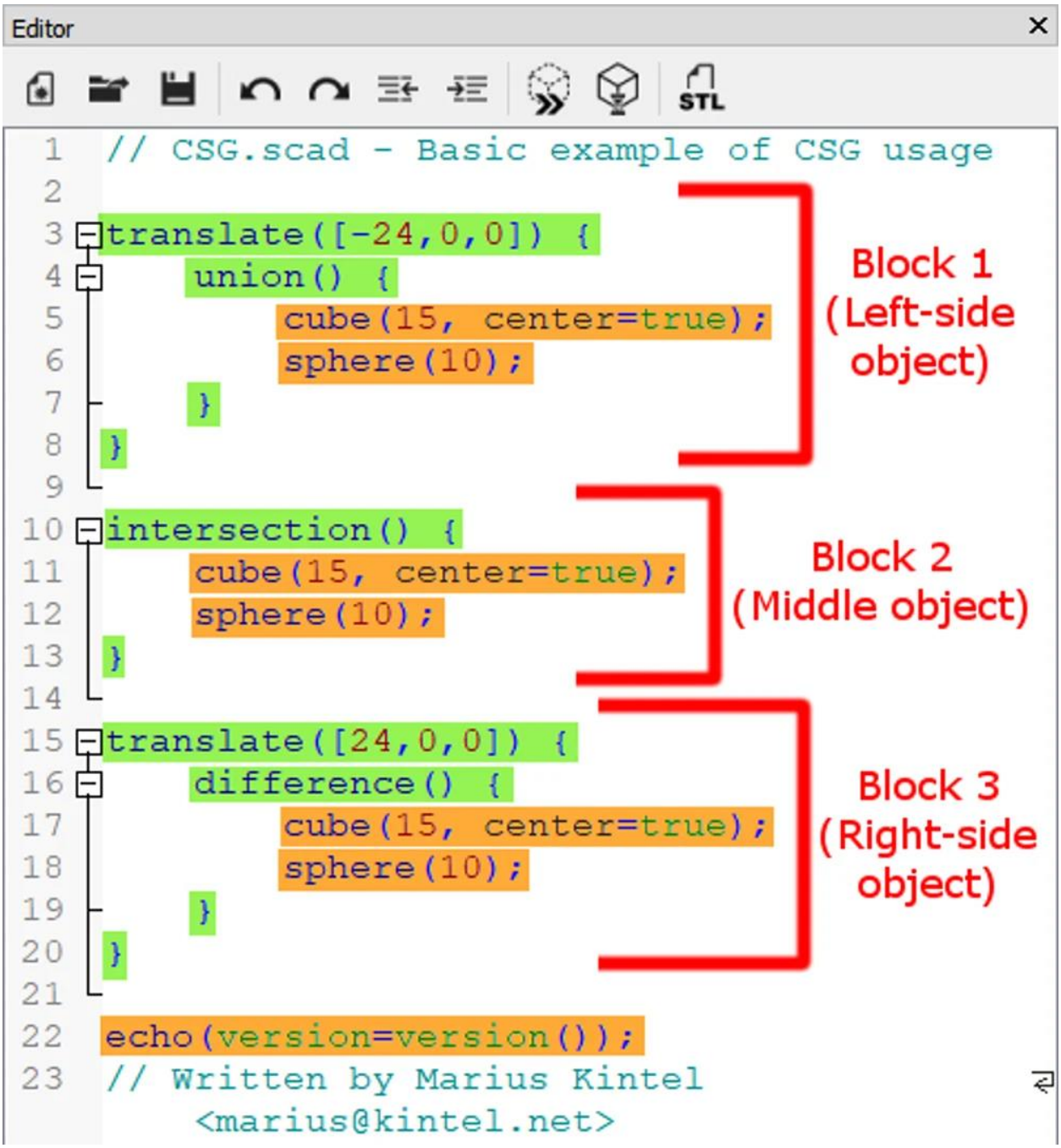
(There are also Vectors, Lists, Modules and Functions, but we'll deal with these advanced concepts in a different OpenSCAD tutorial!)

All of the Objects, Actions and Operators usable by OpenSCAD, along with information on how to use them, can be found in the OpenSCAD User Manual. We'll stick with the simplest ones for this tutorial, but just remember there's a huge toolbox to use once you've gotten comfortable with the basics.

With that out of the way, let’s take a look at CSG.scad to see some live examples of Actions and Operators!

4a. The CSG.scad Example: Combining Objects with Union

Before doing anything, we should save the file under a different name. We’ll be playing around with the code in this tutorial, so we’ll want to keep a safe copy of the original version. Go to File > Save As… and save it as “CSG_tutorial.scad”. Once that’s done, hit the Render button to see the objects that CSG.scad generates. This example makes three separate Objects, using different combinations of Operators and Actions.



Let's take a closer look at the code. When reading OpenSCAD code, it's easier to think of things as "blocks" of code, rather than reading it line-by-line. There are three blocks in CSG.scad, whose boundaries are marked by the black lines on the left side of the code. Each block contains two Actions (Cube and Sphere) along with one or two Operators (Translate, Union, Intersection, Difference).

Let's take a look at the first block of code (starting at the 3rd line and ending at the 8th line). This block defines the shape on the left of the Viewing Area, the sphere inside the cube. This block of code contains two Operators and two Actions:

- **Translate** is an Operator that moves an object according to the given [X,Y,Z] parameters. In this case, it moves an Object -24 mm down the X-axis.
- **Union** is an Operator that combines all of the Objects within its curly brackets into a single Object.
- **Cube** is an Action that creates a cube Object. In this case, the side of each cube is set to 15 mm, and the "center=true" statement tells the Action to draw the cube from the center.
- **Sphere** is an Action that creates a sphere Object. Because the number hasn't been defined as either a radius or a diameter, OpenSCAD assumes it's a radius.

This block demonstrates two critical concepts for working in OpenSCAD. The first is that **Operators are applied only to the Objects within its boundaries**. The Union Operator in this first block only combines the Cube and Sphere that are within its boundaries, and none of the other Objects within this file. Similarly, the Translate Operator in this first block only applies to the Unioned Object. If it didn't, all the Objects in this file would be centered at -24 on the X-axis! (Also note that the boundary of an Operator is defined with a pair of curly braces, and that everything inside its boundary is indented by one level.)

The next important concept is that **OpenSCAD always performs Operations sequentially, starting from the Operator that's closest to the Object and working outwards.** So in this block, the Union operation is performed on the Cube and Sphere first, then the Unioned Object is moved by Translate. Even when working with large, complex combinations of Operators and Actions, start at the innermost Objects/Actions and work backwards until you reach the uppermost Operator.

(Sharp-eyed readers might notice that swapping the Operators in this block wouldn't have any effect on the resulting Object, as Union would work the same even if the Cube and Sphere were moved first. However, there are lots of times where you need to apply Operations in a specific order, so get used to thinking about applying Operators in sequence!)