Chapter 6: Power System Blockset (PSB)

This document will not make you a MATLAB specialist, but it will provide a method for technicians to approach the software. Indeed, it was designed by mathematicians for mathematicians. In simple terms, any system can be represented by a sequence of mathematical expressions. While this approach has the merit of being the Power System Blockset (PSB), now known as Simscape Electrical **universal, it is very far removed from the needs of technicians who think in terms of elements, and not in equations. Moreover, equations quickly become very complex. Fortunately,** Simulink blocks are **MATLAB has evolved towards a more technical approach to systems by providing** electrical machines in **"Boxes" simulating the most common elements. This document will assist with this "box" approach in MATLAB.**

Note: This document is a draft version that can be improved with everyone's help. This guide was created using MATLAB version 2010A.

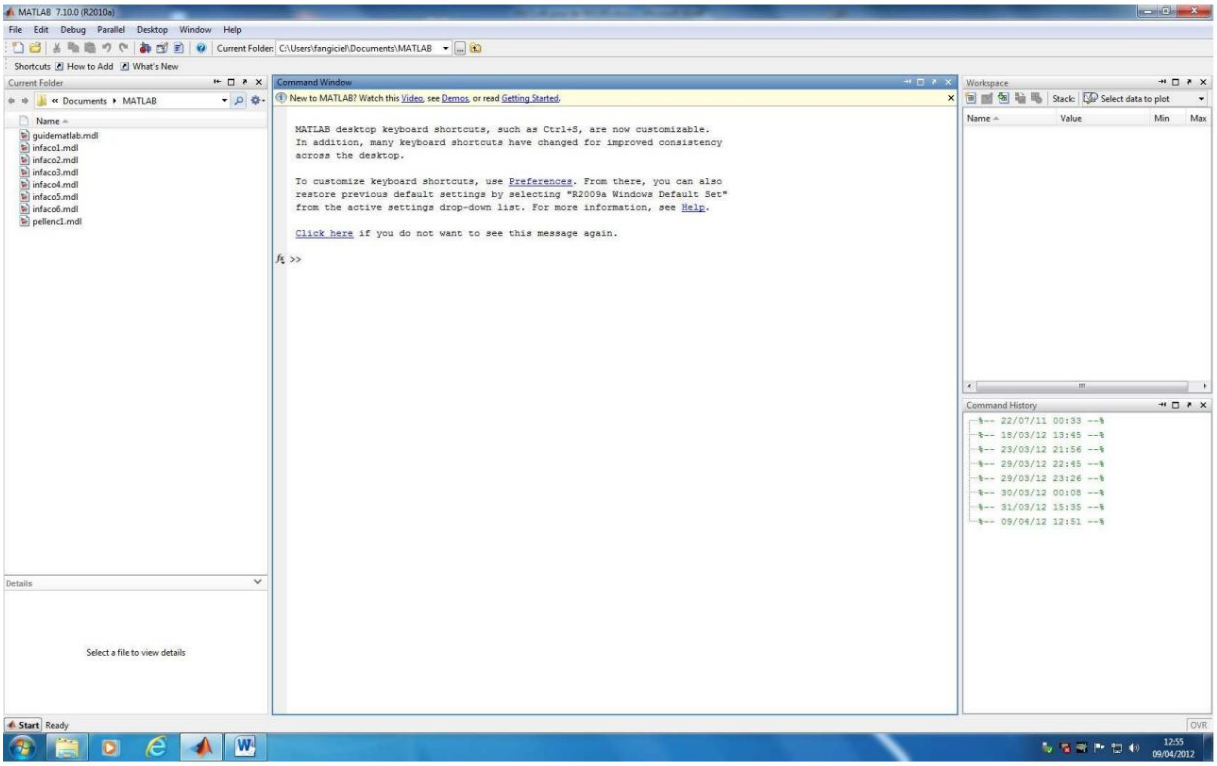
Introduction.

The biggest difficulty when wanting to use MATLAB is that most tutorials start from a mathematical approach to systems that is poorly suited to the needs of technicians.

However, there is another method. Thanks to SIMSCAPE, it is possible to model a system from a ready-made "box" by adjusting the key parameters.

A new approach.

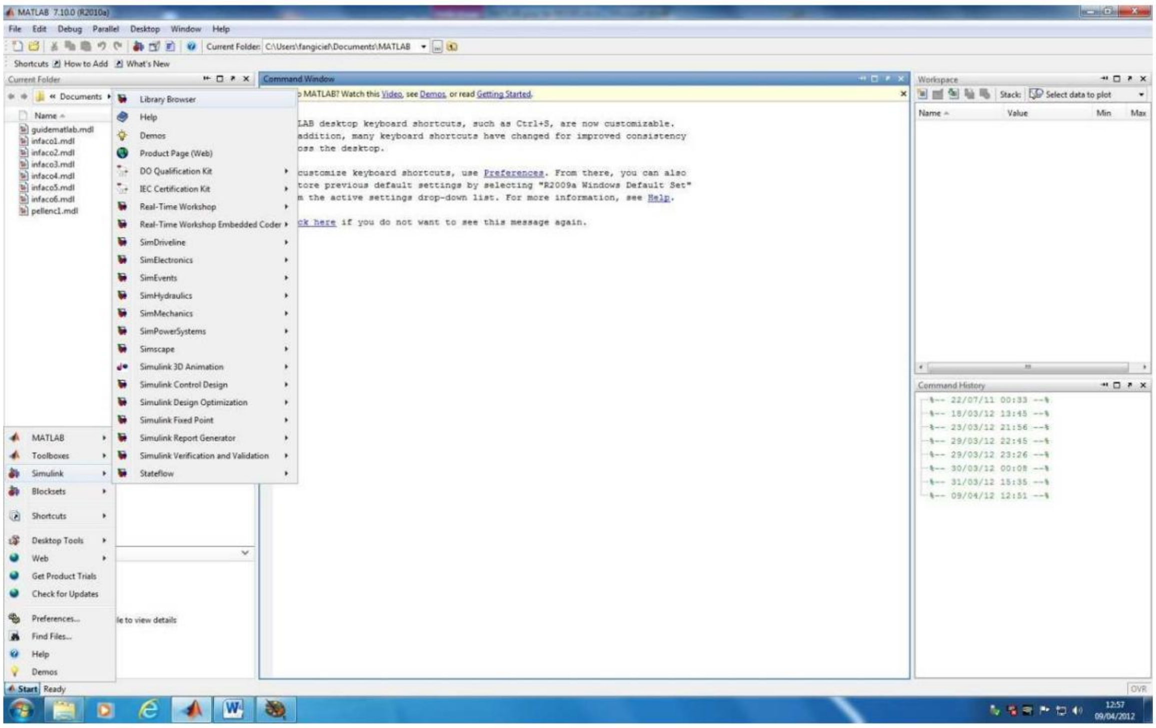
To fully understand this tutorial, you need to have MATLAB simultaneously. Once the software is launched, go to the SIMULINK module because the main MATLAB module will not be useful to us in this approach.



Bottom left:

START -> SIMULINK -> LIBRARY BROWSER

Please be patient, the new window takes a while to open. Start by familiarizing yourself with the available "boxes" by looking at the different ready-to-use functions. Then focus your attention on the SIMSCAPE "boxes," which contain the essentials for our multiphysics system needs.



You can also choose directly by category:

START -> SIMULINK -> SIMSCAPE.

A good example.

It's often said that a diagram is worth a thousand words. Therefore, in order to
To apply this wise precept, I will take as an example a simple multi-physics system, the INFACO pruner, whose operating time with batteries we wish to evaluate.

This issue was chosen because it involves several disciplinary fields.

Here is a short presentation of this system which will serve as our central theme for this study. The system consists of a battery bank providing electrical power, and a motor with safety features for cutting force and temperature (safety features are not covered in this guide). To reduce motor speed and increase torque, the system includes a gearbox (the type of gearbox is irrelevant in Simulink since it uses a generic model that only considers the reduction ratio, but it is possible to adjust the efficiency by adding a gearbox, which will be explained later). The cutting system does not need to be modeled as such because, for the operating time simulation, only the cutting force needs to be considered.

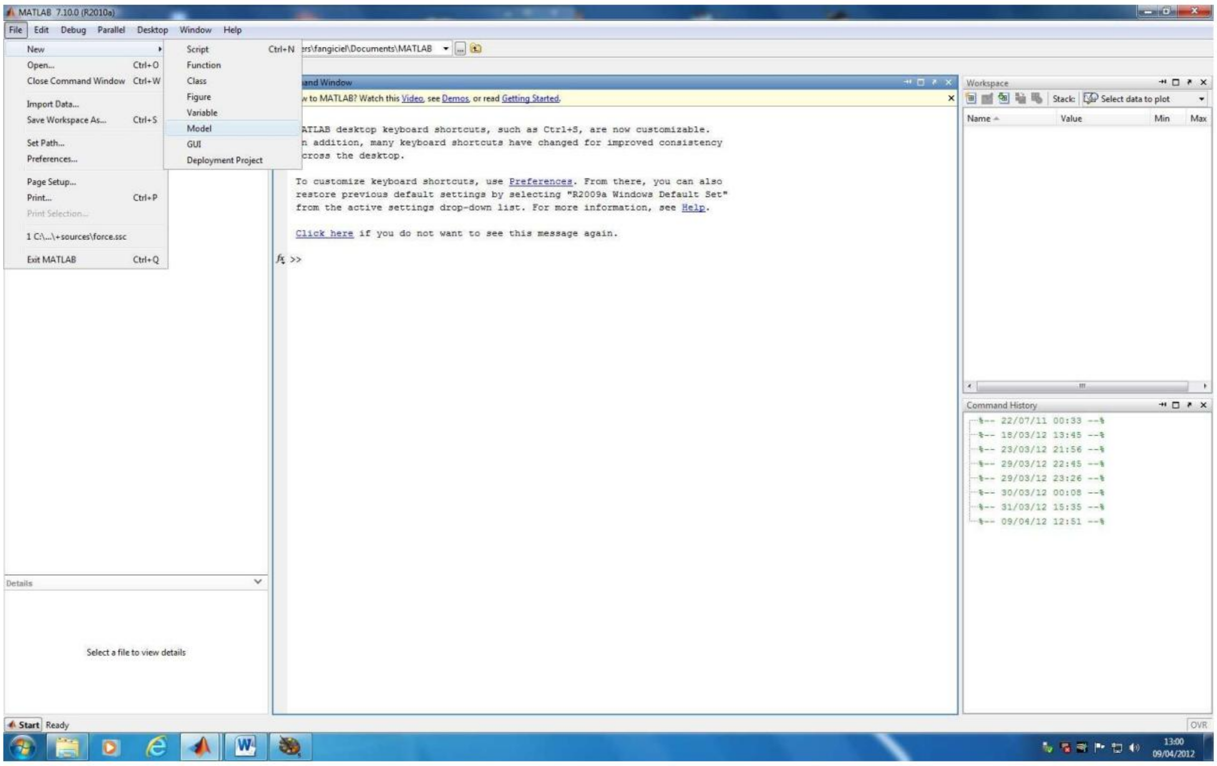
account.

Reminder: in a DC motor, the current is proportional to the torque, therefore to the energy consumed.

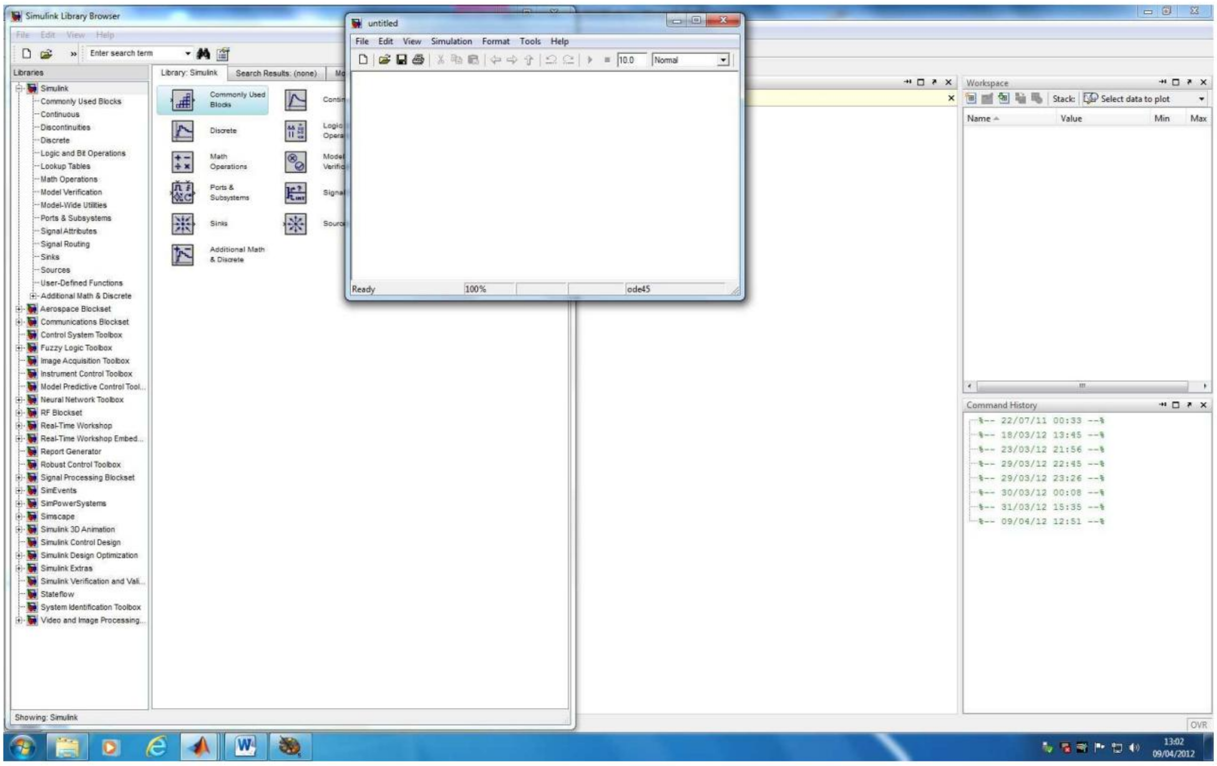
Furthermore, the absence of modeling of the cutting system is imposed because there is no ready-made module in SIMSCAPE to represent a scissor cutting system.

It's time to model with SIMSCAPE. To be able to exit the environment of MATLAB do:

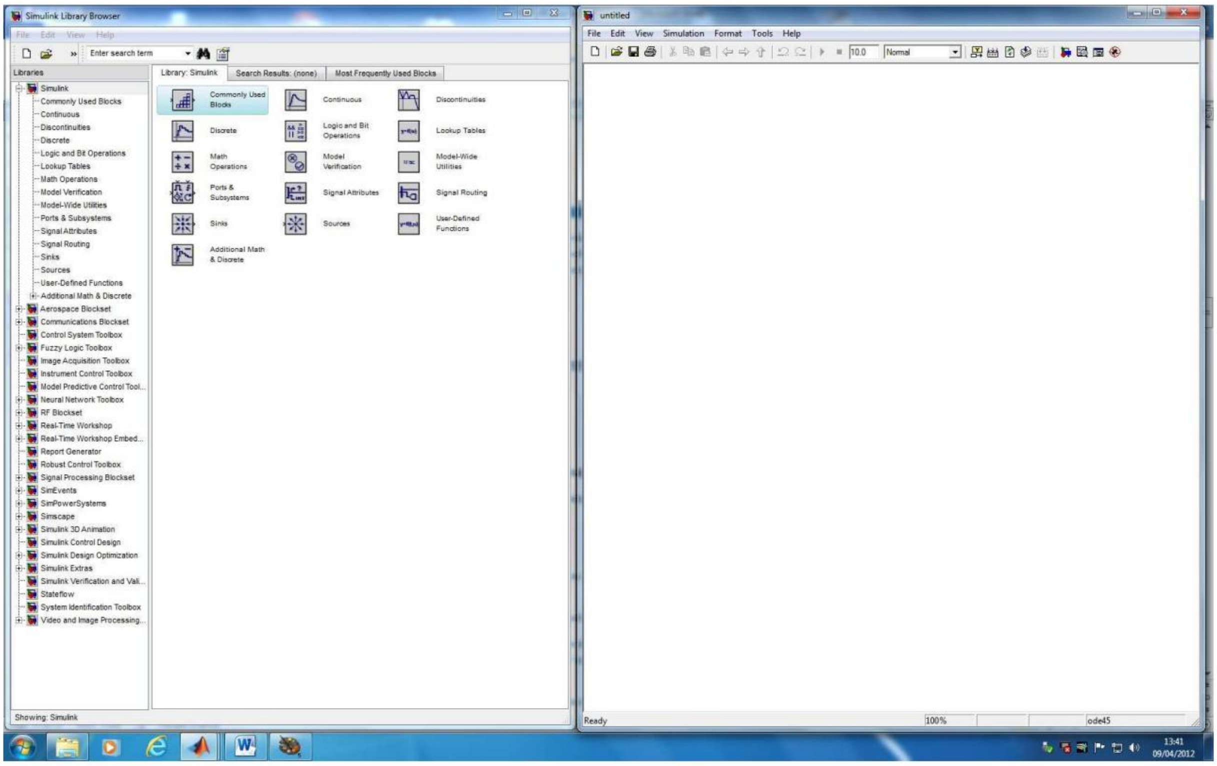
FILE -> New Model.



Normally a window named "untitled" opens which will allow us to create our model from the "boxes" of SIMSCAPE.



To obtain a comfortable workspace, resize the "LIBRARY BROWSER" window to occupy the left half of your screen and then do the same for the simulation window on the right side of your screen (FULL HD screen recommended).



Note: MATLAB, LIBRARY BROWSER and UNTITLED are independent windows.

Since the electrically oriented part is the beginning of the diagram, it will be dealt with first.

He was one of the "Boxes".

In this guide, the approach is to create the model of the pruning shears without any mathematical equation.

The first "box" we're going to use is "BATTERY".

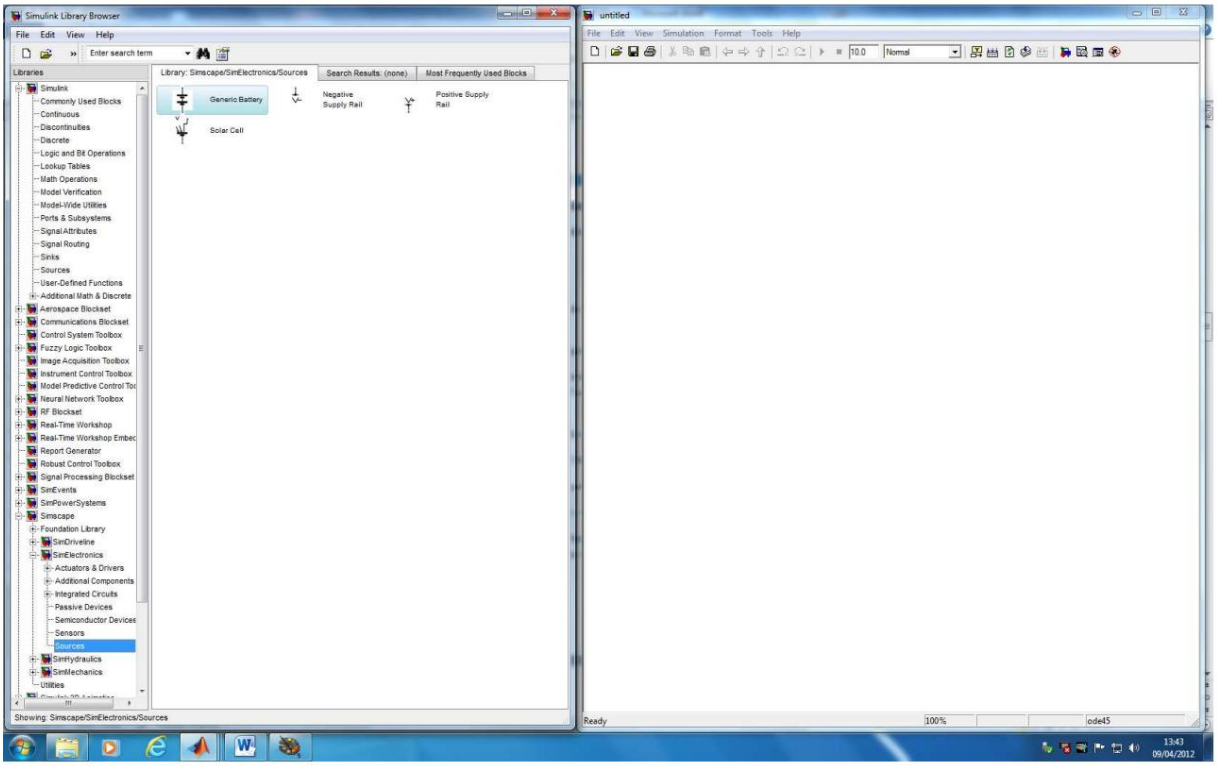
Normally, the SIMSCAPE selection window is always open on the left side of your screen. For those who may have accidentally closed it, here's what to do:

Activate the MATLAB window, then click on the bottom left corner:

START -> SIMULINK -> LBRAIRY BROWSER.

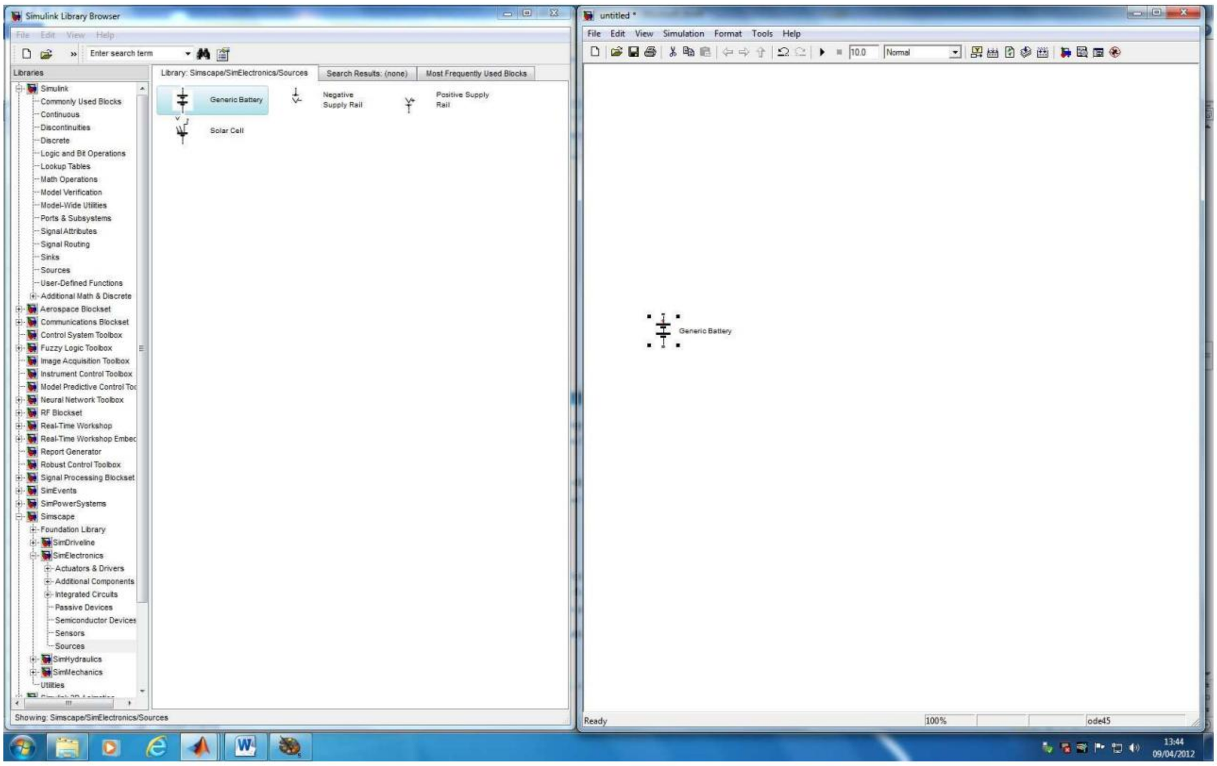
From here onwards, for everyone (click on the small "+" box to expand the possibilities):

SIMSCAPE -> SIMELECTRONICS -> SOURCES.



It is important to make the effort to navigate the "LIBRARY BROWSER" before creating a model, in order to memorize the different functions available for slicing the system real in a series of "boxes".

Drag and drop the "BATTERY" symbol onto the simulation window that is normally called "untitled" and place it on the left edge.



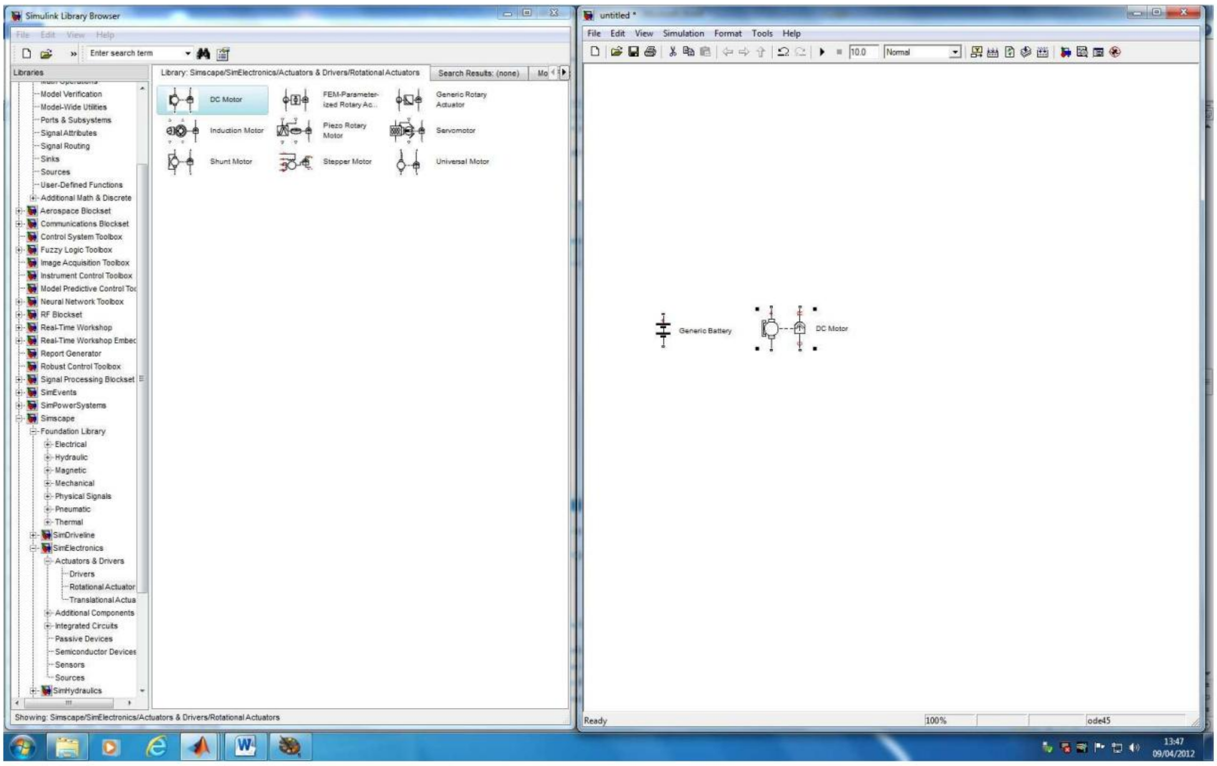
Now we need an engine.

Note: as the electronics only ensure the safety of the motor in case of blockage or excessive cutting force, it will be agreed that its consumption is negligible in normal operation and will not be shown.

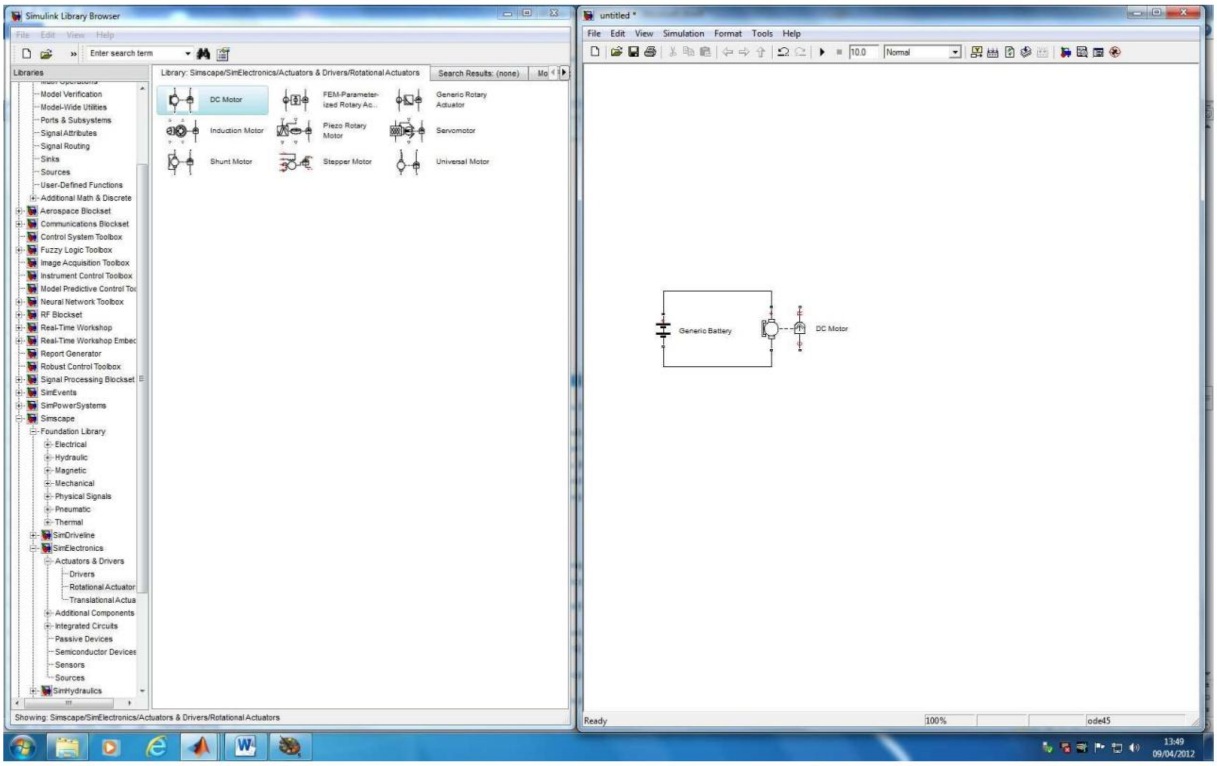
As with the previous box, simply search for "DC MOTOR" in SIMSCAPE. Here's the Instructions:

> **SIMSCAPE -> SIMELECTRONICS -> ACTUATOR AND DRIVERS -> ROTATIONAL ACTUATOR -> DC MOTOR.**

Drag and drop "DC MOTOR" into the simulation window and place the motor just to the right of the battery.



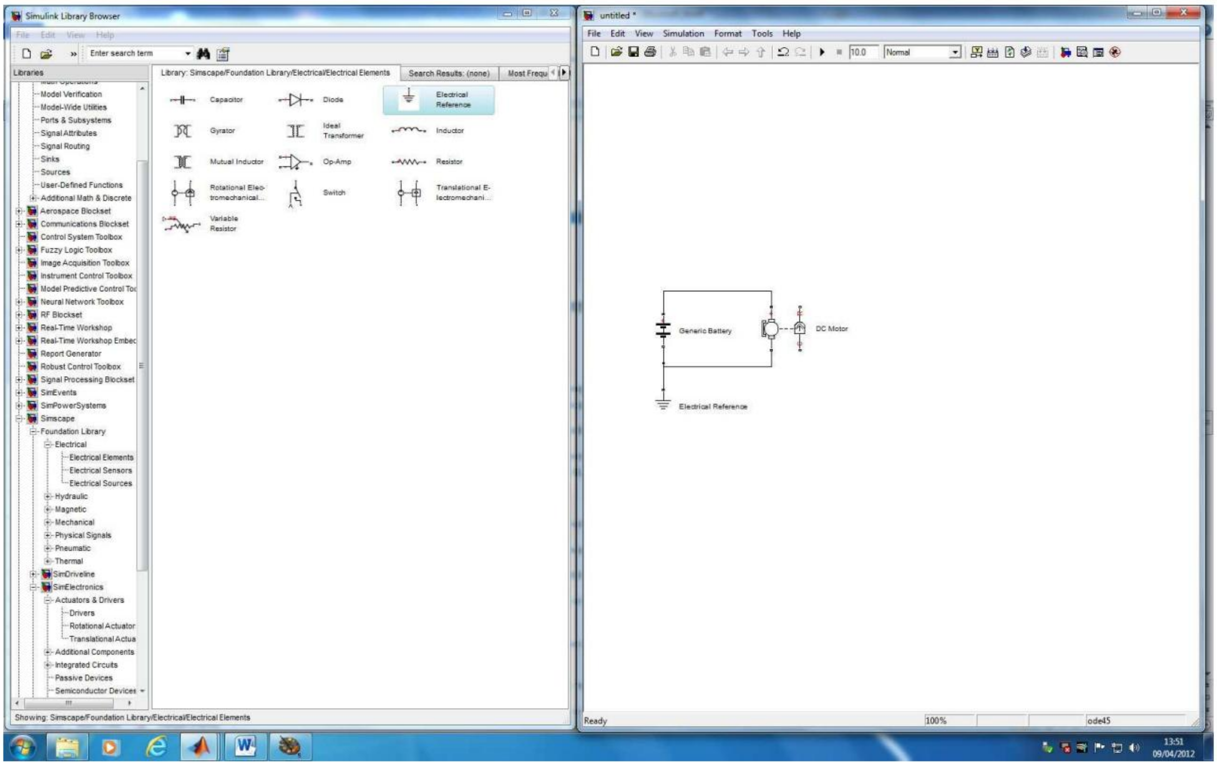
To connect the wires, take the mouse, then click and hold the mouse button on the starting point of your wire. Move your mouse to the destination point. If your cursor changes to a double cross, you've reached the correct location and you can release the mouse button. Otherwise, try again at another location. You must connect one wire from the positive (+) terminal at the top of the generator to the motor, and the other from the negative (-) terminal at the bottom of the generator to the motor.



For an electrical diagram, we are missing the reference point (ground if you prefer, which will also be true for the mechanical part and it will be independent).

SIMSCAPE -> FONDATION LIBRARY -> ELECTRICAL -> ELECTRICAL ELEMENTS.

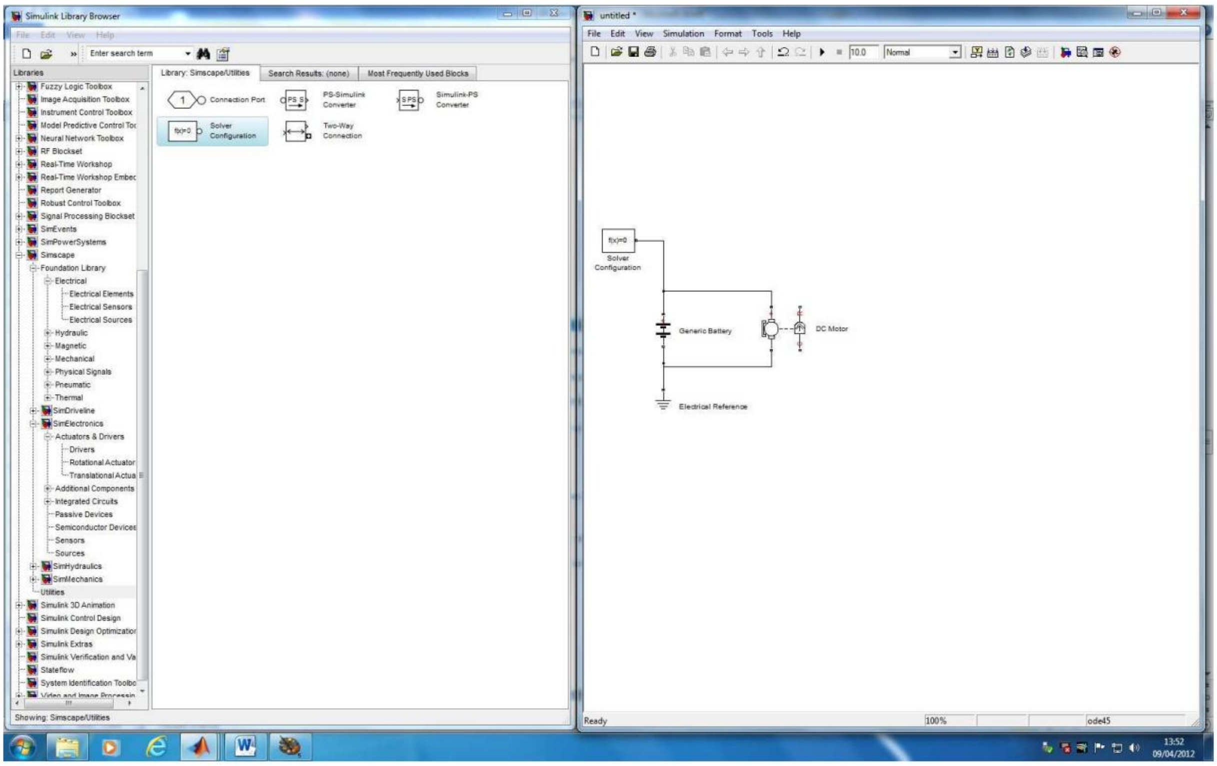
Select ELECTRICAL REFERENCE then drag and drop onto the simulation window onto the – (minus) of the generator then put a wire.



For MATLAB to perform the calculations, a special module called "SOLVER" must be used:

SIMSCAPE -> UTILITIES -> SOLVER CONFIGURATION.

Place “SOLVER” in the top left of the simulation window and then connect it with a wire to the + (positive) of the generator.

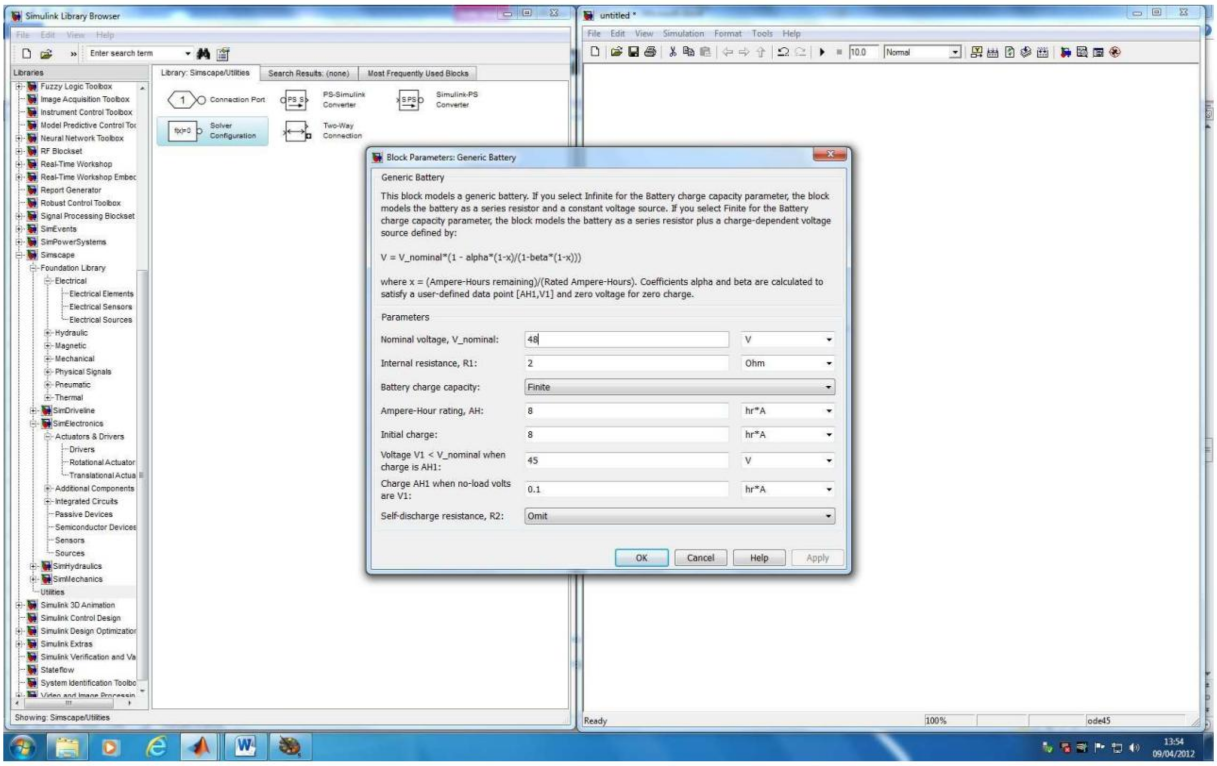


For the electrical part, all that remains is to enter the values by double-clicking on the "boxes".

Note: Values not specified remain at their default values.

For the battery: (value indicated in the technical file of the pruner)

NOMINAL VOLTAGE = 48V	**Open circuit voltage**
BATTERY = FINITE	**Real battery**
Ampere Hour Rating = 8 Ah	**Battery capacity**
INITIAL CHARGE = 8 Ah	**Load value at the start of the simulation**
VOLTAGE V1 = 45V	**Voltage at nominal current**
CHARGE AH1 = 0.1A	**Charging current.**



For the engine: (value indicated in the specifications)

Choose: BY RATED, POWER RATED SPEED AND NO LOAD SPEED

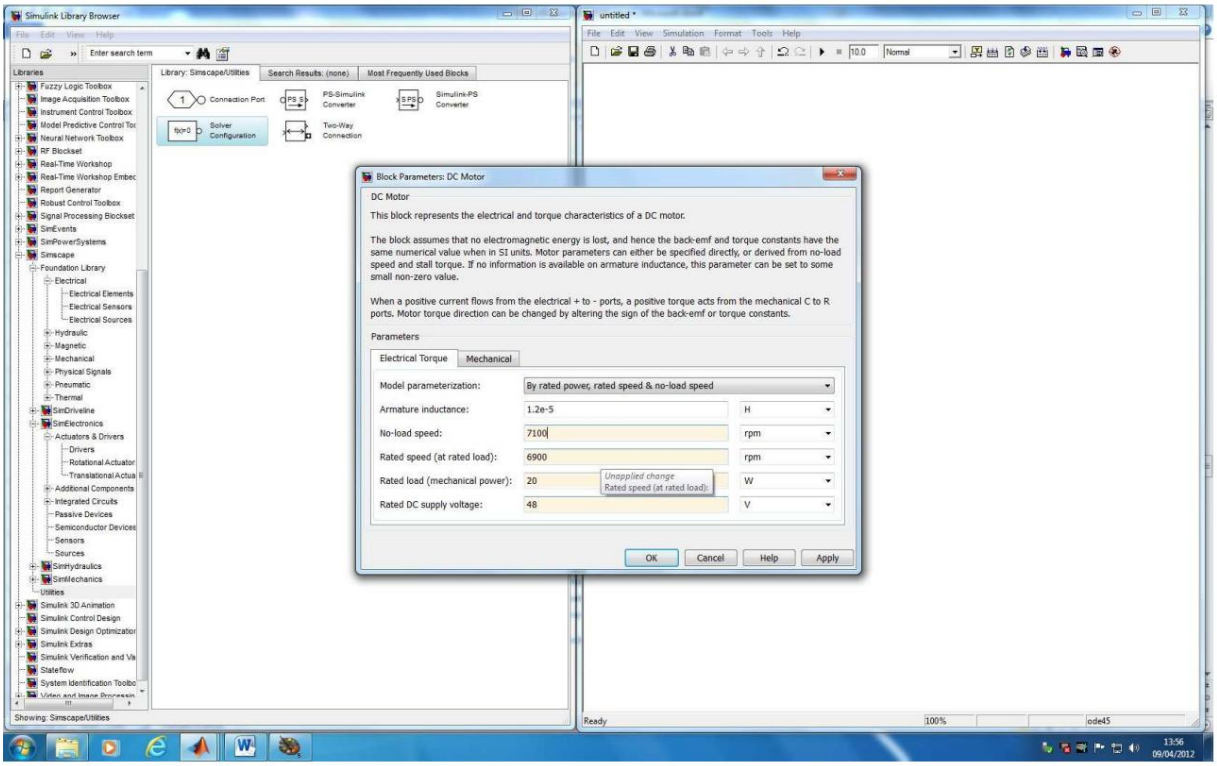
Then :

NO LOAD SPEED (no-load speed) = 7100 RPM

RATED SPEED AT LOAD = 6900 RPM

RATED LOAD (mechanical power) = 20 W

RATED DC VOLTAGE (nominal voltage) = 48 V.



We will talk about electrical measuring devices later.

MECHANICS

While electrical engineering "companies" are numerous, this is less true in mechanical engineering. where the choices are more limited, which means that compromises will sometimes have to be made, sometimes difficult ones.

For the reducer, it's simple because there's a "box" that does everything:

SIMSCAPE -> FOUNDATION LIBRARY -> MECHANICAL -> MECHANISM -> GEAR BOX.

Drag and drop into the simulation window. Connect the motor output (R) to the reducer input (S).