RockSim Program
Guide

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RockSim Program Guide

A guide to all features and functions.

by Paul L. Fossey

This guide provides an overview of the RockSim program suite. In large part, this document contains the same information as the on-line help files shipped with RockSim. Several sections have been added to extend on the brief information in the on-line help files.

RockSim Program Guide

Special thanks to:

All the people who contributed to this document, to my wife Kathy, and to my children, for allowing me to work on what I love, to Tim Van Milligan of Apogee Components for his continued support over the years, to the graphic artist (Shrox) who created this great product logo on the cover page.

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1 Introduction

1.1 Overview

The RockSim application is a model rocket design and flight simulation system. RockSim can help you to visualize your rocket designs and then simulate their flights with various engines and launch conditions. Please bear in mind that the results you obtain with RockSim are only a simulation. Just because the simulation results indicate a stable rocket and a safe flight, there is no guarantee that the actual rocket will behave in a safe manner. You should always follow NAR safety guidelines when launching real rockets.

2 Getting started

2.1 The presentation screens

The RockSim main screen is shown below. You can click anywhere on this image to jump to the related help topics.
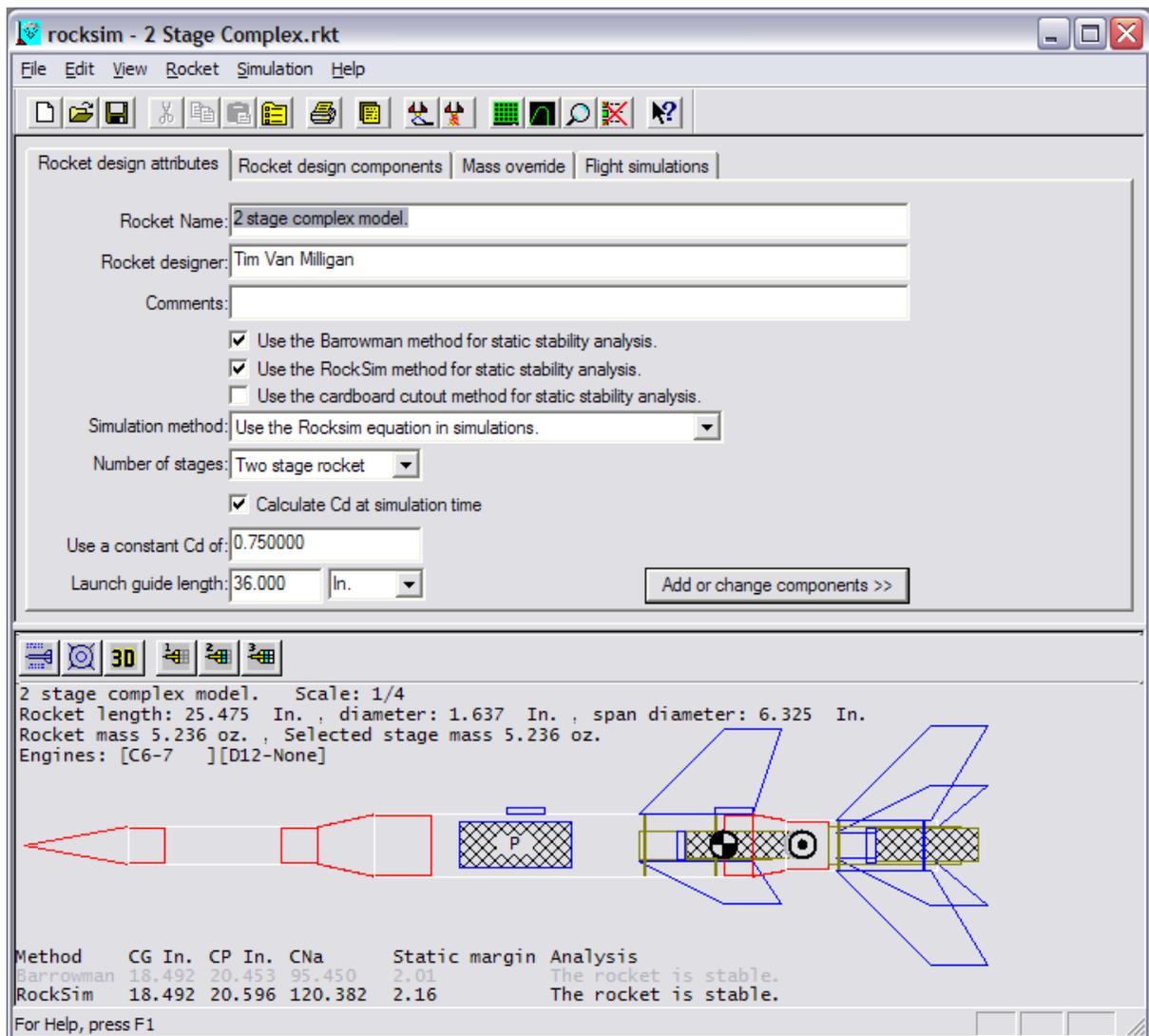
2.2   Main screen

2.2.1   Main screen overview

The main screen is divided into two areas. The upper area contains the main menu, and a tabbed data panel through which most of the rocksim design and simulation work is performed. The lower half of the main screen contains a 2D or 3D rendering of the current rocket design.

The main menu entries are as follows:
File menu - Open designs, Printing, and Export functions.
Edit menu - Standard edit functions, and access to application settings.
View menu - Design view options.
Rocket menu - Cd analysis, Flight analysis.

Simulation menu - Provides access to the various flight simulation functions.

The data tabs on the upper screen are as follows:
Rocket design attributes - Defines the general characteristics of the current design.
Rocket design components - Defines the components with which the current design is built.
Flight simulations - Displays the results of flight simulations.
Mass override - Rocket mass properties, and CP override options.

Also of interest:

2.2.2   Rocket design attributes

Rocket name is a description of the rocket.

Rocket designer is the name of the person or manufacturer who designed the model.

Comments is additional text which you can use to further describe your design.

Calculate Cd at simulation time.
This option, if selected, will enable the Cd prediction software in the simulator. The drag coefficient for the rocket design will be estimated at each iteration in the simulation. If this option is selected, then the values displayed for **Constant Cd 1**, **Constant Cd 2**, and **Constant Cd 3** are ignored.

Constant Cd 1 is the drag coefficient of the sustainer stage alone. If the design is a single stage rocket, then this is simply the drag coefficient of the rocket.
This value will be used when a launch simulation is run unless the **Calculate Cd at simulation time** option is selected.

Constant Cd 2 is the combined drag coefficient of the sustainer stage and one booster stage.
This value will be used when a launch simulation is run unless the **Calculate Cd at simulation time** option is selected.

Constant Cd 3 is the combined drag coefficient of the sustainer stage and two booster stages.
This value will be used when a launch simulation is run unless the **Calculate Cd at simulation time** option is selected.

Rocket configuration describes the stage configuration for the rocket. There are three possible configurations available. A **Single stage** rocket consists of only a sustainer. A **Two Stage** rocket consists of a sustainer, and a single booster stage. A **Three stage** rocket consists of a sustainer and two booster stages. The Rocket configuration can be changed at any time during the design of a rocket. In other words you can simulate the launch of only the sustainer in a multiple stage rocket by temporarily selecting Single stage configuration, and then running a new simulation.

Static stability display method specifies which method(s) of static stability analysis you wish to display for your design. The results of each method selected are displayed with the rocket image on the 2D Side View screen. You have three analysis methods to choose from. They are described below.

Barrowman:
Rocket designs that are comprised of standard nose cone, transition, and fins shapes can be analyzed using the Barrowman equations. These equations have been proven over the last 30 or so years and are quite reliable within their constraints.

Rocket designs that do not fall into the Barrowman equation model require alternate CP determination methods. The RockSim program provides two such methods.

RockSim:
This is a proprietary method of static CP determination.
It is an extension of the Barrowman equations that enables RockSim to estimate the static CP location for rocket configurations that are not supported by the traditional Barrowman equations. Additional information is available in the Appendix.

Cardboard cutout:
This is the old standby method for CP determination. It is simply a cardboard cutout of the side view of your rocket. The CP is the balance point of the cutout. This method tends to produce VERY over stable rockets. Over stable is, however much safer that under stable.

Static stability simulation method
Specifies which stability calculation method to use for simulations. You can choose from either Barrowman or RockSim. The Cardboard cutout method cannot be used for simulation calculations due to the fact that it does not yield the normal force coefficients required by the simulation system.

Also of interest:
Component layout
Mass override
Common features of all component editor screens.

2.2.3   Rocket design components

This screen is used to create or change the various components which are part of the rocket. The screen consist of three sections. On the left is a display of the current rocket components for all stage configurations. The Selected component actions section allows you to change or delete existing components. The Add new component section allows you to add new components to the rocket.

Adding new components:
In order to add a new component to the rocket design, you must first select the location on the rocket where the new component is to be placed. New components are always added after the selected component. When a component is selected, the various buttons in the **Add new component** section will become available.

The following **Add new component** buttons are available:

Body tube   - (Specifications)
Bulkhead   - (Specifications)
Centering ring   - (Specifications)
Engine block   - (Specifications)
Fin set:
  Simple trapezoidal or elliptical - (Specifications)
  Free form   - (Specifications)
Inside tube   - (Specifications)
Launch lug   - (Specifications)
Mass object   - (Specifications)
Nose cone   - (Specifications)
Parachute   - (Specifications)
Sleeve   - (Specifications)
Streamer   - (Specifications)
Sub assembly   - (Specifications)
Transition   - (Specifications)
Tube coupler   - (Specifications)

Modifying existing components:
There are two ways to modify components:

* Double click the component with the left mouse button.
* Select the component and then press the **Edit…** button.
When a component is selected for modification, an appropriate component editor screen is displayed. You can have multiple editors opened at the same time.

Removing components from the rocket:
Select the component that you wish to remove, then press the **Delete** button.

Creating clustered motor mounts:
The following procedure is used to create clustered motor mounts:
1) Create an inside tube and designate it as a motor mount.
2) Select the motor mount tube in the design tree.
3) Click the Cluster wizard.. button.

The cluster wizard screen is then displayed. From here you specify cluster configuration. You may create as many cluster patterns as you can fit within the airframe.

Clipboard support:
Copy - Copy the selected component and all of the components attached to it to the windows clipboard.

Cut - Copy the selected component and all of the components attached to it to the windows clipboard. The compents are then deleted from your design.

Paste - Paste the components previously copied to the clipboard into you design. The pasted components are owned by the selected component.

Drag & Drop support:
You can move one or more components from one location in your design to another using drag & drop.
To drag a component, click on it with the left mouse button, and do not release the mouse button. Drag the component to it's new location and release the mouse button. If you dropped the component onto a valid location, the components will be relocated in your design.

Also of interest:
General design settings
Mass override
Common features of all component editor screens.

2.2.4   **Flight simulations**

The results of previously run simulations are displayed on this tab. The results are displayed in tabular format. The set of results columns displayed can be configured to suit your needs. Please refer to the links at the bottom of this page for more information.

The default simulation data is shown below:
Simulation Number - The sequence number of the simulation.
Results - An icon which indicates the results of the simulation. (See below)
Engines - The engine load for the simulation.
Max Altitude - The maximum altitude attained.
Max. Velocity - The maximum velocity attained.
Max. Acceleration - The maximum acceleration attained.
Time to apogee - The time in seconds until apogee is reached.
Velocity at deployment - The speed of the rocket at the time of recovery system deployment.
Altitude at deployment - The altitude of the rocket at the time of recovery system deployment.

Optimal delay - This is the optimal ejection delay for recovery deployment at apogee.

The results pictures are shown here

The rocket never left the pad. Typical under powered results.

The recovery system ejected before apogee.

The recovery system ejected at apogee.

The recovery system ejected after apogee.

The rocket impacted with the ground prior to the deployment of a recovery device.

Selecting a single simulation
In order to select a single simulation for plotting, deletion, or printing, you must click on the row for the simulation. A selected simulation is displayed in reverse video.

Selecting multiple simulations
Multiple simulations can be selected for deletion. This can be done in several ways.
Using the mouse: Ctrl-Left-Click on each simulation you wish to select.
Using the mouse: Left-Click on the first simulation you wish to select, Shift-Left-Click on the last simulation. The full range of simulations between the first and last will be selected.
Using the keyboard: Press shift-up arrow, shift-down arrow, shift-home, or shift-end to select a range of simulations.

Also of interest
Changing the results columns.
Using abbreviated column labels.
Changing the units for the simulation results.

2.2.5   **Mass Override**

RockSim will, by default attempt to calculate the mass and center of gravity for the rocket. If you wish to override these calculations, you can do so by selecting the "**Use the values shown below for all simulations**" option. This can be useful when you want to run a simulation against a partial rocket design, or to help find optimal engine configurations.

Measured mass data:
Sustainer is the mass of the sustainer without any engines installed.
Second booster is the mass of the second booster stage.
First booster is the mass of the first booster stage.

Measured center of gravity (CG) data:
The values for CG are measured from the tip of the rockets nose cone.

Sustainer is the CG of the sustainer stage.
Sustainer + second booster is the CG of the sustainer and the second booster combined.
Sustainer + second + first booster is the CG of the sustainer, the second booster, and the first booster combined.

Also of interest:
General design settings
Component layout
Common features of all component editor screens.

2.2.6 View screen overview

The view screen is used to draw 2D "blueprints", or 3D renderings of the current rocket design.
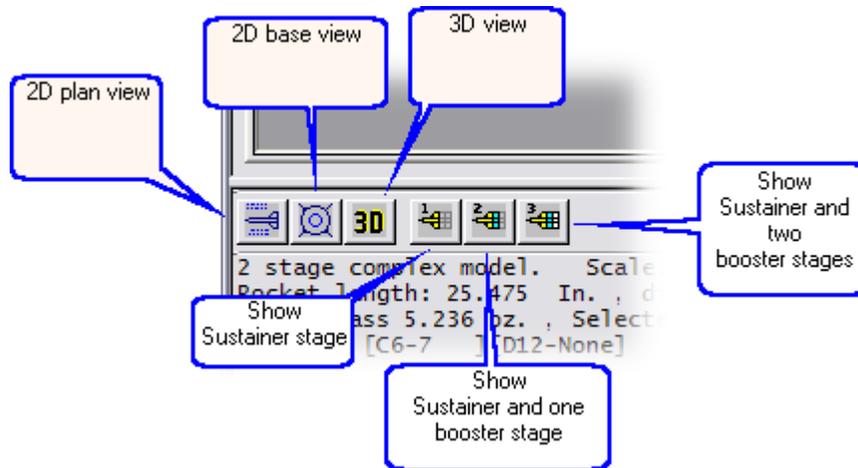
2.2.7 Menu functions

2.2.7.1 File menu

File New...
This command clears the current rocket design and it's associated simulations from the RockSim screen. You can use this command when you wish to start a new design. You will be asked if you wish to save any current design changes prior to clearing the screen.

File Open...
The File open function displays a standard dialog box from which you can select a rocket design to load into the system. RockSim design files have a (.RKT) extension. Once you select a file to open, the simulations and design information are displayed on the screen. Any previously loaded information is replaced.

File Save...
The File save function writes the currently displayed simulations and rocket design information to disk. If you select File save on a new (Untitled) design, then File save acts like File save as.

File Save As...
The File save as function displays a standard dialog box into which you enter a name and location for your rocket information. When you press OK from this dialog box, your simulation and design information is written to disk.

File Print... 🖨
This print menu displays the <u>Print Selection Screen</u>. From this screen you can choose what you wish to print.

File Print Setup...
The File print setup function displays the standard printer setup dialog box. The values which you select in this dialog box are retained until you close the RockSim program.

Export...
The Export menu item displays a secondary menu of export targets. From this menu you can export your rocket design, and simulation results in various formats.

Reload engine data
The File Reload engines function reloads the engine database from disk. This operation enables RockSim to use new engines created by the engine database compiler.

Also of interest:

2.2.7.2   Export menu option

Aero CFD...
Export the current rocket design for use by the AeroCFD program.
You will be prompted for the name of the AeroCFD data file.
AeroCFD / RockSim limitations:
- AeroCFD allows only two sets of fins.
- AeroCFD does not support custom fin plans.
- RockSim does not support the double diamond fin cross section.
These limitations will be addressed in a future release.

2D Image...
Export the rocket design drawing as a 2D image file.
This function displays the export 2D screen.

3D Image...
Export the rocket design as a 3D image.
This function displays the export 3D screen.

3D Model...
Export the rocket design as a 3D model.

Simulation data...
Displays the Simulation export screen. The simulation export function is used to export selected simulation data in comma delimited format. This data can then be imported into other applications for analysis.

2.2.7.3   Edit menu

Edit Application Settings... 📑

This menu option displays the application setting screen.

2.2.7.4 View menu

tool bar

Show or hide the tool bar.

Status bar

Show or hide the status bar.

Side view

View the rocket design as a 2D blueprint style image.

Base view

View the rocket from the bottom as a 2D blueprint style image.

3D view

View the rocket as a 3D model. The 3D view screen

In each of the views described above, you can choose to display various stage configurations. This applies to multi stage designs only.

Sustainer

Display the sustainer (Upper stage) only.

Sustainer + Booster

Display the sustainer and one booster.
This option applies to two, and three stage rockets.

Sustainer + two Booster stages

Display the sustainer and both booster stages.
This option only applies to three stage rockets.

2.2.7.5 Rocket menu

Parts list...

Display a report of the components in the current design.

Materials...

Display the Materials Database maintenance screen.

Cd Analysis...

Display the Cd analysis screen.

Stability analysis...

Display the Stability analysis screen.

2.2.7.6 Simulation menu

Prepare for launch...

Display the Simulation preparation screen. This is where you specify engine load out, recovery options, and

launch site conditions.

Launch... 🔥
Run a new simulation using the current engine load out, recovery options, and launch site conditions. The results of the simulation are displayed on the Simulation results screen.

Plot... ▦
Displays the Graph selection screen. From this screen you can select the data elements that you wish to graph, and how you would like the data presented. Once a graph is selected, then the plot screen is displayed. Pressing the Esc key or clicking the close button on the plot screen will close it.

Display details... 🔍
Displays a detailed report of the currently selected simulation. Pressing escape or the close button will close the screen.

2D Flight profile...
Display the 2D flight profile screen for a selected simulation. This screen displays a flat screen view of the rockets flight characteristics.

Predict Optimal Mass...
Displays the Optimal mass prediction screen. This screen provides the tools required to predict the optimal mass for your model. The mass of your rocket design can be tuned to produce maximum altitude, or maximum coast time.

Delete ✘
Deletes the selected simulations. You can also press the delete key when the simulation list is selected.

Recalculate all simulations
All of the simulations currently displayed for your design are run again.
When your design changes, the previous simulation results could be invalidated.

Recalculate selected simulations
The simulations currently selected for your design are run again.
When your design changes, the previous simulation results could be invalidated.

2.2.7.7 Help menu

Help
Displays this help file.

Read the user guide
Display the RockSim user guide.
This is a user's guide for the RockSim model rocket design and flight simulation
system. It describes the procedures you use to design model and high power
rockets, perform simulated rocket flights and graph, export and print the data generated.

About...
Displays the RockSim about box. If you are unsure about the version number of RockSim, or you are amused by reading Copyright information then check out this screen.

2.3 View screen

2.3.1 2D View Screen

2D Plan view
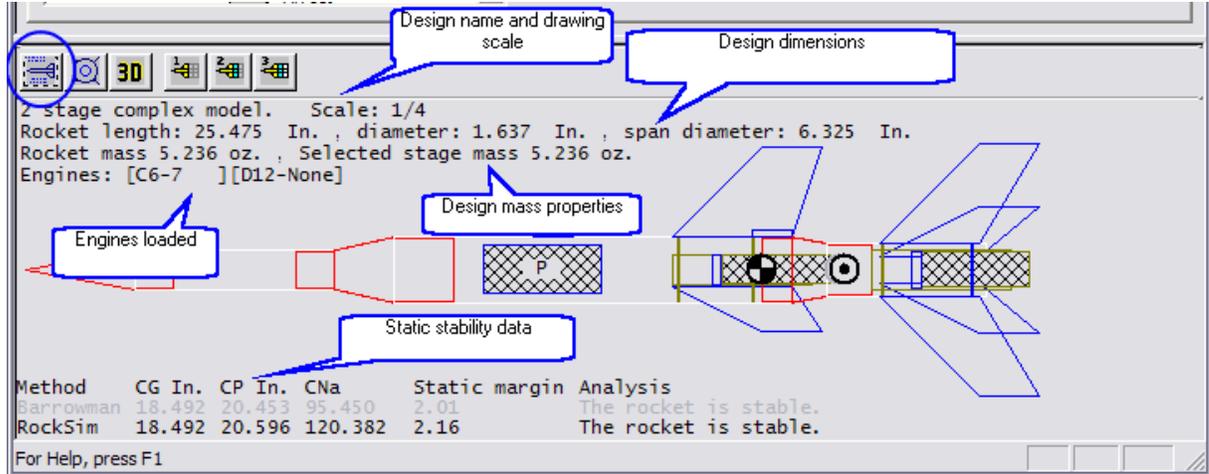
2D Base view
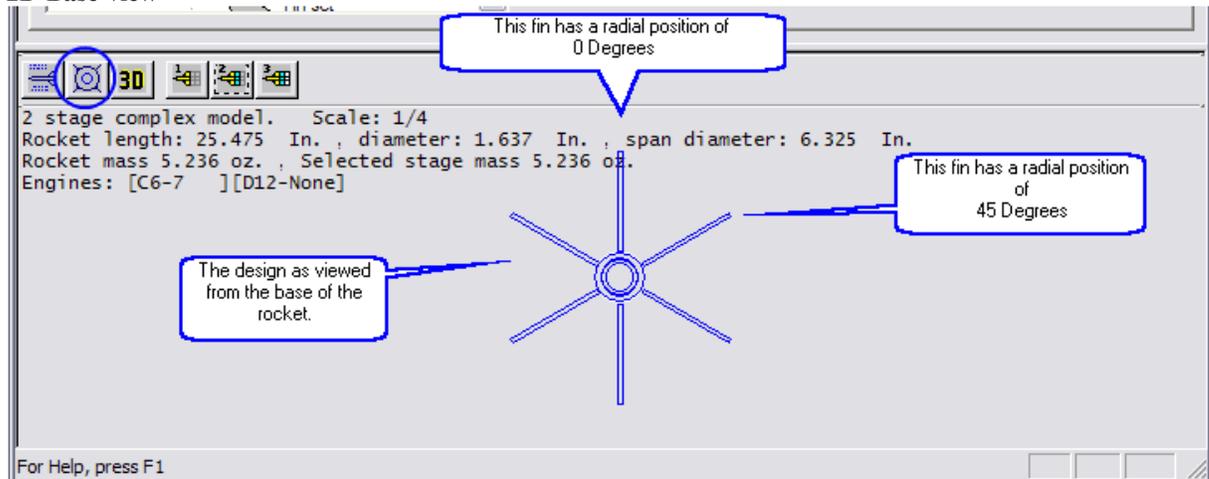
Also of interest:
3D View screen.
3D Camera movement.

2.3.2   **3D View Screen**

3D View
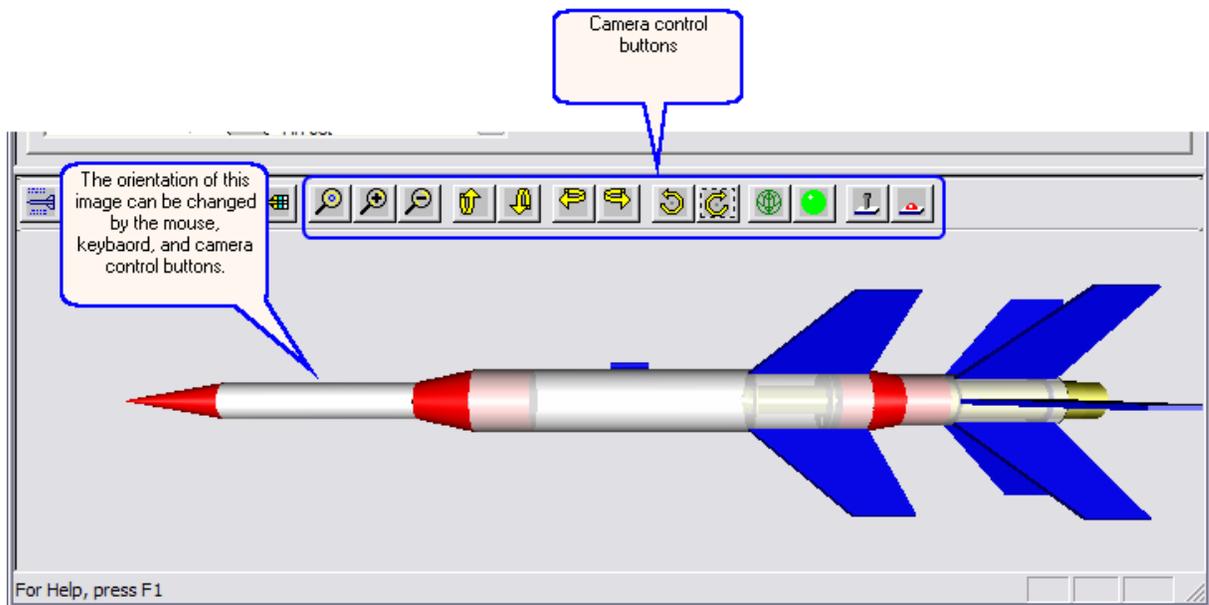
Also of interest:
2D view screen.
3D Camera movement.

2.3.3   **3D Camera control**

When you are viewing the rocket design in 3D mode, the image that you see on the screen is controlled by positioning an imaginary camera. The position and orientation of the camera can be controlled by the tool bar, or by using the mouse buttons and cursor position.

The camera movement mode can be set to **Joystick** (*Position sensitive*) or **Track ball** (*Motion sensitive*). These settings only apply to camera movements directly driven by the mouse cursor position.

Track ball
Select this option to switch to Track ball mode.
In Track ball mode, motion occurs only when the mouse button is pressed and the mouse pointer is moving.

Joystick
Select this option to switch to Joystick mode.
In Joystick mode, motion occurs continuously as long as the mouse button is pressed.

Wire frame
Select this option to cause all 3D objects to render themselves as Wire frame drawings. This can be useful on very slow machines, or when dealing with very complex models.

Wire frame example

Sold

Select this option to cause all 3D objects to render themselves as shaded solid images.

Solid model example

Camera movement using the tool bar buttons:

The tool bar at the top of the screen gives you access to the most common camera controls.

The picture below illustrates the possible camera movements.
Match the color coded movement arrows with their corresponding movement interface.
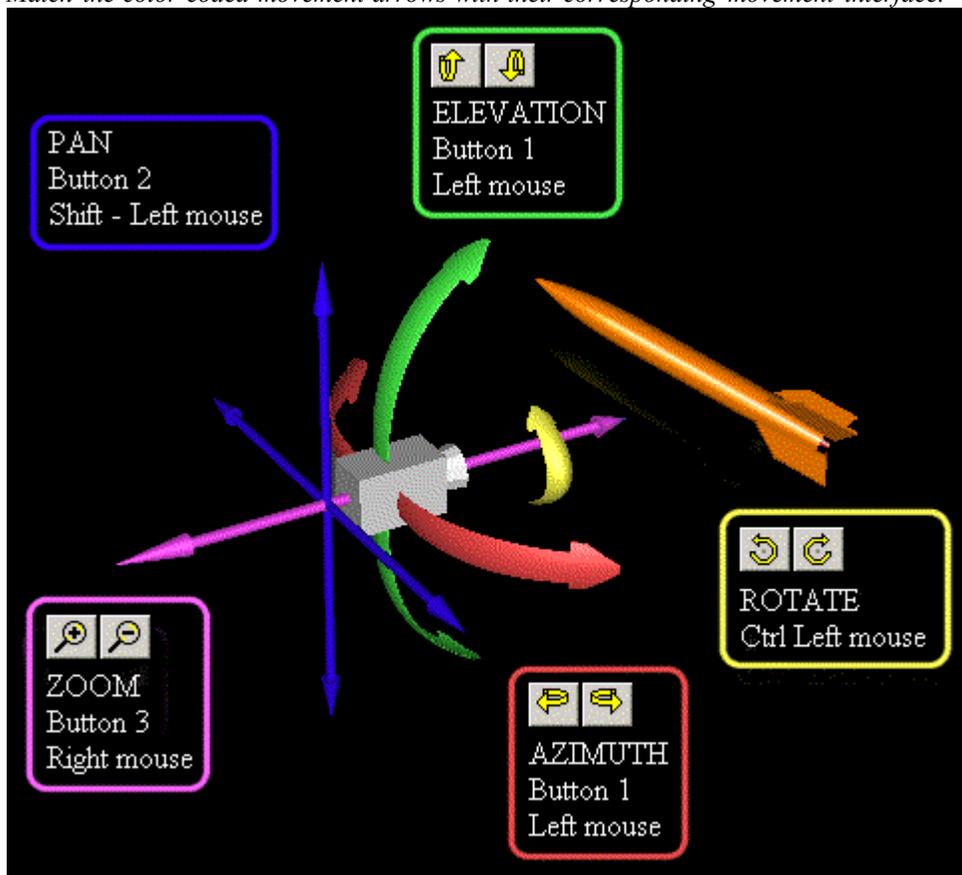
Camera movement using the mouse buttons:

Mouse Button 1 (Left Mouse Button)
Rotate the camera around its focal point. This simultaneously changes the camera azimuth and elevation. The rotation is in the direction defined from the geometric center of the screen towards the mouse position.

<Ctrl> Left Mouse Button
Rotate the camera around its own viewing axis.

Mouse Button 2 (<Shift> Button 1, <Shift> Left Mouse Button)
Pan the camera. In Joystick mode, the direction of pan is from the geometric center of the screen towards the mouse position. In Track ball mode, the direction of pan is the same as the direction the mouse moves.

Mouse Button 3 (Right Mouse Button)
Move (Dolly) the camera forward and backward from the focal point. If the mouse is positioned in the top half of the screen, then move the camera closer to the focal point. If the mouse is in the bottom half of the screen, then move the camera away from the focal point. In Joystick mode, the rate of movement is determined by the distance above or below the horizontal centerline of the screen.

3   Application wide settings

3.1   Application settings overview

The settings property sheets give you access to six pages of RockSim options. The options are stored in a file called RockSim.ini. This fill is saved in your windows root folder.

The six categories of options are shown below:
Simulation - Define the layout of the simulation summary screen, and the simulation resolution and method.
Units - Defines the default units used throughout RockSim.
2D Drawing - Defines the general display properties of the 2D blueprint drawing.
3D Rendering - Defines the general display properties of 3D rocket components.
Reports - Defines the fonts and colors used by the Parts List, Simulation Summary, and Simulation Details reports.

A new options screen is selected by clicking on one of the tabs displayed along the top of the settings screen.

OK
Save your application settings, and exit this screen.

Cancel
Discard your changes, and exit this screen.

Help
Display the help screen associated with the currently active page.

3.2   Settings options

3.2.1   Simulation

Simulation resolution in samples per second
The number of calculations per second used when running rocket launch simulations. The accuracy of simulation results is directly proportional to this value. The default value is 1000 samples per second. Some guidelines for this value are shown below.

For vertical flights of sub-sonic rocket: Use a minimum of 100 samples per second.
For any flights of super sonic rockets: Use a minimum of 400 samples per second.
For non-vertical flights or flights with wind: Use a minimum of 400 samples per second.

Descent resolution in samples per second
The number of calculations per second used when the rocket is descending on a recovery device. When a simulation is run, and all of the stages components are descending on recovery devices, then this value is used as the sample rate. It is a good idea to keep this value low in order to reduce the amount of memory required to store the simulation results.

Simulation method
The mathematical method that is to be used for approximating flight simulation data. There are currently two choices here. The first choice is the ***Explicit Euler method***; this is the same method used in the original RASP program. The Euler method is relatively fast and reasonably accurate. The second choice is the *4th order Runge-Kuta method*. The Runge-Kuta method is extremely accurate, even at smaller step sizes. The price you pay for this accuracy, is MUCH slower execution speed.

Some notes on accuracy:
The accuracy of a numerical approximation system cannot exceed the worst case accuracy of the inputs to that system. Some of the areas in the simulation that contribute to the overall inaccuracy are shown below:

Cd prediction – *Empirical methods of Cd prediction are really a best guess.*

Engine mass and thrust data – *This data is accurate to about +/- 10%.*

Flights at angles of attack of greater that 10-11 Degrees. – *The effects of lifting surface stall angle and the non-linear effects of high angle of attack flight are not handled in this release.*

Wind effects – *The simulation uses a very simple wind model. Nature on the other hand is a bit more unpredictable. The cross wind drag force, like the Cd prediction is a best guess.*

The highest degree of accuracy can be obtained in pure vertical flight with no wind.

Minimum velocity for stable flight
This velocity is used to determine the required launch guide length. The rocket needs to reach this velocity before its flight will be stable.
Please be aware that this value is just a ballpark guess used for reporting. The true minimum velocity is dependent on the particular rocket, and the flight conditions at launch time.

Minimum Cd prediction velocity
The Cd prediction system yields unrealistic results at very low velocities / Reynolds numbers. This value specifies the minimum velocity used to predict the Cd of your design during simulations. If the current simulation velocity is lower than this value, then this value is used in the calculation.

Use long column names on the simulation summary screen
Select this option to use full column names in the simulation list on the main screen. De selecting this option displays the simulation list with abbreviated column labels.

Available simulation summary columns
This is a list of available simulation data that can be displayed on the main screen. You can choose one or more items from this list, and use the **Add ->** button to move them to the **Displayed simulation summary columns**

list.

The available simulation data is shown below:

> **Altitude at deployment** - The altitude of the rocket at the time of recovery system deployment.
> **Comments** – User specified comments about the simulation.
> **Engines** - The engine load for the simulation.
> **Execution time** - The el lapsed time required to run the simulation.
> **Max. Acceleration** - The maximum acceleration attained.
> **Max Altitude** - The maximum altitude attained.
> **Max. Velocity** - The maximum velocity attained.
> **Optimal delay** - This is the optimal ejection delay for recovery deployment at apogee.
> **Results** - An icon which indicates the results of the simulation. (See below)
> **Simulation Number** - The sequence number of the simulation.
> **Time to apogee** - The time in seconds until apogee is reached.
> **Velocity at deployment** - The speed of the rocket at the time of recovery system deployment.

Displayed simulation summary columns
This is the simulation data that will be displayed on the main screen. You can choose one or more items from this list, and then use the ←- **Remove columns** button to eliminate them from the main screen display.

Add columns
Copy the selected items in the **Available simulation summary columns** list into the **Displayed simulation summary column**s list.

Remove columns
Remove the selected items in the **Displayed simulation summary column**s list.

Save
Saves the application settings to your hard drive. The settings are stored in a file called RockSim.ini. This file is located in your Windows root folder.

Cancel
Discards any changes made to the application settings, and closes the settings screen.

Help
Displays this help file.

3.2.2   Units

Display altitude in:
Altitude values will be displayed in the selected units.

Display velocity in:
Velocity values will be displayed in the selected units.

Display acceleration in:
Acceleration values will be displayed in the selected units.

Display mass in:
Mass values will be displayed in the selected units.

Display lengths in:

Length values will be displayed in the selected units.
Length values are used for rocket components.

Display temperature in:
Temperature values will be displayed in the selected units.

Display barometric pressure in:
Barometric pressure values will be displayed in the selected units.

Use default English units.
Selects the following units:
Altitude in feet.
Velocity in feet / sec.
Acceleration in feet / sec / sec.
Mass in ounces (Advp.).
Lengths in inches.
Temperature in degrees Fahrenheit.
Barometric pressure in inches of Hg.

Use default metric units.
Selects the following units.
Altitude in meters.
Velocity in meters / sec.
Acceleration in meters / sec / sec.
Mass in grams.
Lengths in millimeters.
Temperature in degrees centigrade.
Barometric pressure in mm of Hg.

NOTE: The RockSim application stores all of it's rocket design data in the units shown below. Whenever data is displayed or printed, it is converted from these internal units, into your selected units. This can occasionally result in some minor rounding errors.

Altitude in meters.
Velocity in meters / sec.
Acceleration in meters / sec / sec.
Mass in grams.
Lengths in millimeters.
Temperature in degrees centigrade.
Barometric pressure in mm of Hg.

3.2.3 2D Drawing

Scale drawing to a whole number ratio
If this option is selected, then RockSim attempts to display the 2D drawing scaled to a whole number ratio.
This means that the design will be displayed as 1/1 Scale, 1/2 Scale, 1/4 Scale, Etc.
If this option is not selected, the RockSim will always use the maximum width and height of the drawing screen for the rocket image.

Display text and markers with the drawing
Selecting this option enables the display of the items below.
If this option is not selected, then none of the items shown below will be displayed.

Display rocket title
Displays the rockets name at the top of the screen.

Display the scale of the drawing
Displays the current scale ratio of the rocket.

Display the dimensions of the rocket
Displays the length, diameter, and span diameter of the rocket.

Display the engine load out
Displays a description of the current engine load out.

Display the stability analysis table
Displays a table containing the calculated static stability data for the rocket.

Display the CG marker
Displays the standard CG marker icon on the side of the rocket.

Display the CP marker
Displays the standard CP marker on the side of the rocket.

Pen width
Selects the drawing pen width. The default value is 1. A value of one is usually fine for a screen display. Higher values are often required for printing due to the fact that printer resolution can greatly exceed screen resolution. A pen width of 1 on a high resolution printer can be nearly invisible.

Background color
This is the background color used in the drawing.
To change this color, press the button to the right of the color label.

Drawing color
This is the color used for drawing decorations.
To change this color, press the button to the right of the color label.

Highlight color
This is the color used to highlight the part currently being edited.
To change this color, press the button to the right of the color label.

Stability analysis display colors
The stability analysis table, and the associated CP markers are color coded to distinguish then from one another.
To change this color, press the button to the right of the color labels.

Barrowman color

Rocksim color

Cutout color

Text font and color
Specifies the font and color used for all text on the drawing. This excludes the colors assigned to the **Stability analysis table**.

3.2.4   3D Rendering

Render internal surface details
If this option is selected then 3D objects will render their internal walls and details.
This setting can effect 3D display performance.

Use variable resolution parts
When the camera is being moved on slower systems, or if the model is very complex, the frame rate can be very slow. Selecting this option will reduce the resolution of some or all of the model components while the camera is being moved. This can improve performance on slower systems.

Object resolution section
The 3D objects that are created to represent your rocket design are made up of multiple polygons. The appearance of the object is improved with a larger number of polygons. The rendering speed, however is greatly effected by the total number of polygons being displayed. The settings that follow control the number of polygons used to render different types of parts. The simplest way to set these values is to user the Low Res....., Medium Res...., and High Res.... buttons.

Low Res....
Preset all resolution values to low resolution.

Medium Res....
Preset all resolution values to medium resolution.

High Res....
Preset all resolution values to medium resolution.

Extrusion
These settings effect the resolution of all Nose Cones, Transitions, Body Tubes, Launch Lugs, and Engines.

> **Curve**
> This is the number of points used to create the profile of Nose Cones, and transition sections.

> **Filter**
> This is the number of points used around the circumference of round components.

3.2.5   Reports

The selections on this screen determine the appearance of all text reports that RockSim can generate.

The report types are:
The Parts List report.
The Simulation Details report.
The Simulation Summary report.

Page header font and color...
Select the font and color used for page headers. This applies to the part list, and simulation text reports.

Section header font and color…
Select the font and color used for section headers. This applies to the parts list.

Normal text font and color…

Select the font and color used for report bodies. This applies to the parts list and simulation text reports.

Error text font and color…
Select the font and color used for error notifications. This applies to the parts list.

Column header font and color…
Select the font and color used for column headers in the simulation summary report.

To change any of these values, press the button to the right of the label.

4 Designing rockets

4.1 Rocket Designer Screen

The Rocket design sheet gives you access to four pages of data that are used to specify the design for your rocket. The pages are divided into functional categories as described below.

The General page defines the name of your rocket, the number of stages, the drag coefficient option, and the stability calculation data.

The Components page is used to add, modify, and delete the components that make up you design.

The Construction and Finish tab defines the default surface finish used for the components in your design.

The Mass Override page allows you to bypass the default mass properties of your rocket.

OK
Save your rocket design properties, and exit this screen.

Cancel
Discard your changes, and exit this screen.

Help
Display the help screen associated with the currently active page.

4.2 Component screens

All of the component design screens have the same general layout.

Component mass
This is the calculated mass of the component being edited. As changes to the component specifications are made, this data will be updated.

NOTE: If you have selected a mass override setting for the component, then this value will not be recalculated.

Mfg. Part description
If the component specifications originated from the database, then the part description is displayed here. If the component is new, or not from the database, then Custom is displayed here.

Choose from database...
Displays the list of components currently stored in the database. You can choose a component from this list.

Save to database...
Displays the Database update screen . From here you can enter the manufactures Name, Part number, and description for the

component, and save it to the database.

OK
Closes the component editor window. Any changes that you have made to the component are retained in the rocket design.

Cancel
Undo any changes made to the component, and close the component editor window.
If the component was newly created, then it is removed from the rocket design.

Help...
Display online help.

Common data tabs for the component editors:
Radial position - Location of the component around the circumference of the airframe.
Drawing tab - The 2D and 3D color specifications.

Also of interest:
General design settings
Component layout
Mass override
2D view screen.
3D view screen.
3D camera control.

4.3   Construction and Finish

Default surface finish.
This specifies the relative surface characteristics of the rocket design. There are four finish types available. A brief description of these types is shown below:
This value will be allied to all new components that you add to your design.

Polished indicates a slick glossy surface.

Gloss indicates a typical gloss spray paint finish.

Matte indicates a dull hand painted type of surface.

Unfinished indicates the worst case surface finish.

4.4   Radial position

The setings on this tab control the positioning of components relative to the airframe centerline.

Radial distance (not present for all components)
The distance from the centerline of the component to the centerline of the airframe.

Angle
The angle from 0 to 360 degrees where the centerline of the component is located. The angle is measured clockwise from a point on the right hand side of the component.

4.5   Nose cone

Name
This is the component name that will be displayed in the component selection list, and in the parts list report.

Shape
This is the general shape of the nose cone. You can choose from several shape classifications. The choices are **Conical , Ogive , Parabolic, Elliptical, Power series, Parabolic series, and Sears-Haack.**

Shape control
For the Power series, Parabolic series, and Sears-Haack selections, an additional shape control parameter is displayed on the screen. The slider control adjacent to the **Shape control** field will vary the relative curvature of the nose cone.

Tell me more about the mathematics behind the nose shapes.

Length
This is the distance from the nose cone tip to the body tube junction.

Diameter
This is the base diameter of the nose cone. This value is usually the same as the outer diameter of the associated body tube.

Base length
This is the length of an optional straight section of the nose cone that extends from the base of the selected shape to the base of the nose cone.

Material
The material that the nose cone is made of.

Construction
Specifies the construction type of the nose cone. You can choose between *Solid* and *Hollow*. If Hollow is specified, then Thickness is required.

Wall Thickness
This is the wall thickness for a Hollow nose cone. This value is only required for Hollow nose cones.

Core diameter
If a solid nose cone has a hole drilled in the base extending into the nose cone, then this is the diameter of that hole.

Core length
If a solid nose cone has a hole drilled in the base extending into the nose cone, then this is the depth of that hole.

NOTE: If either Core diameter or Core length is set to zero, then both values will be ignored.

Shoulders

Shoulder
This part of the nose cone fits into the attached body tube.

Length
This is the length of the nose cone shoulder.. If a shoulder Dia. is specified, then you must specify this value.

Diameter
This is the outer diameter of the shoulder. If a shoulder Len. is specified, then you must specify this value.

Choose compatible body tube
Display a database selection screen with a list of body tubes. You can choose a body tube that the nose cone is destined to fit. The shoulder diameter will then be set to the correct size.

Clear shoulder settings
Remove the nose cone shoulder by setting the Length and Diameter to zero.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc.... And Mass fields will override the calculated CG and mass for the nose cone. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the nose cone CG. This distance is relative to the top of the nose cone.

Mass
This is the measured mass of the nose cone. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.6   Body tube

General

Name
The name of the body tube.

OD
The outside diameter of the body tube.

ID
The inside diameter of the body tube.

Length
The length of the body tube.

Material
The material that the body tube is made of.

This tube is a motor mount
Selecting this option specifies that the body tube will be used as a motor mount. At least one tube must be designated as a motor mount. If you do not specify a motor mount tube, then you will not be able to run flight simulations on your design.

Engine diameter
This is the engine diameter that will be loaded into this motor mount tube. When you first designate the body tube as a motor mount, rocksim will calculate the default engine diameter. You can override this value if you choose.

Radial position
These settings only apply to inside body tubes.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc...., and Mass fields will override the calculated CG and mass for the body tube. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the nose cone CG. This distance is relative to the top of the body tube.

Mass
This is the measured mass of the body tube. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Component layout
Common features of all design screens.

4.7   Inside tube

General

Name
The name of the inside tube.

OD
The outside diameter of the inside tube.

ID
The inside diameter of the inside tube.

Length
The length of the inside tube.

Material
The material that the inside tube is made of.

This tube is a motor mount
Selecting this option specifies that the inside tube will be used as a motor mount. At least one tube in each stage must be designated as a motor mount. If you do not specify a motor mount tube, then you will not be able to run flight simulations on your design.

NOTE: Inside tubes can be converted into clusters of tubes within the air frame. For additional information on the creation of cluster arrangements please refer to the Component layout screen, and the Cluster wizard

screen.

Radial position

Radial distance
This is distance between the center line of the inside tube, and the center line of the owning component.
A radial distance of zero will exactly center the inside tube within the owning component.

Angle
This is the angular location of the inside tube. This is a value between 0 and 360 degrees.
Zero degrees corresponds to the right hand side of the owning component as viewed from the rear end.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the inside tube. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the nose cone CG. This distance is relative to the top of the inside tube.

Mass
This is the measured mass of the inside tube. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.8   Transition

General

Name
The name of the transition component.

Shape
This is the general shape of the transition. You can choose from several shape classifications. The choices are **Conical , Ogive , Parabolic, Elliptical, Power series, Parabolic series, and Sears-Haack.**

Shape control
For the Power series, Parabolic series, and Sears-Haack selections, an additional shape control parameter is displayed on the screen. The slider control adjacent to the **Shape control** field will vary the relative curvature of the transition.

Tell me more about the mathematics behind the transition shapes.

Front Dia.
This is the front diameter of the transition.

Rear Dia.
This is the rear diameter of the transition.

Length
This is the length of the transition. This dimension does not include the length of the shoulders.

Displayed below the Len. you will see a text notation for the *Equiv. nose Len*. This information serves a very specific, and obscure purpose. If you wish to mount fins on you nose cone, you need to know this length value. RockSim does not directly support attaching fins to nose cones. RockSim does, however support attaching fins to transitions.

Material
The material used for the transition.

Construction: Solid , or Hollow
Specifies the construction type of the transition. If Hollow is specified, then Thickness is required.

Wall Thickness
This the wall thickness for a Hollow transition.

Core Dia.
This specifies the diameter of a drilled out core extending through the transition component. This diameter is only applied to **Solid** transitions.

Shoulders

Front / Rear shoulders
Transition parts often fit into the front attached body tube, and the rear attached body tube. If the transition is a boat tail, then there will be no rear shoulder.

Front shoulder:

Front shoulder length.
This is the length of the front shoulder. If Front shoulder Dia. is specified then you must specify this value.

Front shoulder diameter.
This is the outer diameter of the front shoulder. If Front shoulder Len. is specified, then you must specify this value.

Choose a compatible body tube.
Push this button to choose the front transition dimensions to fit a particular body tube.
Upon selection of a body tube, the Front Dia, and the Front shoulder Diameter. will be set to the correct dimensions.

Rear shoulder

Rear shoulder length.
This is the length of the rear shoulder. If Rear shoulder Dia. is specified, then you must specify this value.

Rear shoulder diameter.
This is the outer diameter of the rear shoulder. If the **Rear shoulder Len**. is specified, then you must specify this value.

Choose a compatible body tube.
Push this button to choose the rear transition dimensions to fit a particular body tube.

Upon selection of a body tube, the Rear Dia, and the Rear shoulder Dia. will be set to the correct dimensions.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc... And Mass fields will override the calculated CG and mass for the transition. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc...
This is the location of the transition CG. This distance is relative to the top of the transition.

Mass
This is the measured mass of the transition. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.9 Simple fin set

General

Number of fins
This is the number fins in this fin set. It is assumed that the fins will be placed symmetrically around the owning body tube. The current version of RockSim does not support asymmetric fin designs.

Fin shape
This is the general shape of the fin. Chose trapezoidal or elliptical.

Root chord Len.
This is the length of the root chord fin edge. This is the fin edge that attaches to the owning body tube.

Tip chord Len.
This is the length of the fin tip chord. This edge is parallel to the root chord. The fin tip chord only applies to trapezoidal fin shapes.

Sweep angle
The sweep angle is the deflection angle of the leading edge of the fin. This angle is measured from a line perpendicular to the airframe centerline .

Sweep Len
This is the horizontal distance between the leading root chord edge and the leading tip chord edge. The sweep distance only applies to trapezoidal fin shapes. The sweep distance can be positive or negative. Positive sweep distances place the leading tip cord edge behind the leading root cord edge. Negative sweep distances place the leading tip cord edge in front of the leading root cord edge.

Span
This is the perpendicular distance between the root chord edge and the tip chord edge.

Location
This is the distance from the front of the owing body tube to the leading root chord edge.

Thickness
This is the thickness of the fin stock.

Material
This is the material used for the fin set.

TTW Fin mount

Tab offset
The distance from the front of the root edge to the fin tab.

Tab length
The length of the fin tab.

Tab depth
The depth of the fin tab. This is the distance from the root edge of the fin to the bottom of the fin tab.

Calculate the tab depth for me
Press this button, and the program will attempt to calculate the fin tab depth. This depth is determined by looking for the location of inside
body tubes that are beneath the fins.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the fin set. This feature is typically used for manufactured parts, where you don't know the material, thickness, Etc..

CG Loc....
This is the location of the fin set CG. This distance is relative to the front of the fin root edge.

Mass
This is the measured mass of the fin set. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.10 Complex fin set

General

Number of fins
This is the number fins in this fin set. It is assumed that the fins will be placed symmetrically around the owning body tube.

NOTE: The Barrowman equations only support fin counts of 3, 4, or 6. If you choose any other fin count, then only the RockSim method can be used for static stability calculations.

Location
This is the distance from the front of the owing body tube to the leading root chord edge.

Edit fin plan
The <u>fin planner screen</u> is displayed when you press this button. The fin planner screen is used to edit the vertex points that define the shape of the fin.

Thickness
The thickness of the material used to build the fins.

Cross section
The cross sectional shape of the fin. This property is used to determine the drag coefficient for the fins.

Material
This is the material used for the fin set.

TTW Fin mount

Tab offset
The distance from the front of the root edge to the fin tab.

Tab length
The length of the fin tab.

Tab depth
The depth of the fin tab. This is the distance from the root edge of the fin to the bottom of the fin tab.

Calculate the tab depth for me
Press this button, and the program will attempt to calculate the fin tab depth. This depth is determined by looking for the location of inside
body tubes that are beneath the fins.

Radial position

Angle
The radial position of the fin(s) around the airframe. This is the position of the first fin in the set.
An angle setting of zero degrees is straight up as viewed from the base of the rocket. Angles increase in a clockwise direction like a compass reference.
NOTE: The Barrorman equations only support multiple symmetrical fins sets if the first fin in all sets are located at the same radial angle position on the airframe.
If you choose to use different radial angle positions for multiple fins sets, then only the RockSim method can be used for static stability calculations.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the fin set. This feature is typically used for manufactured parts, where you don't know the material, thickness, Etc..

CG Loc....
This is the location of the fin set CG. This distance is relative to the front of the fin root edge.

Mass
This is the measured mass of the fin set. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Component layout
Common features of all design screens.

4.11   Free form fin planner

The tool bar buttons:

Grid
Show or hide the grid lines.

Grid labels.
Show or hide the grid labels. Grid labels are only displayed when the grid is set to visible.

Snap to grid.
Enable or disable snap to grid. When snap to grid is enabled, then points which you add or move will align themselves to the nearest **Snap to** coordinate.

Show line end points.
Show or hide the end points of the fin plan data points. When your fin plan contains many points which are close together, this option can be useful.

Zoom in.
Magnify the view of the fin plan.

Zoom to fit all.
Set the zoom level to view all of the plan points.

Zoom out.
Shrink the view of the fin plan.

Add or change plan data points.
Select this option to add new plan points or move existing plan points.

* To add a new plan point, click on, or near the line where you wish to add the new plan point.

* To move an existing plan point, left click (and hold the mouse button down), then drag the plan point to another location. When you release the mouse button, the plan point will be placed on the grid.

* To select an existing plan point without moving it, Shift-Click on the plan point.

Delete plan data points.
Select this option to delete existing plan points.

Chamfer the plan corner at the selected point.
Select this option to chamfer (Round off) a corner of the fin plan at the currently selected point. You will be prompted for a radius and resolution for the chamfer.

Undo the previous operation.
Each time you add, move, or delete a point, the previous fin plan is saved in memory. The same is true of chamfer operations. Pressing the Undo button restores the previous fin plans to the display in reverse order.

Display the graph paper style screen**.**
This function allows you to change the display characteristics of the fin plan graph paper.

Selected point X1, Y1.
These are the coordinates of the currently selected plan point. If you wish to change the coordinates of the selected plan point, you can enter override values for X1 or Y1. When you manually alter one of these fields, a small check mark will appear next to the field. Click the check mark to accept the new value you entered.

Grid size
This is the size of the grid overlay in current design units.

Snap to
This is the size of the invisible snap to grid overlay in current design units.

Hide
Press this button to return to the custom fin set screen.

Also of interest:
Common features of all design screens.

4.12   Graph paper style

Background color
The background color of display area.

Grid color
The color of the grid lines.

Point color
The color of the plan point markers.

Selected point color
The color of a selected plan point.

Line color
The color of the lines connecting the plan points.

Selected line color
The color of a selected line.

Grid label font and color
The screen font and foreground color of the grid axis labels.

Also of interest:
Return to the Free form fin planer screen.
Common features of all design screens.

4.13   Tube fin set

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the fin set. This feature is typically used for manufactured parts, where you don't know the material, thickness, Etc..

CG Loc....
This is the location of the fin set CG. This distance is relative to the front of the fin root edge.

Mass
This is the measured mass of the fin set. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Component layout
Common features of all design screens.

4.14   Ring tail

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the fin set. This feature is typically used for manufactured parts, where you don't know the material, thickness, Etc..

CG Loc....
This is the location of the fin set CG. This distance is relative to the front of the fin root edge.

Mass
This is the measured mass of the fin set. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Component layout
Common features of all design screens.

4.15 Bulkhead

General

Name
This is the name of the bulkhead.

OD
This is the outer diameter of the bulkhead. The outer diameter is determined by the inner diameter of the owning body tube.

ID
This is the inner diameter of the bulkhead. An inner diameter of zero indicates a solid bulkhead.

Thickness
This is the thickness of the bulkhead.

Auto size known dimensions
Select this option if you want rocksim to calculate the OD of the bulkhead.

Location
This is the location of the bulkhead relative to the front of the owning body tube.

Material
This is the material used for the bulkhead.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the bulkhead. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the bulkhead CG. This distance is relative to the top of the bulkhead.

Mass
This is the measured mass of the bulkhead. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Component layout
Common features of all design screens.

4.16 Centering ring

Name
This is the name of the centering ring.

OD
This is the outer diameter of the centering ring. The outer diameter is determined by the inside diameter of the

owing component.

The hole pattern in a centering ring is calculated automatically based on the position of the centering ring relative to the position(s) of the inside tubes in the design.

Thickness
This is the thickness of the centering ring.

Auto size known dimensions
Select this option if you want rocksim to calculate the OD of the centering ring, and the position and diameter of any required holes. The location and dimension of the drilled holes is determined by the position of the centering ring relative to inside tubes.

Location
This is the location of the centering ring relative to the front of the owning body tube.

Material
This is the material used for the centering ring.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the centering ring. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the centering ring CG. This distance is relative to the top of the centering ring. Usually this is simply 1/2 the thickness of the centering ring.

Mass
This is the measured mass of the centering ring. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.17 Sleeve

General

Name
This is the name of the sleeve.

OD
This is the outer diameter of the sleeve.

ID
This is the inner diameter of the sleeve.
The inner diameter is determined by the outer diameter of the owning body tube.

Length
This is the length of the sleeve.

Auto size known dimensions
Select this option if you want rocksim to calculate the ID of the sleeve.

Location
This is the location of the sleeve relative to the front of the owning body tube.

Material
This is the material used for the sleeve.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the sleeve. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the nose cone CG. This distance is relative to the top of the sleeve.

Mass
This is the measured mass of the body tube. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.18 Tube coupler

General

Name
This is the name of the tube coupler.

OD
This is the outer diameter of the tube coupler.

ID
This is the inner diameter of the tube coupler.

Length
This is the length of the tube coupler.

Auto size known dimensions
Select this option if you want rocksim to calculate the OD of the tube coupler.

Location
This is the location of the tube coupler relative to the front of the owning body tube.

Material
This is the material used for the tube coupler.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc.., and Mass fields will override the calculated CG and mass for the tube coupler. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc...
This is the location of the nose cone CG. This distance is relative to the top of the tube coupler.

Mass
This is the measured mass of the tube coupler. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.19   Engine block

General

Name
This is the name of the engine block.

Outer diameter
This is the outer diameter of the engine block. The outer diameter is determined by the inner diameter of the owning motor mount tube.

Inner diameter
This is the inner diameter of the engine block.

Thickness
This is the thickness of the engine block.

Auto size known dimensions
Select this option if you want rocksim to calculate the OD of the engine block.

Location
This is the location of the engine block relative to the front of the owning body tube.

Material
This is the material used for the engine block.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the engine block. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the engine block CG. This distance is relative to the top of the engine block.

Mass
This is the measured mass of the engine block. If Use known CG/Mass is selected, then a value must be specified for this field.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.20   Launch lug

Outer diameter
The outside diameter of the launch lug.

Inner diameter
The inside diameter of the launch lug.

Length
The length of the launch lug.

Mfg. Type
The manufactured part number. The default selection is "Custom", which implies that you will fully specify the launch lug.

Material
The material that the launch lug is made of.

Drawing
Refer to the Drawing topic for information on assigning colors and surface characteristics.

Also of interest:
Common features of all design screens.

4.21   Subassembly

General

A subassembly is a place holder component. You attach parts to the sub assembly component, and you can then treat the group of parts as a single unit.

Name
The name of the sub assembly. This is the name that will be displayed in the parts list, and on the component screen.

File name

This is the name of the disk file containing the data for the sub assembly. This file name is specified when you press the Save to database button.

Description
This provides additional notes or comments about the sub assembly.

Relative location
Changes the relative position of all of the components attached to the subassembly.

NOTE: The operation of the Choose from database... , and the Save to database... buttons is different for subassemblies. Please refer to the description that follows.

Choose from database...
Open a sub assembly file. A standard file open window is displayed asking you to specify a subassembly file. If you choose to open the file, then the contents of the subassembly is replaced by the file.

Save to database...
Saves the subassembly to a file. A standard file save window is displayed asking you to specify a file name for the subassembly. If you choose a file name, and then elect to save, the contents of the subassembly and all of it's associated components are written to a file in XML format.

Also of interest:
Common features of all design screens.

4.22   Streamer

Length
This is the length of the streamer.

Width
This is the width of the streamer.

Number of streamers
This is the number of streamers.

Position in tube
This is the position from the front of the owning body tube.

Thickness
This is the thickness of the streamer.

Material
This is the material that the streamer are made of.

This streamer is folded
Select this option if the streamer is folded in a ziz zag pattern. This increased the Cd of the streamer. Note that you will not see the effects of this unless you have also selected Auto calculate the Cd. The Cd prediction model increases the Cd by a factor of three when folded is selected.

Auto calculate the Cd
Select this option if you want RockSim to calculate the Cd of the streamer for you. If this option is not selected, then you can enter you own value for the Cd.

Cd
This is the drag coefficient of the streamer that will be used in descent rate calculations during simulation.

Recommend a streamer
Calculate an acceptable streamer for the current rocket design.

Mass override

Use known CG/Mass.
If this value is selected, then the following CG Loc..., and Mass fields will override the calculated CG and mass for the streamer. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

CG Loc....
This is the location of the nose cone CG. This distance is relative to the top of the streamer.

Mass
This is the measured mass of the streamer. If Use known CG/Mass is selected, then a value must be specified for this field.

Also of interest:
Common features of all design screens.

4.23   Parachute

Shape
This is the shape of the parachute. Choose from Round, Square, 5 Sided , 6 Sided , 7 Sided or 8 Sided.

Chute count
This is the number of parachutes.

Spill hole diameter
This is the spill hole diameter.

Shroud line count
This is the number of attached shroud lines.

Outer diameter
This is the outer diameter of the parachute.

Location in tube
This is the location from the front of the owning body tube.

Use known CG/Mass.
If this value is selected, then the following CG Loc.... And Mass fields will override the calculated CG and mass for the nose cone. This feature is typically used for manufactured parts, where you don't know the material, wall thickness, Etc..

Mass
This is the measured mass of the transition. If Use known CG/Mass is selected, then a value must be specified for this field.

Thickness
This is the thickness of the parachute material.

Mfg. Type
The manufactured part number. The default selection is "Custom", which implies that you will fully specify the parachute.

Chute material
This is the material used for the parachute canopy.

Recommended rates: Low , Mid , High
Press these buttons to calculate parachute specifications for a range of descent rates.

Current rate
This is the rate of descent that the parachute specifications will produce. Changes to other parachute specifications will cause this field to change. Making changes to Current rate will recalculate a new parachute diameter.

Calculated descent mass
This is the mass of the stage configuration that will be descending with the prachute. This is the mass of the rocket components plust the mass of any engine casings loaded into the stage.

Descent rate analysis
An analysis of the current parachute configuration is displayed just above the rocket image. The analysis results are based upon the recommended descent rates. Your rocket design may well be able to handle descent rates that are outside the recommended range.

Also of interest:
Common features of all design screens.

4.24 Mass object

Name
This is the name of the mass object.

Classification
There are two choices here.
- General - Use this for most mass objects. Only a name and a known mass is required.
- Shock cord - Use this to specify a shock cord for the rocket design.

General mass objects:

Location
This is the location of the mass object in the owning body tube.

Mass
This is the mass of the object. It's CG is assumed to be the same as it's location. This data is only specified for mass objects with a general classification.

Why use mass objects
Mass objects with a general classification can be used whenever you need to add an arbitrary mass to a body tube. For example, you could use a mass object to represent a pay load, or some other component that is not explicitly supported by RockSim. A shock cord is a special type of mass object. Shock cords require a length and material specification.

Shock cords

Location

This is the location of the shock cords center of mass within the owning body tube.

Length
This is the length of the shock cord.

Material
This is the material that the shock cord is made from.

Also of interest:
Common features of all design screens.

4.25   Cluster wizard

The cluster wizard consists of a series of related screens. The Next and Back buttons are used to move from one screen to another. When you get to the final screen, you have the option of accepting the cluster pattern or closing the cluster wizard screen without any changes.

RockSim 5.0 creates clusters by cloning inside motor mount tubes. In other words, you select an individual motor mount tube, and the cluster wizard makes n copies of the tube, and arranges them within the airframe according to the pattern you select. You can combine as many cluster patterns as you like. You are of course restricted by the number of tubes that will fit in the airframe.

Choose a cluster pattern from the list below:

A list of available fixed cluster patterns is available, and there is a variable ring configuration. Click on the desired pattern and then click next.

Fixed cluster patterns
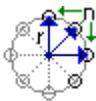
Variable ring pattern

Define additional details

Radius of the cluster ring. *(Applies to Variable ring pattern only)*
Specifies the distance from the airframe centerline to the center line of the cluster tubes.

Number of tubes in the cluster. *(Applies to Variable ring pattern only)*
Specifies the number of tubes that form the cluster ring.

Optional cluster rotation angle *(Degrees)*
A rotation angle applied to all of the tubes in the cluster. This is used to create clusters that overlap. This angle offset rotates the tubes into the empty spaces in a previously created cluster pattern.

Generate new names for tubes
Select this option if you want the cluster wizard to create new component names for the cloned tubes. If this option is selected then the Name prefix information is used to create the new names. Example: if Name prefix is "Mount", then the tube names would become "Mount 1", "Mount 2", Etc.

Name prefix
The text used to generate new tube names. (See **Generate new names for tubes** above)

Preview cluster details

Calculated cluster diameter
This is the OD of the selected cluster pattern.

Maximum allowable cluster diameter
This is the ID of the airframe.

You are not allowed to create clusters that are outside the airframe. The reason for this is that we currently do not have code in place to predict the effect on CP or Drag coefficient.

Cluster wizard operation complete

Create cluster
Click this button to create the specified cluster pattern.

Cancel
Click this button to close the cluster wizard screen, and make no changes.

4.26   Drawing

The Drawing tab is presented with all component editor screens. This information determines the 2D drawing color, and 3D surface characteristics for the components.

2D Drawing

Color
This is the 2D drawing color that will be used for this component.

3D Rendering

Use a simple color model
Selecting this option greatly simplifies the color selection for 3D rendering. You need to specify only the base color for the component. All other parameters are automatically calculated by the program. If you do not select this option, then you can specify all of the 3D surface rendering parameters yourself. See the additional options below.

Opacity
This determines the degree to which light will pass through the component. The range of values is between 0.0 and 1.0. A value of 1.0 renders the component as completely opaque. A value of zero renders the component completely transparent.

Advanced options:

Diffuse color
This is the color reflected off of the component.

Diffuse level
This is the intensity level applied to the Diffuse color.

Use the Diffuse color for Ambient, and Specular color
If you select this option, then the specified Diffuse color will be substituted for the Ambient color, and the Specular color.

Ambient color
This is the color that appears on the component even without a light source illuminating it.

Ambient level
This is the intensity level applied to the Ambient color.

Specifications for surface finish.

Specular color
This is the color of the reflection highlights.

Specular level
This determines how much light is apparently reflected from the surface of the component.

Specular power
This determines how smooth the surface of the object appears to be.

The picture show below illustrates the function of the specular parameters.
In this picture The Diffuse color is Red, and the Specular color is White.
The Specular level is varied from 0 to 1.0 along the horizontal.
The Specular power is varied from 0 to 100 along the vertial.

Also of interest:
General design settings
Component layout
Common features of all component editor screens.

4.27   Database update screen

This screen is used by all component editors to save specifications to the database.

The l;list at the top of the screen displays a summary of the records currently stored in the database. You can copy data from this list into the fields on the bottom of the screen by using the arrow buttons next to the fields.

Manufacturer
Specifies the name of the component vendor for the new component.
NOTE: Commas will be stripped out of this text due to the file format used for the data files.

Part number
Specifies the manufacturer's part number for the new component
NOTE: Commas will be stripped out of this text due to the file format used for the data files.

Part description

Provides additional information about the part.
NOTE: Commas will be stripped out of this text due to the file format used for the data files.

Save
Store the component specifications in the database, and then close the database update screen.

Cancel
Close the database update screen. The component specifications are not saved to the database.

4.28 Drag analysis

The drag coefficient for your rocket design is the sum of the drag components shown below.

Nose and body
The combined drag coefficient of the nose cone and body tube.

Base
The drag coefficient caused by the low pressure at the rear of the rocket.

Fin
The drag coefficient caused by all of the fin sets.

Launch lug
The drag coefficient caused by the launch lugs.

Predicted Cd
The sum of (Nose and body Cd) + (Base Cd) + (Fin Cd) + (Launch lug Cd).

Cd adjusted for transonic and supersonic effects.
When the velocity of your rocket exceeds mach 0.8, the Cd is adjusted to simulate the sharp increase in drag coefficient encountered at these speeds.

Velocity
Adjust this slider control to observe the Cd of your rocket at various velocities. All of the Cd components mentioned in the above text are recalculated when you change the velocity.

Mach number
The ratio of the speed of sound to your rockets velocity. (Mach number = Speed of sound / Velocity.

4.29 Stability analysis

The stability plot selection screen contains the settings that govern the appearance of the stability analysis graph.

The support for asymmetrical fin placement in RockSim requires a different method of viewing static stability. In designs that contain asymmetrical fin designs, the calculation of static stability is dependent on the direction of the wind relative to the rocket. The stability analysis graph presents a polar style graph that indicates the static stability from all possible radial angle positions.

Graph type:
You can choose between two styles of stability analysis graphs.
1) Plot CP, and CG Vs. radial view angle
This graph type shows the relationship between the CP and CG of the model for radial angles between 0 degrees, and 359.9 degrees.

2) Plot static margin Vs. radial view angle
This graph type shows the static margin for radial angles between 0 degrees and 359.9 degrees.

The next section contains the settings that determine the Color and Line style used to represent the data in the graph.

CG reference line:
Determines the color and line style used to represent the rocket CG.

Stable configuration indicator:
Determines the color and line style used to indicate stable configuration for a given wind angle.

Unstable configuration indicator:
Determines the color and line style used to indicate unstable configuration for a given wind angle.

Display fin placement annotation:
Enable this option if you want to display the placement of the fins in the background of the stability graph.

Fin placement annotation:
Determines the color and line style of the fin position indicators. Please note that the fin position indicators are not drawn to their actual scale.

Fin placement end marker:
Determines the color and style of the fin position indicator end points. These indicators improve the visibility of the fin placement indicator lines.

5 Simulations

5.1 Simulation preparation

5.1.1 Simulation overview

A simulation as RockSim defines is the data output resulting from a simulated flight of your rocket design. In order to run a simulation, you must provide initial parameters beyond the design of your rocket. The values for these parameters are accessed on the Simulation preparation screen.

The simulation preparation screen consists of three main areas:
* The engine selection screen specifies the engine load out for the flight.
* The flight events screen specifies the deployment of recovery devices.
* The simulation controls screen specifies the end point of the simulation.
* The launch conditions screen specifies the atmospheric, and launch guide angle data.

The **Launch** button
This button will launch your rocket using the current set of parameters.
The rocket can also be launched from the main screen by way of the Simlation menu.

The **Close** button
This button will close the Simulation preparation screen. The current simulation parameters are retained.

Also of interest:

5.1.2 Engine selection

Select the motor mount you wish to load from the list below
This is a list of all the motor mounts in you rocket design. In order to load an engine into a motor mount, or change the engine currently loaded, you must click on the mount description. The engine selection for the selected mount will be displayed in the data fields below.

Load
Load the current engine specifications into the selected motor mount.

Load all
Load the current engine specifications into all of the motor mounts.

Clear
Unloads the selected motor mount.

Clear all
Unloads all of the motor mounts.

Engine Mfg.
This is the engine manufacturer text for the current engine specifications.
This field is read only. Use the Choose engine button (See Below).

Engine Code
This is the engine code for the current engine specifications.
This field is read only. Use the Choose engine button (See Below).

Display engine list...
Displays the Engine Selection list. You can choose an engine for the selected motor mount.

Ejection delay
This is the time between engine burnout, and the firing of the ejection delay.
You can enter a delay in seconds, or choose one of the predefined values from the engine database.

NOTE: This time value is used to fire the next stage, or optionally deploy a recovery device.

Engine overhang from motor mount tube
This is the length of the engine casing that protrudes from the bottom end of the motor mount tube.

Also of interest:
Simulation overview.
Recovery device setup.
Simulation controls.
Launch conditions.
Competition settings.

5.1.3 Recovery device setup

Current simulation events:
This is a list of all of the recovery devices (*streamers and parachutes*) in your design.
This screen is used to determine the deployment conditions for these recovery devices.
Select a recovery device from this list in order to change its deployment specifications.

Event type
Describes when in the flight the selected recovery device will be deployed. Depending on the event type, there may be additional information required (*see Altitude and Time below*).

The following deployment events are currently supported:

Deploy at apogee
The selected recovery device is deployed at apogee.

Deploy at engine ejection
The selected recovery device is deploys when the engine ejection timeout occurs.

Deploy at the specified altitude
The recovery device is deployed at the specified Altitude. This event will not occur until after apogee is detected.

Deploy at the specified number of seconds
The recovery device is deployed (Time) seconds after the stage is launched.

Deploy at the specified number of seconds after apogee
The recovery device is deployed (Time) seconds after apogee is detected.

Altitude
Deployment altitude used by the "Deploy at the specified altitude" event type.

Time
The deployment time in seconds used by the following event types:
Deploy at the specified number of seconds
Deploy at the specified number of seconds after apogee

Also of interest:
Simulation overview.
Engine selection
Simulation controls.
Launch conditions.
Competition settings.

5.1.4 Simulation controls

Simulation end point
Specifies point in the simulation where the calculations are terminated.

You have three choices here:

* End the simulation when the sustainer reaches apogee.
* End the simulation when the first recovery device is deployed.
* End the simulation when the rocket returns to the ground.

Also of interest :
Simulation overview.
Engine selection

Recovery device setup.
Launch conditions.
Competition settings.

5.1.5   Launch conditions

This screen describes the conditions of your simulated launch site.

Altitude
This is the altitude above sea level of your launch site.

% Relative humidity
This is the relative water vapor content of the air at ground level.
The air density, for a given temperature and pressure, is inversely proportional to the relative humidity.

Temperature
This is the ground level temperature.

Latitude
This is the latitude above or below the equator of the launch site.

Launch guide angle
This is the initial launch guide angle.
The value is specified in degrees from vertical.
* Positive angles deflect the launch guide to the right.
* Negative angles deflect the launch guide to the left.

Wind conditions:
This is a choice list that presents standardized wind speed ranges. Selecting a value from this sets the Low wind speed, and the High wind speed to standard NOAA values. If you choose Custom speed range, then you can manually set the Low wind speed, and High wind speed values.

Low wind speed
This is the lowest wind velocity at the launch site.
* The wind is assumed to move only in a horizontal direction.
* Positive values indicate the wind moving from left to right.
* Negative values indicate the wind moving from right to left.

High wind speed:
This is the highest wind velocity at the launch site.

Wind turbulence:
This is a choice list that presents values for the Wind change frequency. This value is in radians per second. If you choose Custom turbulence, then you can manually set the Wind change frequency. If you choose No turbulence, then the value for Low wind speed will be used in the simulations.

Wind change frequency:
This is the rate of wind speed change used for simulations. The units are radians per second.

The wind model used by rocksim when a non zero wind change frequency is specified is a sin wave that oscillates between
Low wind speed, and High wind speed. The starting point on this
curve is a random value.

Wind starts at altitude
This is the altitude when the wind velocity is added into the simulation equations.
Prior to this altitude the wind velocity is assumed to be zero.

Barometric pressure
This is the air pressure at ground level.

Cloud coverage:
This is a choice list that presents standardized cloud cover ranges. Selecting a value from this sets the **Cloud cover low limit**, and the **Cloud cover high limit** to standard NOAA values. If you choose Custom cloud coverage, then you can manually set the Cloud cover Low limit, and Cloud cover High limit values.

The values for cloud cover are used to determine the presence of Thermals at the launch site. The cloud cover percentage used in the simulation will be a random value between Cloud cover low limit, and Cloud cover high limit.

Cloud cover low limit:
This is the lowest possible cloud cover percentage.

Cloud cover high limit:
This is the highest possible cloud cover percentage.

Thermal positioning:
This is a choice list that presents standardized thermal positions. Selecting a value from this sets the **Thermal position** value. If you choose Custom position, then you can manually set the Thermal position value. If you choose Random position, then the position of the nearest thermal will be randomly chosen.

Thermal position:
This is the position of the edge of the thermal relative to the launch point. Positive value place the location of the first thermal to the right of the launch position.

Thermal Dia:
This is the average diameter of the Thermals used in simulations.

Thermal height:
This is the average height of the Thermals used in simulations.

Thermal speed / Strength:
This is a choice list that presents fixed Thermal strengths. The strength of a Thermal is it's Thermal speed. The choices are presented to give you some idea of typical Thermal strengths. If you choose Custom strength, then you can manually specify the average Thermal speed.

Thermal speed:
This is the velocity of the rising air column of Thermals used in simulations.

Allow multiple thermals:
This option allows the creation of multiple thermals. The position of the first thermal can be random, or absolute. Additional thermals are randomly placed further away from the launch site than the first thermal.

Maximum number of thermals:
This specifies the maximum number of thermals that will be created. This value only applies then **Allow multiple thermals** is n use.

NOTE: The selection for cloud cover determines the likelihood of any thermals appearing.

Also of interest:
Simulation overview.
Engine selection
Simulation controls.
Competition settings.

5.1.6   Competition settings

This screen presents competition settings to be used during simulations.

Use these random competition conditions during simulations:
This check box enables the use of all the settings contained on this page. If the check box is not set, then none of these conditions will be used for simulations.

Launch site diameter:
This is the diameter of the launch site. Any rockets landing within this circle are not considdered lost.

Max. model drift range:
This specifies the maximum drift range beyond the outside of the Launch site diameter. Any rockets that drift beyon this range are considdered lost.

Include igniter variability for Drag races:
This check box

Max engine ignition delay:
This value specifies the maximum igniter delay that will be applied to all engines during the simulation. This value is only used   when the Include igniter variability for Drag races check box is in use.

Failure modes / Disqualified flights:

These settings determine the various competion failure modes available during simulations. All of these values are expressed as decimal percentages. For example a value of 0.01 means there is a 1% chance of that failure mode happening.

Engine misfire:
This is the percent chance of an engine misfiring. This failure mode is applied to all of the engines in a simulation. If by chance, all of the engines in a simulation fail, then
the simulation will simply not be run.

Model loss:
This is the percent chance of a model falling outside the Launch site diameter being lost.

Airframe failure:
This is the percent chance of a random airframe failure.

Recovery device failure:
This is the percent chance of a recovery device failing to deploy, or in some way failing. If this happens, then there is a chance that the rocket will crash.

Payload damage:
This is the percent chance that payload damage will occur.

Alt. track loss:
This is the percent chance that the altitude of the model could not be tracked.

NOTE:
All of the failure modes are displayed on the simulation detail report.

5.1.7   Engine Selection List

Motor mount
A description of the selected motor mount.

Engine diameter display
You can control the engine diameters that are displayed in the list by selecting one of the three options here.

(1) Show only engines that match the mount diameter.

(2) Show only engines that match the mount diameter, or are smaller.
   Example: If the mount diameter is 18 mm, then all 18 mm, 13 mm, and 10.5 mm engines would be displayed.

(3) Show all engines.

You select an engine in one two ways:
(1) You can click on the engine in the list, and then press the OK button.
(2) You can double click on the engine in the list.

OK
Press this after selecting and engine, and the Engine selection list will be closed.
The engine that you selected will be loaded into the motor mount.

Cancel
Press this to close the Engine selection list without selecting and engine.

5.2   Simulation graphs

5.2.1   Graph selection screen

Graph name
Specifies a unique name for the graph selections. This name can be used to recall the selections for later use.

X-Axis
Specifies the data element that will be displayed on the X-Axis of the graph. The usual selection here is Time, although you may choose any data element. (See: Simulation data elements).

Y-Axis 1 …Y-Axis 5
Specifies from one to five data channels to be displayed on the Y-Axis of the graph.
 (See: Simulation data elements).

Colors
Specifies the color used to plot the data points on a particular axis.

Line style
Specified the line style used to plot the data points on a particular axis.

Start graph at

This determines the point in the flight where the graph begins. The choices shown below are all based on time into the flight.

The following choices are available:

at time = 0.0 – This is the beginning of the simulation data.
at the following flight time – This is a user defined start time.
when the rocket clears the launch guide.
when the rocket reaches maximum velocity.
when the rocket reaches maximum acceleration.
when final engine burnout occurs.
when the rocket reaches apogee.

End graph at
This determines the point in the flight where the graph ends. The choices shown below are all based on time into the flight.

at the end of the data – This is the end of the simulation data.
at the following flight time – This is a user defined end time.
when the rocket clears the launch guide.
when the rocket reaches maximum velocity.
when the rocket reaches maximum acceleration.
when final engine burnout occurs.
when the rocket reaches apogee.

Exit
Closes the graph selection screen. No graph is displayed.

Plot graph
Closes the graph selection screen, and displays the selected graph.

NOTE: If you are launching your rocket with a zero launch guide angle, and no wind, then it is of no use to plot any horizontal (x) data elements. The horizontal components of the data vectors will all be zero for these flights.

Also of interest:
Simulation data elements.

5.3   Flight profile

5.3.1   2D Flight profile

The 2D flight profile screen lets you visualize a simulated flight for your design.

Details…
Display the flight profile details screen. The details screen displays all of the data for the currently displayed simulation flight position.

Auto run…
Display the 2D flight profile auto play screen. This screen controls the simulation playback in as a "movie".

> **Step size** is the time slice used to portray the flight.
> **Go** starts the animation sequence.
> **Stop** halts the animation in place.

Hide closed the auto play screen.

Preferences…
Display the 2D flight profile preferences screen. This screen contains the settings that determine the appearance of the 2D flight profile screen.

Exit
Exit the flight profile screen.

Time
Move this slider to manually control the flight position of the rocket. This control is useful in conjunction with the 2D flight profile details screen. You can step the rocket through it's flight and observe the calculated data points for each time slice.

NOTES:
If you wish to view the flight details screen and the flight profile screen at the same time, then follow these step below.

re size the flight profile screen so that is occupies the left side of your desktop.
Display the details screen, and re size it to fit on the right hand side of the screen.
The next time you display the flight profile and details screen, they will retain this positioning.

5.4   Optimal mass prediction.

5.4.1   Optimal mass prediction.

Calculation mode
This specifies the method you wish to use to predict the optimal mass for your design.

- **Automatic. Find optimal mass.**
Automatic mode uses the Golden Section Search algorithm to locate the optimal mass for peak altitude. The default tolerance for this calculation is set to 0.01 meters. If you wish to change this value you can edit RockSim.ini and change the [Simulation] - OptmassTolerance setting.

- **Manual. Plot graphs.**
In Manual mode, you specify a range of sustainer mass values, and run a series of simulations. Although manual mode can take longer, you can them plot the mass vs. altitude curves.

Initial sustainer mass
The starting mass used for the sustainer in the simulations. Note that this mass does not include the mass of the engines loaded into the rocket, it is therefore acceptable to use a mass of zero here.

Ending sustainer mass
The final sustainer mass used in the simulations. Note that this mass does not include the mass of the engines loaded into the rocket.

Mass increment
This is the amount of mass to add to the sustainer for each iteration of the prediction process.

Start simulation
Press this button to begin the optimal mass prediction process. Once the simulations are started, the End the simulation button will activate.

End the simulation
Press this button to end an optimal mass prediction process that is running.

Graph colors
This section specifies the colors that will be used on the simulation results graphs. To change a color, click on the button under the label.

Display graph
Press this button to display a graph of the optimal mass prediction results. Note that graph data is only available after running a series of simulations in Manual mode.

Optimal mass prediction results
The results of the series of simulations are displayed here.

Current sustainer mass
This is the mass of the sustainer as specified by the design.

Peak altitude
This is the altitude that would be obtained if the sustainer mass equals the Optimal altitude mass.

Optimal altitude mass
This is the sustainer mass that will enable your design to reach maximum altitude.

Peak coast time
This the coast time that would be obtained if the sustainer mass equals the Optimal coast mass.

Optimal coast mass
This is the sustainer mass that will enable your design to reach maximum coast time.

NOTES
This series of simulations may take a while, depending on the speed of your machine, the current setting of **Simulation resolution in samples per second**, and the current prediction tolerance.

The sustainer mass values displayed in the results are the "Unloaded" values. These mass values DO NOT INCLUDE the mass of the engines loaded into the rocket.

There are some rocket configurations for which an optimal mass cannot be calculated. In these the configurations, the mass of the engines exceeds the mass required for optimal performance. The best you can do in these cases, is to simply make the airframe as light as possible.

5.5   Exporting data

5.5.1   Exporting data

File name
Specifies the name of the output file that will contain the exported data.

Browse
Displays the standard file save as dialog box. From here you can select the name of the export file.

Export
This selection determines what simulation data will be exported. You can choose either **Export** *all simulation data*, or **Export** *only the data elements selected below.* There is a list of available simulation flight data

displayed below the Export selection entry. You can select one or more entries for export from this list.

Export the data…
Writes out the specified data export file.

Cancel
Closes the export screen.

6 Database files

6.1 Materials database

<u>Specifications</u>

Material
This is a list of all of the materials currently stored in the database. Selecting an entry from this list will display the attributes of the selected material in the fields described below.

Material name
This is the name of the material. This name will be displayed on the various design screens in the Material selection field.

Units
This selection specifies the units used to specify the material density. The following units are available:
Volume: kg/m3   kg per cubic meter.
Volume: lb/ft3   pounds per cubic foot.
Volume: g/cm3   grams per cubic centimeter
Linear: g/cm   grams per centimeter   (Shock cords and shroud lines only)
Linear: g/mm   grams per millimeter   (Shock cords and shroud lines only)
Linear: oz/in   ounces per inch   (Shock cords and shroud lines only)
Area: g/cm2   grams per square centimeter
Area: oz./in2   ounces per square inch

Low density
Specifies the low density in a range of density values for the material.

High density
Specifies the high density in a range of density values for the material.

Average density
Specifies the average density. This value is automatically calculated whenever you change the low density or high density values.

<u>Database I/O and control buttons</u>

Save
Saves the currently displayed material to the database. This can be an update to material selected from the materials list or a new material.

Clear
Pressing this button clears all data entry fields and deselects the selected entry on the materials list.

Delete

Pressing this button will delete the currently selected material from the database.

Cancel
Exit the material maintenance screen.

Material usage designation

Available for use in rocket components
Checking off this option makes the material available for selection in rocket component design screens. The material is still subject to the designation filters shown below. If this option is not checked off, then the material will never be displayed on a component design screen, regardless of the filter settings.

Select all
Push this button to make the material available for all design screens.

Clear all
Push this button to make the material unavailable for all design screens.

The filter selections shown below designate which rocket components will have the material available for use.

Body tubes
Bulkheads
Centering rings
Engine blocks
Fin sets
Launch lugs
Nose cones
Parachutes - (Canopy material)
Cords & Lines (Shock cords and parachute shroud lines)
Streamers
Sleeves
Transitions
Tube couplers

6.2   Rocket component data files

RockSim uses a series of comma delimited files to store component data.
The Appendix contains a description of these data files.

7   Printing

7.1   Printing options

The print selection screen lets you decide what aspects of your rocket design and simulation information you wish to print. The selections which you make on this screen are retained between RockSim sessions.

Rocket information
Selecting this option enables the rocket design information for printing.

Drawing

Prints a 2D blueprint of the rocket design. For rockets with more than one stage, the blueprint is printed for each stage configuration.

Parts list

Prints a detailed parts list for the rocket design.

Templates

Selecting this option enables the templates for printing.

Nose cone

Prints a template for turning a nose cone.

Transitions

Prints templates for turning transitions.

Fin sets

Prints templates for fin sets.

Centering rings, Bulkheads, Etc.

Prints templates for centering rings, bulkheads, engine blocks, Etc.

Simulation information

Selecting this option enables the simulation data for printing.

All simulations

Selecting this option prints information for all simulations.

Selected simulations

Selecting this option only prints information from the currently selected simulations.

Summary report

Prints a report of simulation results. The format of this report is similar to the Simulation List APP_SIM_LIST shown on the to of the main display screen.

Detailed report

Prints a detailed report for each simulation. This report is the same as the Simulation details screen which is accessed from the simulation menu.

Graphs

Prints a graph of simulation results. The graph is the same one displayed by the Simulation plot screen.

NOTE: It is recommended that landscape mode be used for all printed reports.

8   Appendices

8.1   Simulation data

There are several data points that are tracked for each time slice of a simulation. The list below gives a brief description of the data points. Formulas are given for each of the data points where space permits.

Coordinate conventions:
+x == To the right.
-x == To the left.
+y == Up.
-y == Down.

Thrust is the magnitude of the total engine thrust in newtons.
x Thrust is the horizontal component of the thrust vector in newtons

$Tx = \sum T_{engine}$

y Thrust is the vertical component of the thrust vector in newtons.

$Ty = \sum Tengine$

Drag is the magnitude of the drag force on the rocket in newtons.
x Drag is the horizontal component of the drag force on the rocket in newtons.

$Dx = \frac{1}{2} \rho \ Vx^2 \ A_{ref} \ Cd$

y Drag is the vertical component of the drag force on the rocket in newtons.

$Dy = \frac{1}{2} \rho \ Vy^2 \ A_{ref} \ Cd$

Acceleration is the magnitude of the rocket's acceleration.
x Acceleration is the horizontal component of the rocket's acceleration.

$Ax = (Tx + Dx) / M$

y Acceleration is the vertical component of the rocket's acceleration.

$Ay = (Ty + Dy) / M - g$

Velocity is the magnitude of the rocket's velocity.
x Velocity is the horizontal component of the rocket's velocity.

$Vx = Ax \ \Delta\tau$

y Velocity is the vertical component of the rocket's velocity.

$Vy = Vy + Ay \ \Delta\tau$

Altitude is the altitude above ground level.

$Alt = Alt + Vy \ \Delta\tau$

Mass is the current mass of the rocket.

$M = Mrocket + \sum Mengine$

Range is the horizontal distance of the rocket from the launch pad.

$R = R + Vx \ \Delta\tau$

Flight angle is the rocket's relative angle to the horizontal plane in degrees. A flight angle of zero degrees is horizontal flight along the +X axis.

$\theta = PR \ \Delta\tau$

Wind angle of attack is the wind induced angle of attack in degrees. This is the difference between the current flight path and the relative wind path.

Cd is the drag coefficient of the rocket. This value can either be calculated for each time slice or hard wired to a fixed value.

CG is the location of the rocket's center of mass/gravity relative to the tip of the nose cone.
This value changes as engine propellant burns off, and when the rocket changes stage configurations.

CP is the location of the rocket's center of pressure relative to the tip of the nose cone.

Angular acceleration is the rocket's pitch rotation rate in radians/sec/sec.
$AA = (\Gamma / I_L) - CDF$

CDF is the "corrective damping effect".
$CDF = (C2 * PR) / I_L$

Corrective moment coefficient

$C1 = \frac{1}{2} \rho V^2 A_{ref} C_{N\alpha} (X_{N\alpha} - CG)$

Damping moment coefficient

$C2 = (\frac{1}{2} \rho V^2 A_{ref} \sum (C_{N\alpha part} (X_{N\alpha part} - CG)^2)) + C_{jet}$
Where:
$C_{N\alpha\ part}$ == the Normal force coefficient of an airframe component. (Nose, Fin, Transition, …).
$X_{N\alpha part}$ == the Location of an airframe component CP.
C_{jet} == the jet damping coefficient. This is currently approximated as (propellant mass / burn time).

Longitudinal moment of inertia

$I_L = \sum I_{Lpart}$
This is the moment of inertia for the rocket calculated using a reference axis passing through the rocket's current CG, and perpendicular to the rocket's longitudinal axis.

Radial moment of inertia

$I_R = \sum I_{Rpart}$
This is the moment of inertia for the rocket calculated using the rocket's longitudinal axis as the reference axis.

Nat. Freq. at zero roll rate
Defined as: sqrt(C1 / I_L);

Damping Ratio
Define as: C2 / (2 sqrt(C1 I_L))

Prec. Freq.
Defined as: (I_R W2) / I_L

Nat. Coupled Freq.
Defined as: sqrt(C1 / (I_L + I_R))

Coupled Damping Ratio
Defined as: C2 / (2 sqrt(C1 * (I_L + I_R)))

Torque
$\Gamma = Nf (X_{N\alpha} - CG)$

Pitch rate
$PR = PR + (AA \Delta\tau)$

Pitch force
This is the rotational force applied to the rocket.

$Nf = \frac{1}{2}\, \rho\; Vx^2\; A_{ref}\; C_{N\alpha}\; \alpha$

Cross wind drag
This is the drag force created by a cross wind blowing across the rocket's airframe.

Cross wind lift
This is the small lift force created by a cross wind acting on the rocket's airframe. *(The simulator currently ignores this factor.)*

Some terms used in the above descriptions:

α == the angle of attack
$\Delta\tau$ == delta time == 1 / (simulation samples per second)
g == the acceleration due to gravity
ρ == the air density (kg/m^3)
A_{ref} == the cross sectional area of the rocket
V == the velocity of the rocket
$C_{N\alpha}$ == the normal force coefficient of the rocket. (Output from the Barrowman equations.)
$X_{N\alpha}$ == the location of the rocket's CP (Center of aerodynamic pressure)
CG == the location of the rocket's CG. (Center of mass)
$C1$ == the corrective moment coefficient
$C2$ == the damping moment coefficient
I_L == the longitudinal moment of inertia
I_R == the radial moment of inertia

Also of interest:
Graph data selection screen.
Simulation export screen.

8.2   Simulation atmosphere model

RockSim uses the 1976 U.S. Standard Atmosphere model.

The calculations at standard conditions have been validated against published tables.
The validation program is available upon request.

Corrections have been added to account for the following parameters:

Launch conditions:
Altitude relative to sea level.
Temperature.
Atmospheric pressure.
Humidity.

Limitations on the 1976 standard atmosphere:
The maximum simulation altitude is
86,000 meters
or
282,152 feet

8.3 Nose cone and transition mathematics

The various nose cone and transition shapes supported by this software are based on mathematical formulas. These formulas are presented here in a form that yields a radius based on a specified offset from the front of the component.

y == The radius.
x == The offset from the front of the component.
R == the component base radius.
D == the component base diameter.
L == the component length.
K == the shape control parameter.
sqrt(z) == The square root of z.

Typical formula: $y = f(x)$

Conical
$y = x (R / L)$

Ogive

$a = (D / 4) + (L^2 / D)$
$b = (D / 2) - a$
$d = sqrt (a^2 - (L - x)^2)$
$y = d + b$

Parabolic

$a = R / sqrt(L)$
$y = a \, sqrt(x)$

Elliptical
The elliptical shape is actually a Prolate Hemi-Spheroid.

$y = R \, sqrt(1 - ((L - x)^2 / (L^2)))$

Power series

$y = R ((x / L)^K)$

For a cone: Set K = 0
For a ½ Power Nose: Set K = ½.
For a ¾ Power Nose: Set K = ¾.

Parabolic series
$Xn = x / L$
$y = R ((2 \, Xn) - (K \, Xn^2)) / (2 - K);$

For a ½ Power Parabolic Nose: Set K = ½.
For a ¾ Power Parabolic Nose: Set K = ¾.
For a Parabolic Nose: Set K = 1. (This creates a circular arc.)

Sears-Haack
$Xn = x / L$
$Xi = acos(1 - (2\ Xn))$
$y = R (1 / sqrt(\pi)) * sqrt(Xi - (1/2\ sin(2\ Xi)) + (K * Sin^3\ Xi));$

For a Von-Karman Nose: Set K = 1.

8.4   Static stability calculations

The RockSim program can be configured to use a proprietary method of static CP determination.
This method is an extension of the Barrowman equations that enables RockSim to estimate the static CP location for rocket configurations that are not supported by the traditional Barrowman equations.

The extensions to the Barrowman equations are summarized below.

* KBT / KB(F) interference factor is included in the fin calculations.
This is the correction factor for the body in the presence of the fins. Barrowman chose to leave this out of his original formulas in order to keep the equations simpler.

* Non-trapezoidal fin plans are correctly handled.

* Fins with root edges fully or partially attached to transition sections are correctly handled.

* Symmetrical fin sets with any number of fins are supported. The Barrowman equations only support symmetrical fins sets with 3, 4, or 6 fins.
RockSim supports any number of fins between 1 and 8 per set.

* Fins can be positioned radially around the airframe at any angle. The Barrowman equations require that all symmetrical fin sets have their first fin aligned at the same angle around the airframe.

Additional details of this stability calculation method are contained in an R&D report available from Apogee components.

8.5   References

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8.6   Command line operation

RockSim can also run without it's traditional graphical user interface. This mode of operation is triggered by passing command line parameters into RockSim when it is started. The details of the command line parameters are shown below.

Using RockSim on the command line:

rocksim.exe *file_specification switches*

Where:
file_specification is either the name of a single RockSim design file, or a search specification for multiple files.

switches are:

-simulations
-s
This parameter will rerun all of the simulations stored in the design files, and then save the results.

-conversion convert_to
-c convert_to
This parameter will convert each of the design files into the file types specified by the convert_to parameter.

convert_to is a '|' separated list or conversion targets.

Available conversion targets are:
AeroCFD or A - RockSim designs are saved as AeroCFD data files. The naming convention is
RockSimName.txt.

Examples:

Rerun all of the simulations in a specific file:
rocksim.exe agm-65b.rkt -s

Rerun all of the simulations in all files:
rocksim.exe C:\RockSim\Designs*.rkt -s

SOME PLATFORM SPECIFIC NOTES:

Windows (95, 98, 98SE, ME, NT, 2000, XP):
In console mode, RockSim displays it's results in a separate console window.
If you are running rocksim in a shell script (Like Cygnus Bash), or in a DOS Batch file,
you should run it using the following command:
start /WAIT rocksim.exe *file_specification switches*

8.7   File formats

8.7.1   RockSim XML format

A RockSim design file stores you rocket design information as well as simulation results. Beginning with
version 5.03 of RockSim, these design files are stored in XML format.

There is a file called RS_XML.txt installed in the RockSim folder at install time. This file is generated by a
Perl script at the time rocksim is built. It contains a complete list of all the possible elements in every rocksim
XML file.

The general structure of a RockSim XML file is as follows:

<RockSimDocument>
 <FileVersion>1</FileVersion>
 <DesignInformation>
 <RocketDesign>
  ... The rocket design data is here ...
 <Stage3Parts>
  ... Sustainrer components are here ...
  </Stage3Parts>

```
<Stage2Parts>
 ... Booster components are here ...
  </Stage2Parts>
  <Stage1Parts>
 ... Booster components are here ...
  </Stage1Parts>
 </RocketDesign>
 </DesignInformation>
 <SimulationResultsList>
 <SimulationResults>
 ... Simulation results for simulation #1 are here ...
 </SimulationResults>
 <SimulationResults>
 ... Simulation results for simulation #2 are here ...
 </SimulationResults>
 </SimulationResultsList>
</RockSimDocument>
```

8.7.2 General description of the database files

The rocksim database files all share the same general format. This format is described below.

* All of the database files are comma delimited ASCII files.
* The line terminator is <CR><LF> (CR == 0x0D , LF = 0x0A)
* There is one record per line.
* The first line in each file is a header record.

Component database files:
The first four columns of all the component database files are the same.

Column 0 == Manufacturer name.
Column 1 == Manufacturer part number.
Column 2 == Description of the component.
Column 3 == <units>

Where:
 <units> == <inches>|<feet>|<millimeters>|<centimeters>|<meters>
<inches> == in | in. | us
<feet> == ft | ft.
<millimeters> == mm | metric
<centimeters> == cm
<meters> == m

Materials database files:
T.B.D.

8.7.3 Nose cone database file

Column 4 == The nose cone length in <units>
Column 5 == The nose cone base diameter in <units>

Column 6 == The shape control parameter - unitless
Column 7 == The length of the nose cone shoulder in <units>
Column 8 == The OD of the nose cone shoulder in <units>
Column 9 == The thickness of the nose cone wall in <units> (Applies to hollow nose cones)
Column 10 == The <shape> of the nose cone. (See below).
Column 11 == The <configuration> of the nose cone (See below).
Column 12 == The nose cone material.
Column 13 == The nose cone center of gravity (This is the mass override value) in <units>, as measured from the tip of the nose cone.
Column 14 == <mass units>
Column 15 == The nose cone mass in <mass units> (This is the mass override value).
Column 16 == The nose cone base extension length in <units>

Where:

<shape> == <ogive>|<cone>|<parabola>|<ellipse>|<power series>|<parabolic series>|<sears-haack series>
<ogive> == o | ogive
<cone> == c | cone
<parabola> == p | parabolic
<ellipse> == e | elliptical
<power series> == ps | power-series
<parabolic series> == pbs | parabolic-series
<sears-haack series> == sh | sears-haack

<configuration> == <solid> | <hollow>
<solid> == s | solid
<hollow> == h | hollow

<mass units> == <ounces> | <grams>
<ounces> == oz | oz. | us
<grams> == g | metric

8.7.4   Transition database file

Column 4 == The length of the forward shoulder in <units>.
Column 5 == The OD of the forward shoulder in <units>.
Column 6 == The forward diameter of the transition in <units>.
Column 7 == The length of the transition in <units>.
Column 8 == The rear diameter of the transition in <units>.
Column 9 == The core diameter in <units>. This is the diameter of a hole drilled through the length of the transition.
Column 10 == The length of the rear shoulder in <units>.
Column 11 == The OD of the rear shoulder in <units>.
Column 12 == The wall thickness for hollow transitions in <units>.
Column 13 == The construction <type>.
Column 14 == The transition material.
Column 15 == The transition center of gravity (This is the mass override value) in <units>, as measured from the front of the transition.
Column 16 == <mass units>
Column 17 == The transition mass in <mass units> (This is the mass override value).
Column 18 == The <shape> of the transition. (See below).
Column 19 == The shape control parameter. unitless

Where:

<shape> == <ogive>|<cone>|<parabola>|<ellipse>|<power series>|<parabolic series>|<sears-haack series>
<ogive> == o | ogive
<cone> == c | cone
<parabola> == p | parabolic
<ellipse> == e | elliptical
<power series> == ps | power-series
<parabolic series> == pbs | parabolic-series
<sears-haack series> == sh | sears-haack

<type> == <solid> | <hollow>
<solid> == s | solid
<hollow> == h | hollow

<mass units> == <ounces> | <grams>
<ounces> == oz | oz. | us
<grams> == g | metric

8.7.5   Simple fin set

Column 4 == CR (Root cord) in <units>.
Column 5 == CT (Tip cord) in <units>.
Column 6 == S (Semi-span) in <units>.
Column 7 == XR (Sweep angle, or distance. See column 12)
Column 8 == Thickness in <units>.
Column 9 == <shape type> (See below)
Column 10 == <tip shape> (See below)
Column 11 == The fin material.
Column 12 == <sweep mode>

Where:

<shape type> == <trapezoidal> | <elliptical>
<trapezoidal> == t | trapezoid
<elliptical> == e | elliptical

<tip shape> == <square> | <rounded> | <airfoil>
<square> == s | square
<rounded> == r | rounded
<airfoil> == a | airfoil

<sweep mode> == <angle> | <distance>
<angle> == 0
<distance> == 1

8.7.6   Free form fin set

Column 4 == CR (Root cord) in <units>.
Column 5 == CT (Tip cord) in <units>.
Column 6 == S (Semi-span) in <units>.

Column 7 == XR (Sweep angle, or distance. See column 12)
Column 8 == Thickness in <units>.
Column 9 == reserved s/b blank.
Column 10 == <tip shape> (See below)
Column 11 == The fin set material.
Column 12 == The number of vertex points which follow.
Column 13 == <vertex 1>
Column 14 == <vertex 2>
.
.
.
Column 140 == <vertext 128>

NOTE 1: Columns 4 though 7 are optional, ans can be set to zero.
They are in place for backward compatability.

NOTE 2: There are a maximum of 128 vertext points supported. These points do not include the data points
required to fit the root edge of the fin along curved sections of the airframe.

Where:

<tip shape> == <square> | <rounded> | <airfoil>
<square> == s | square
<rounded> == r | rounded
<airfoil> == a | airfoil

NOTE: The '|' in the <vertext list>

<vertext> == <x>|<y>
<x> == An x-axis location in <units>. The x-axis is along the rocket airframe.
<y> == A y-axis location in <units>. The y-axis is perpendicular to the rocket airframe.

x=0 , y=0 is defined as the leading / formard most point of the fin root cord.

The first point is always located at the trailing edge of the root cord.
The points are specified in a counter clockwise direction until the leading edge of the root cord is reached.

Example:
A one inch, airfoiled, square fin. Made from 1/8" basswood.
There are four vertext points required.

DIY, NoPartNo, NoPartDesc, in., 0, 0, 0, 0, 0.125, airfoil, basswood, 4, 1|0 , 1|1 , 0|1 , 0|0

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