Eweek OpenRocket Tutorial

In this tutorial the basic functions of OpenRocket will be demonstrated in relation to the rules set up for this event. This should help you get started with the program and many items learned here can be used to design any other rocket you would like in the future! If you would like a video tutorial I have included a link to a YouTube tutorial that I found that is very short and covers a lot of the basics needed for this project

https://www.youtube.com/watch?v=egHbZUEr Co

- 1. OpenRocket can be downloaded from here <u>https://openrocket.info/</u> This is an executable jar file meaning as long as you have java already installed it will run when you open it without needing an installation.
- 2. After downloading and installing Java and the OpenRocket software, open the program. You will be greeted with a screen similar to the one below.



The region circled in red is the design tree. As you begin to build your rocket, all the components will be displayed here in a list format, showing their dependence on one another. In addition to this, once a component is created, its properties can be edited by double clicking on its icon. The region in blue is where you select components to add to the rocket. We will talk more about these icons later in this tutorial. Finally, the region in green shows a model of the rocket. From here we can visualize how the rocket will look, including all internal and external components. This region will also display Center of

Pressure (CP) and Center of Gravity (CG) distances measured from the nose of the rocket, as well as a stability margin value!

3. Select the nose cone option to get started. This will populate a nose cone into the design window and part tree and pull up a configuration window for the part.

mponent name:	Vose cone		Select preset
General Shoulder	Override	Appearance Comment	
Nose cone shape: Shape parameter:	Ogive		An ogive nose cone has a profile that is a segment of a circle. The shape parameter value 1 produces a tangent ogive , which
lose cone length: Base diameter:	5.906 ÷		has a smooth transition to the body tube, values less than 1 produce secant ogives
	Automa	tic 📕	Component material:
Wall thickness:	0.079	in	Cardboard (0.393 oz/in³) ~
	Filled		Component finish:

We will use the preset parts in the program's database for this component. To do this click the dropdown circled in red on the top right

inponent name:	vose coné			Sel	ectpreset
eneral Shoulder	Override	Appearance	Comment	Fro	ect preset m database
lose cone shape:	Ogive	~		An ogive nose cone has a pro	The start is a
hape parameter:	1	- 1]	segment of a circle. The shap	e parameter
lose cone length:	5.25			has a smooth transition to the	body tube.
iose cone lengui.	5125			values less than 1 produce se	cant ogives.
ase diameter:	1.63	in —			-
	Automa	atic		Component material:	
Vall thickness:	0.815	in —]	Balsa (0.074 oz/in³)	~
	Filled			Component finish:	
				Regular paint (2.36 mil) 🗸 🗸	Set for all

Checkmark the component you want to use, this adds it to the pull down menu **but does not apply the part**. Once you hit ok you need to use the pulldown select part menu again and the option you chose will be there to select. This process will be used for the nose cone, body tube, tube couplers, and inner tubes if needed in your design. Make sure the nose cone shoulder fits the inner diameter of the tube you select

4. To make fins, parachutes and other internal components of the body tube you must first select the tube in the parts tree or design window so that OpenRocket knows you want that component to be the parent. You will see that the part types that were greyed out before become active once you do this. There are three types of fins you can use, trapezoidal, elliptical, or freeform. Freeform will allow you to set custom geometry for the fins while trapezoidal is a standard shape defined by these parameters. It is up to you to



Figure 10 - Rocket Body and Fin Inputs geometry definitions.

design this part however the material you specify must be either plywood(birch) minimum thickness of 1/8in, aluminum, or carbon fiber. The Component Material

neral Fin tabs C	Override	Appearance	Comment
umber of fins:	3	÷	Fin cross section: Pounded
in rotation:	0	•	
in cant:	0	•	Component material:
oot chord:	1.969	🔶 in	Plywood (birch) (0.364 oz/in³) V
ip <mark>chord:</mark>	1.969	≑ in	Component finism:
eight:	1.181	÷ in	
weep length:	0.984	🔹 in	Root Fillets
weep angle:	39.8	•	Fillet radius: 0 🔶 in
osition relative to:	Bottom	of the parent	omponent v
plus	0	🔶 in	

dropdown is where you can set this circled in red. Any bulkheads and centering rings

added must also follow these same material selection parameters.

5. Next add the parachute and shock cord to the main body tube. The sizing of the parachute will need to be changed based on the results of the simulations that will be run later. Do not change default ripstop nylon and drag coefficient. Shroud lines can be left at default values for simplicity. Shock cord should be made out of 14mm Tubular Nylon and be 3x the total length of the rocket.

nponent name: Parachute					Select preset	
eneral Radial position Override Appearance Comment						
Canopy:	Position relative to:	Top of	the pa	arent co	omponent	~
Diameter: 11.811 🔷 in	plus	1.26	÷	in	—	
Drag coefficient C _D : 0.80 • Reset	Packed length:	1.654	÷	in		
Material: Ripstop nylon (0.22 oz/ft²) v	Packed diameter:	0.709	•	in		
Shroud lines:	Deploys at: †	First eje	ection	charge	of this stage	~
Number of lines: 6	plus	0	sec	onds		
Material: Elastic cord (round 2mm, 1/16 in) (0.019 oz/ft) v	Altitude:†	656	÷	ft	·]	
	† This parameter can	be overr	idden	in each	flight configuration	on.

nponent name: Shock cord	
eneral Override Appearance Comment	
nock cord length: [50 🔷 in 🚽	Position relative to: Top of the parent component
Shock cord material:	plus 0.787 🚖 in
Tubular nylon (14 mm, 9/16 in) (0.172 oz/ft) 🛛 🗸	Packed length: 2.047 🖨 in 🖳
	Packed diameter: 0.472 文 in 🕒

6. Next a motor needs to be selected. Click on the Motors & and Configuration tab on the top of the screen. Then on the side where it says motor mount select the tube that will hold the motor. The New Configuration button will then become active, click it then

*A simple model rocket					
ile <u>E</u> dit Tools <u>H</u> elp	4				
Rocket design Motors & Configuratio	n Fig				
		New Configuration	Rename Configuration Re	emove Configuration	Copy Configuration
Motors Recovery Stages					
Motor mounts:	Configuration			Inner Tube	
Body tube				1 2012 2020	
Inner Tube	-				
iew Type: Side view 🗸 🍃	Fit (100%) V Stage 1				
0° in .1 .0.5 0	0.5 1 1.5 2 2.5 3	3.6 4 4.6 5 5.5 6		8.5 9 9.5	10 10.5 11
A simple model rocket					
Length 16.732 in, max. dk	ameter 0.964 in I oz				

double click on the new line it creates where it says none highlighted in blue.

- 7. In the motor selector limit the total impulse to H or below. Using a motor higher than H will be disqualified in this competition. The motor must also match the diameter of the tube that you used as your motor mount. A motor block will be needed above the motor to stop it from shooting through the rocket when ignited
- 8. Once a motor is selected it should poluate in the design window. If it is not there use the Flight Configuration drop down on the right. With a motor in place you will need to adjust

the size and shape of the rocket and fins until you find a configuration with a stability margin of 1.3 or higher. The rough estimate of this can be found on the right of the screen circled in red however this is for .3 mach and may not be the critical stability margin needed at rail departure. This will be assed in the simulation plots later.

View Type: Side view Image: Side view	4 45 5 55 8 85 7 75 8	8.5 9 9.5 10 10.5 11	Flight configuration: [[6:5:1] ↓]
Control and a control decretable control decreta	anden on her and an an	haran daman baran daman da	nendokonski konski konski Stellit, 22 sel € (Cr. 239 m) at 44.30
2 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		9	
1 4 2 4 4 Angeles 181 1 (Mach 0.03) 2 4 Mar. availability 1 (10 18 hu ⁴ 1 Mar. availability 1 hu ⁴ Chick is select 5 Mitholds to select other Deable click to eff. Clock-drog to move			

9. Once you have a design you like go to the third tab on the top, the flight simulations tab. Click new simulation and enter the values as follows for launch conditions:

🖌 Edit simulation		· · · · · · · · · · · · · · · · · · ·
Simulation name:		Simulation 2
Flight configuration:		[A8-3] v
Launch conditions Simula	ation options	
Wind		Launch site
Average windspeed:	0 😫 mph	Latitude: 28.6 🔹 ° N
Standard deviation:	0 🖨 mph	Longitude: -80.6 🖨 ° E
Turbulence intensity:	10 🔶 % Medium	Altitude: 0 🖨 ft
Wind direction:	90 🔹 • –	
Atmospheric conditions		Length: 10 + ft
Use International	Standard Atmosphere	Always launch directly up-wind or down-wind
Temperature:	59 🗘 °F 🗕	Angle: 0 🔹 •
Pressure:	3 🗘 mbar	Direction: 90 🗘 • -
		Reset to default Save as default
		Simulate & Plot Close

10. Hit simulate and plot and set up the plot with these parameters, they will help you in refining your design to meet the mission requirements

🖋 Edit simulation					×
Simulation name: Simulation 2					
Plot data Export data					
Preset plot configurations: Cust	tom				~
X axis type: Time	√ Un	it: s	The da axis typ	ta will be pe is not	plotted in time order even if the X time.
Y axis types:					Flight events:
Altitude	✓ Unit: ft	Axis: L	eft 🗸	8	Launch
Vertical velocity	✓ Unit: ft/s	Axis: /	Auto 🗸	8	
Stability margin calibers	✓ Unit:	Axis:	Auto 🗸	0	Motor burnout
Mach number	✓ Unit:	Axis: A	Auto 🗸	8	Apogee
					Recovery device deployment
					Simulation end
<				>	All None
New Y axis plot type					
<< Edit					Plot Close

11. Your simulation will look something like this example. From this plot you will need to assess your stability margin based on what it is at launch rail clearance. For parachute sizing look at the vertical velocity after apogee or use the ground hit velocity in the



simulations page. Additionally you will need to select the ejection delay so that it occurs near apogee and at a low velocity. You can zoom in the plot by creating a selection box

with your mouse where you want the new view to include. The simulations page will tell you a time to apogee you can use to adjust the value. Ejection charge time is set in the

Select thrust curve:	C6 ~						Show Details						
Ejection charge delay:	r: 5 ~ ~						Hide motors already used in the mount						
(1 Hide very similar t	Number of seconds on hrust curves	"Nane")					AMW/ProX AeroTech						
Manufacturer	Designation	Total Imp	Туре	Diameter	Length		Alpha Hybrid Rocketry LLC						
Estes	A8	2	Single-use	0.709 in	2.76 in	~							
Klima	A6	2	Unknown	0.709 in	2.76 in								
Quest	A6Q	2	Single-use	0.709 in	2.76 in		Central Dedicts						
Quest	A8	2	Single-use	0.709 in	2.72 in								
Southern Cross Rocke	. A8	2	Single-use	0.709 in	2.76 in								
WECO Feuerwerk	A8	3	Single-use	0.709 in	2.76 in		Clear All Select All						
Estes	B6	4	Single-use	0.709 in	2.76 in								
Estes	B4	5	Single-use	0.709 in	2.76 in		Total Impulse						
Klima	B4	5	Unknown	0.709 in	2.76 in								
Quest	B6Q	5	Single-use	0.709 in	2.76 in								
Southern Cross Rocke	. B6	5	Single-use	0.709 in	2.76 in								
WECO Feuerwerk	B4	5	Single-use	0.709 in	2.76 in		A D C D L I O II I J K L H N C						
WECO Feuerwerk	C6	7	Single-use	0.709 in	2.76 in								
AeroTech	C3.4	9	Unknown	0.709 in	2.83 in		Motor Dimensions						
Apogee	C4	9	Single-use	0.709 in	1.97 in		Motor mount dimensions: 0.709 in x 2.95 in						
Estes	C5	9	Single-use	0.709 in	2.76 in		Diameter						
Quest	C6	9	Single-use	0.709 in	2.76 in								
Apogee	C10	10	Single-use	0.709 in	1.97 in		Limit motor diameter to mount diameter						
Estes	C6	10	Single-use	0.709 in	2.76 in								
Klima	C2	10	Unknown	0.709 in	2.76 in								
Klima	C6	10	Unknown	0.709 in	2.76 in		0 0.512 0.709 0.945 1.14 1.5 2.13 2.95 3.86 -						
Southern Cross Rocke	. C6	10	Single-use	0.709 in	2.76 in		Length						
AeroTech	D2.3	17	Unknown	0.709 in	2.83 in		Limit motor length to mount length						
Apogee	D3	18	Single-use	0.709 in	3.03 in								
Klima	D3	18	Unknown	0.709 in	2.76 in								
		1	1										

motor selection window as shown

12. From there iterate on your design until it follows all the rules and have fun! If you need help you can join the UB SEDS Discord:<u>https://discord.gg/gU5RCXHXnB</u> and use the eweek-design-challenge-help channel. Your final OpenRocket file must be submitted using the following name scheme FirstName_LastName_ClubYouRepresent to <u>william.elliott@ubseds.org</u> by Thursday 8am.