

A place to find information about playing, and succeeding at, Kerbal Space Program.



Controls Compatibility

NAV

It means controls are compatible with controller-navigation, including radial menu or accelerator controls.

CURSOR

It means controls are compatible with the cursor.

Note: If both are compatible, you can toggle between modes by pressing the L3 button.

The Construction Interface

There is a lot you can do during construction. You will be picking and aligning parts, adjusting staging and almost certainly coming back to add a chute that you forgot the first time.



The Parts Toolbox

NAV

CURSOR

You will find the items you need to build a vessel in the parts toolbox. Through the use of filters you can target a search for that perfect part.

Toggle Advanced Mode:

Press the  button on categories to show/hide the additional advanced filters including resource type, bulkhead size, tech level and more.



Sort Actions:

In cursor mode, press the  button on a label to sort the parts.

Part Picker:

Press the  button to pick up parts from the toolbox and use them in the editor.

In cursor mode, you can also drop unwanted parts here to discard them.

Part Details

Press the  button on parts in the toolbox to toggle the display of additional info.



Manual / Construction Interface / Part Details

Part Details

NAV

You can adjust how much detail is shown by pressing the button while a part is selected in the toolbox.

General Details:

Basic information like mass, resource capacity, crew capacity and more.

Part Name and Model:

Including a one meter scale for reference.

Description:

Learn a bit more about the use and history of each part.

Cost:

Monitoring your build costs in career mode is key.

Module Details:

This section contains more details on the specific modules that make up the part.

Mk1-2 Command Pod



Mass: 4.12 t
Crash Tolerance: 45.0 m/s
Max. Temp. Int/Skin: 1400/2400 K
Crew Capacity: 3

Electric Charge: 150.0
Mono Propellant: 30.0

Manufacturer:
Kerlington Model Rockets and Paper Products Inc

This modern cockpit is designed to be fully re-useable. Its spacious cabin can hold a maximum of 3 crew.

Cost: ₣ 3800.00

Command
Minimum Crew to Operate: 1

Reaction Wheel
Pitch Torque: 15.0
Yaw Torque: 15.0
Roll Torque: 15.0

Requires:
- Electric Charge: 1.2/sec.

Science Experiment
Crew Report
Collectable data: ✓
Rerunnable: ✓
Resettable: ✓
Reset requires: ElectricCharge
Reset cost: 1

Electric Charge
Amount: 150.0
Max: 0.00

Return to Game

Action Groups

NAV

With action groups you can cause multiple actions to happen at a single radial menu action. A common setup might be to have all solar panels toggle on one radial menu action, or all radiators extend. With the layout seen here you select an item on listed actions to alter the groups.

Stock Groups:

You can add to the stock actions through these items in the list.

Custom Groups:

These let you define actions to occur when accessed from the radial menu



Group Actions:

Actions listed here will be triggered when the highlighted group is activated.

Part Actions:

This shows the available actions for the part selected in the editor.

If the part selected was placed using symmetry then the action will include all the parts in the symmetry group.

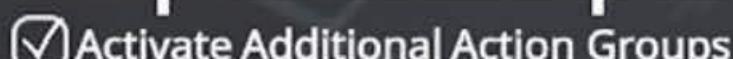
The Abort Action Group:

This stock group can be used to fire off your escape tower and save your crew in the event of a launch issue. Not saying it's likely, but accidents do happen.

Action Sets

Action sets let you assign action or axis groups in multiple sets - which can be toggled on and off in flight.

- Enable them here at the bottom of the action group window.



You add a control to a set just like how action groups work

- Select a Set.



- Add a part control to it.

The in-flight App lets you see and change which set is active.



- Expand/Collapse



- Check to block the vessel controls when this set is active

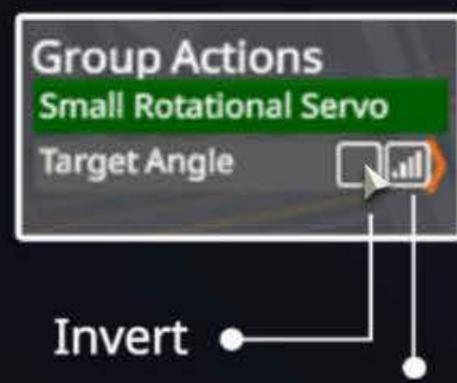
- Rename the action set to remember its function

- Check to override the default set when this set is active.

Axis Groups

Axis groups allow you to control a selected part's values with your input controls, similar to how an action group allows control of a part's action.

You map a part value to an Axis Group to in the same way. Select the part and the axis group, then click to assign the field.



Invert
Absolute/Incremental

Two additional controls appear for axis groups.

Invert: Reverses the direction controlled value responds

Absolute/Incremental: Changes how your controller/keys change the field. Absolute works more like pitch and yaw. Incremental works like the main throttle.

Vessel Crewing

NAV

The crew tab in the construction interface helps you to assign kerbals to the seats in your vessel.

Crew Seats:

Here you will see a segment for each part in the vessel that has seats.

Press the button to assign kerbals to seats from the available crew, or remove kerbals from seats if you need an empty seat for a rescue.



Available Kerbals:

The kerbals listed here are the ones on your roster. Pay special attention to the role and skill level of your kerbals, especially in career.

If you run out you may need to hire more.

Astronaut Complex:

Pressing will take you to the AC where you can hire (or fire) members of your space program.

Moving Kerbals Around:

You can assign kerbals to positions by *dragging* them, or using the tick/cross buttons that are displayed when your cursor is over one. There are lots of ways to make sure you fill a seat, but you'll still forget sometimes.

Scene Actions and Vessel Details

CURSOR

OPTIONS

Pressing  you open a menu from where you can control what happens to your vessel.





The Staging Stack and App Launcher

NAV

CURSOR

With the staging stack you can set up the activities that will happen at each stage of the vessel's flight. During flight you will see a version of this which shows some extra information. Alongside this is the app launcher for the construction scenes.

Here we see the six stages of a vessel and the parts assigned to each stage.

When a stage is activated, the parts assigned to that stage are activated.

Add Stage Below:

This will add an empty stage that is ready to have parts dragged into it.

Remove Empty Stage:
Deletes the stage next to the icon.
This only works for empty stages.

App Launcher:

From here you can access a range of information.



● Moving Stages:

You can select a stage pressing the  button and drag selected one to change its order in the stack.

• Moving Stages:

You can select a part pressing the  button and drag it between the stages by moving its icon.

- Empty Stage:

Ready to have parts *dragged* into it.

• Reset Staging:

This will reset the staging to what KSP "thinks" is the original state... be warned, letting computers think has caused problems before!

Note: The staging stack is visible during flight as well, with some slight variations.



Return to Game

Δv Tools - VAB/SPH

Provides information about the Δv of your rocket. See the Δv KSPedia page to understand Δv better!

- **Celestial body select:**

Select the CB for atmospheric Δv figures.



Atmosphere:
Toggle between pressure situations

Altitude Slider:
Selects altitude for the altitude option

Hide/Show all stages:
Toggles expanded information on all stages.

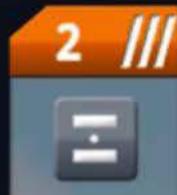
- **Information Display:**

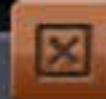
Which data appears in expanded stage information.

Stage Header:
Click here to toggle this stage's expanded stage information.

Stage Δv :
Readout for Δv of this stage. If this stage generates zero Δv , no value is displayed.

Total vessel Δv :
Readout of the current total for all stages. Clicking here also toggles on/off all expanded stage information.





The Engineer's Report

This app can save you from disaster - if you're paying attention. The engineer's report lists things of note about the vessel under construction.

Basic Information:

Here you will find things like part count, size and mass. In career mode you will see when you hit the limits of your facilities.

Checklist Severities:

There are three severity levels for checks:

- Informational
- ▲ Warning
- Critical

Design Checklist:

In the bottom half of the app will be the list of checks that may need your attention. You don't have to fix these, but it is always a good idea to give them a once over.



Information on Centers and Costs

NAV

CURSOR

Near the snap and symmetry controls you will find buttons to toggle the "center" indicators.

Vessel Cost and Funds

This info shows the cost of launching the current vessel, including the resources on board.

The second value is your available Funds (if you're in career mode)



Center of Mass (CoM)

The center of mass is the place where the sum of all the individual components mass is balanced. Think of it as the balance point.



Center of Thrust (CoT)

This marker shows the sum of all the sources of thrust to generate this marker. It displays the CoT of all the engines in the vessel.



Center of Lift (CoL)

This marker shows the sum of all the lift forces on the vessel. Much more on this in the section about aircraft.



Construction Gizmos

NAV

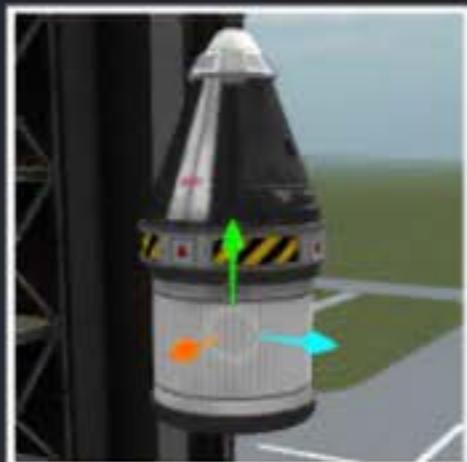
CURSOR

In the construction interface there are four tools to help you design the perfect vessel.



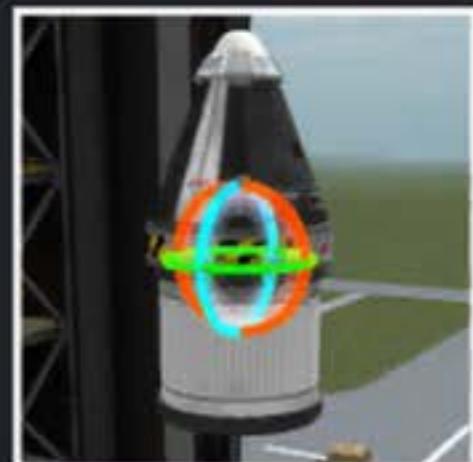
Place Gizmo (Default)

Activate this tool to pick up and connect parts.



Offset Gizmo

Provides handles to drag the part along each axis.



Rotate Gizmo

Provides handles to rotate the part along each axis.



Root Gizmo

Lets you change the root part of any group of parts. It is a two part process of clicking the group then selecting the new root part.

Fine Control Option:

* Open radial menu and select "Toggle AngleSnap". It will make the offset and rotate tools work in greater increments.

* With snap enabled, holding down will make the offset and rotate tools work in smaller increments.

Symmetry and Snapping

To help balance your vessels when building, there are two functions that can be a great help.

Angle Snap

The angle snap tool makes it easier to get exact angles around the centerline of the vessel. By default it works in 15° increments; holding down **R1** will make it work in finer 5° steps.



Angle Snap On



Angle Snap Off

Symmetry

There are two types of symmetry - radial and mirror. Radial symmetry is usually used with rockets to place 2, 3, 4 or more parts around the central axis. Mirror symmetry is what you normally use with aircraft to place items either side of the center line.

Radial



No Symmetry



2x Symmetry



3x Symmetry



4x Symmetry

and more...

Mirror



Example Placement in 2x Symmetry



2x Radial Symmetry



2x Mirror Symmetry

Variant Switcher

Some parts now have different looks and shapes.



You can also select the variant by name and color pattern in the Part Action Window

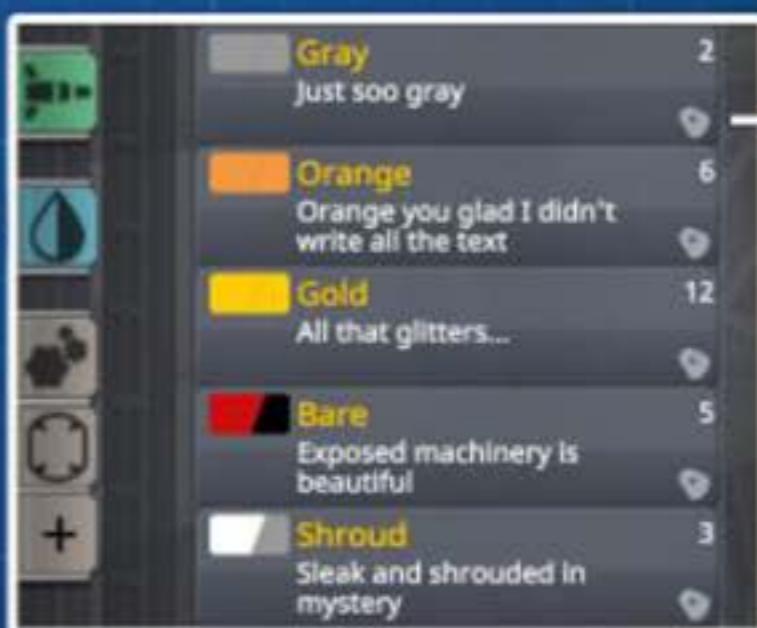


Look for this icon to cycle between the available variants.

You can also apply that theme to all existing parts in the current vessel with



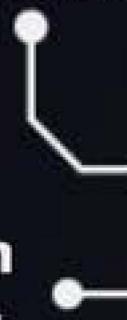
From the themes panel you can select the a Variant Theme and all parts with that theme will use if for new parts being placed. You can also apply that



The Flight Interface

Below is the main flight interface. You will be spending a lot of time here, so there is more information about each labeled area in the following pages.

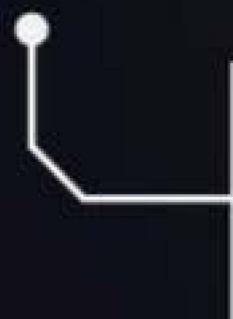
Time Controls



Action Menu



Staging Stack



Mode Controls



Altimeter



NavBall

App Launcher



Kerbal Portraits



Manual / Flight Interface / The NavBall

CURSOR

The NavBall

This helps you understand your vessel's orientation. Think of it as a three-dimensional compass: the blue half of the sphere indicating away from the body you're orbiting (sometimes known as the sky when you are landed), the brown half is towards it (ground) and the line between them an artificial horizon.



NavBall Markers

On the NavBall you will see a range of symbols that indicate points of reference:

	Prograde		Normal		Radial-In		Maneuver Prograde
	Retrograde		Anti-Normal		Radial-Out		Level Indicator

Return to Game

Mode Control

CURSOR

The mode control shows important information regarding the inputs and control of your vessel. It can be changed between staging, docking and map modes using radial menu (△) or pressing L3 to show cursor and select the desired icon.

- Staging Indicators:

Shows the active stage number and the stage lock indicator (green for go, purple for locked).

- Mode Buttons:

Activates staging, docking and map modes.



- Pitch/Yaw/Roll Indicators:

Shows the state of the three input axes and any trim applied.

Precision Mode:

Note that the PYR Indicators change to blue when precision mode is enabled.



Docking Mode:

Shows specialized control input indicators for the two docking modes: rotation (ROT) and translation (LIN).



The Staging Stack

NAV

CURSOR

The staging stack helps you to visualize the vessel's current and upcoming stages. In flight mode it shows you how much fuel is attached to running engines, and also lets you adjust the stages "on the fly."

Here we see the six stages of a vessel and the parts assigned to each stage.

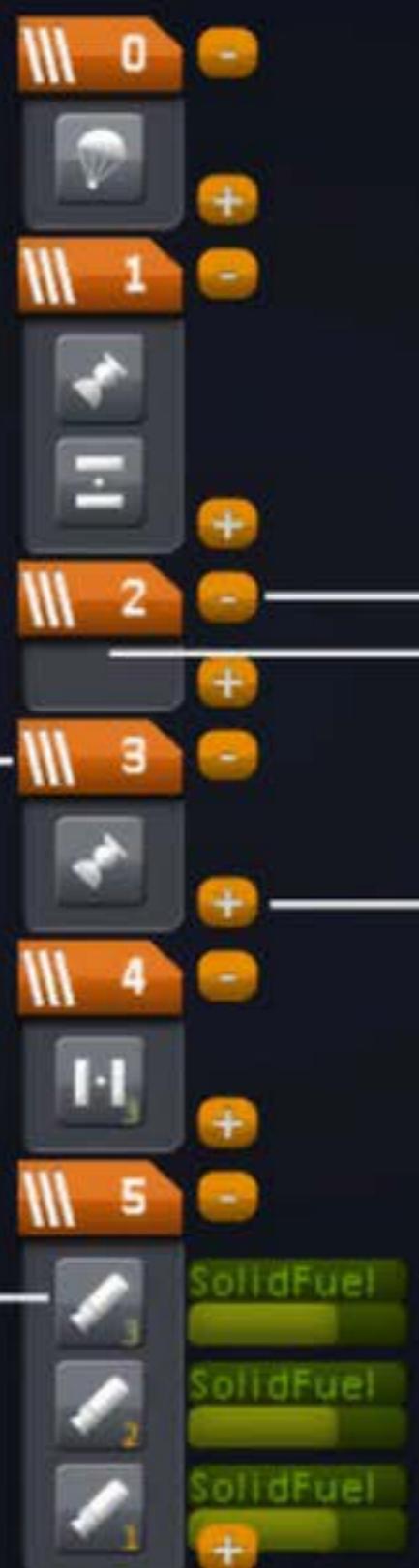
When a stage is activated, the parts assigned to that stage are activated.

Moving Stages:

You can select a stage pressing the button and drag selected one to change its order in the stack.

Moving Parts:

You can select a part pressing the button and drag it between the stages by moving its icon.



Remove Empty Stage:

Deletes the stage next to the icon.

Note: this only works for empty stages.

Empty Stage:

Ready to have parts dragged into it.

Add Stage Below:

This will add an empty stage that is ready to have parts dragged into it.

Active Stage Resources:

Shows the resources this active stage is consuming.

Δv Tools - Flight Mode

Provides information about the Δv of your rocket. See the Δv KSPedia page to understand Δv better!



● **Stage Header:**

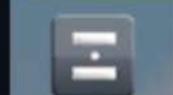
Click here to toggle this stage's expanded stage information.

1

1120m/s



2



1120m/s

● **Stage Δv :**

Readout for Δv of this stage. If this stage generates zero Δv , no value is displayed.

● **Total vessel Δv :**

Readout of the current total for all stages. Clicking here also toggles on/off all expanded stage information.

Air Pressure and Δv :

Rocket engines get more efficient at lower air pressure - some more than others! Example:

Δv at sea level



Δv in vacuum



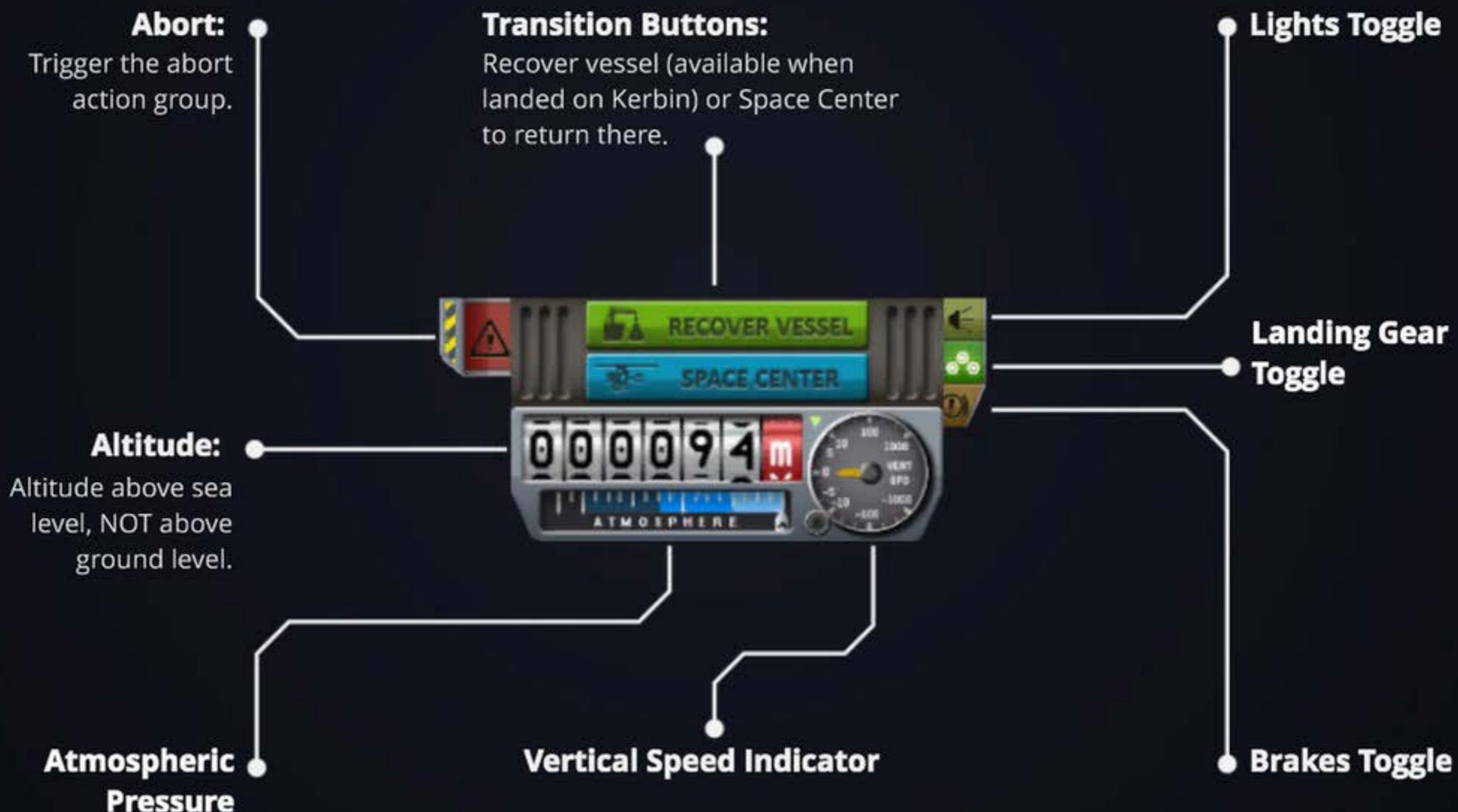
CURSOR

The Altimeter*

This is the altimeter control - and the gear toggle, and the brake toggle, and the abort button, and...

Alright, it does show a few more things than just altitude, and does let you control a number of functions. You can see these below.

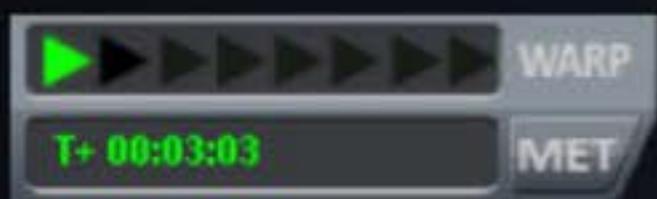
* May contain "some" other information and controls.



Time Controls and Action Menus

NAV

CURSOR



Using the time controls you can adjust, or "warp" time as well as toggle between mission elapsed time (MET) and universe time (UT).

EVA Action Menus

Kerbals on EVA also have contextual actions they can perform. There are some examples in the picture here.



Part Action Menus

Most parts have a contextual menu that lets you interact with them. You will see details of the part and any actions you can perform.



The App Launcher

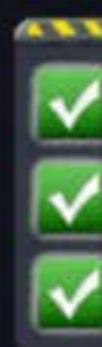
NAV

CURSOR

From the app launcher you can access a range of tools and information. Some examples are shown here.

Messages App:

Where important career events are shown.



Contracts App:

Current contracts with their parameters and completion status.

Contracts	
Set distance record of 5,000m.	✓
Achieve a land distance of 5,000m from KSC	✓
Set speed record of 150m/s.	
Achieve speeds exceeding 150m/s	○
Set altitude record at 3,500m.	
Achieve an altitude of at least 3,500m	○

Resources App:

Shows resources in your vessel. Enable the checkbox next to a resource to see where that is on the vessel.

Resources	
<input type="checkbox"/> ElectricCharge	135 / 150 (0.00)
<input type="checkbox"/> MonoPropellant	780 / 780 (0)
<input type="checkbox"/> LiquidFuel	249 / 360 (0)
<input type="checkbox"/> Oxidizer	305 / 440 (0)
Stage View <input type="checkbox"/>	

KSPedia App

You are here.



Currencies App:

Your current Funds, Reputation and Science.

Kerbal Portraits

During flight you can monitor the fear - I mean excitement - of your astronauts via the portraits in the bottom-right corner. Hovering over a specific kerbal will give you detailed info on them.

Interior Overlay Mode

Reveal the vessel's interior spaces. It's like looking at the man behind the curtain.



Add/Remove Slots

Adjust how many portraits are shown in the list.

Kerbal Information

The kerbal's name. Their role and skill level will be shown when the cursor is over a portrait.

View Action (IVA)

Also known as Intravehicular Activity. Changes the camera to show you this kerbal's point of view.

EVA Action

Extravehicular Activity: this kerbal will exit the spacecraft.*

*EVA while flying in atmosphere can be detrimental to a kerbal's health.

EVA Activities

NAV

CURSOR

When kerbals are out and about you can direct them to interact with what's around them via the action menus.



Below are a number of the activities that can be performed:

- Repair wheels.
- Collect surface samples
- Collect science from experiments.
- Plant flags.
- Extend and retract panels.
- Extend and retract landing gear.
- EVA reports.
- Repack parachutes.
- And more...

In career mode some activities are available to specific roles and levels only. For example, the "Repair Wheel" activity is only available to engineers that are level 3 and above.

Kerbal Parachute

Kerbals with sufficient experience can now enjoy the feeling of flight (without crashing at the end) by using their EVA chute.



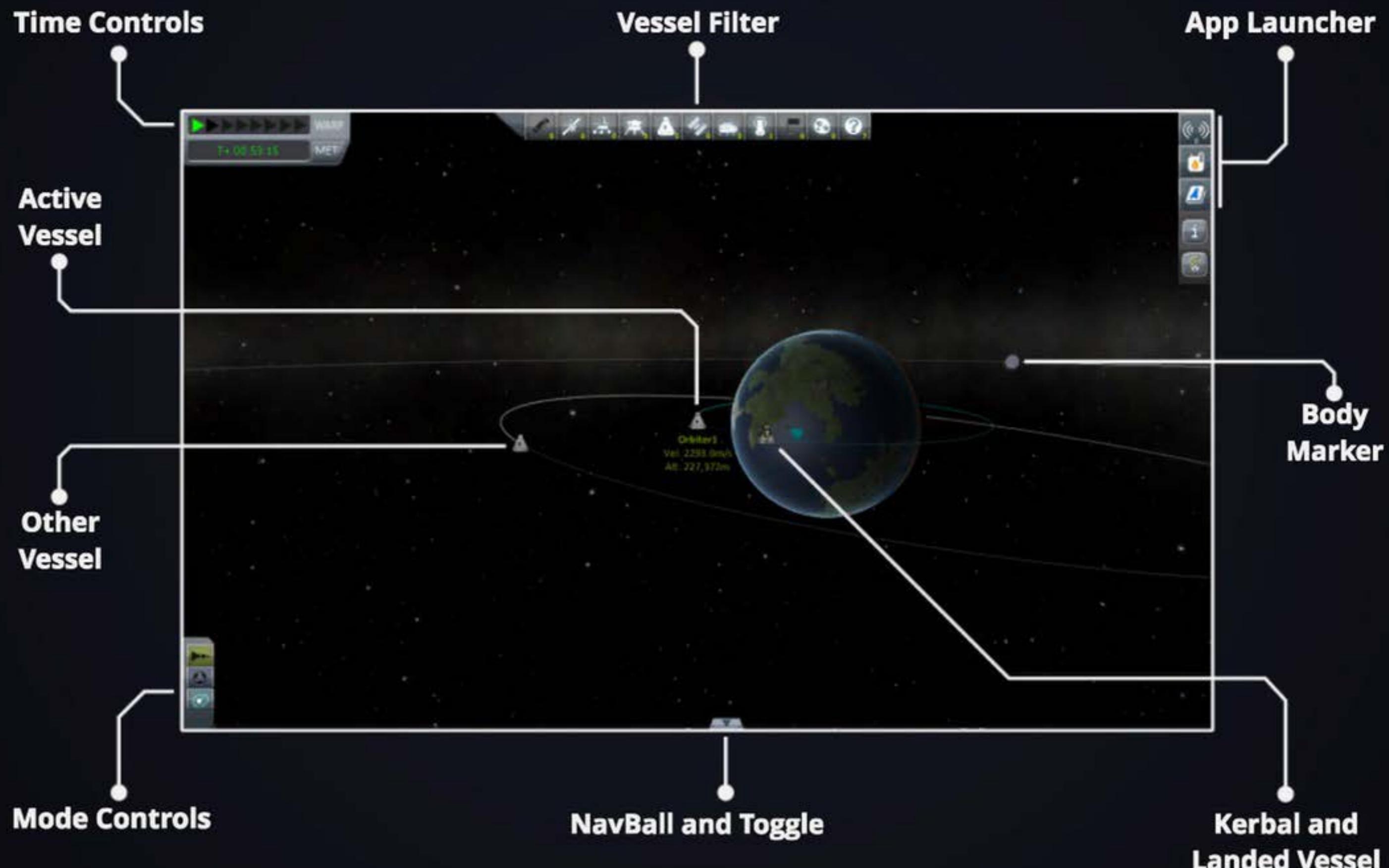
When above Level 3 a kerbal will have an EVA chute that can be deployed and repacked, just like the vessel chutes.

These chutes are vastly more advanced through the use of extra strings that let you turn and dive!!

Deploy	
Pitch Forward	
Pitch Backward	
Turn Left	
Turn Right	

The Map Interface

This is the view from the map. Here you see the big picture for the active vessel and other nearby objects in space.



Orbit Nodes

When looking at orbits there are a number of helpful indicators.



Note: The color of the orbit helps to differentiate between the active and target vessels.

Apoapsis/Periapsis Node:



Where the vessel is furthest (Ap) and closest (Pe) to the planet it is orbiting.

Ascending/Descending Node:



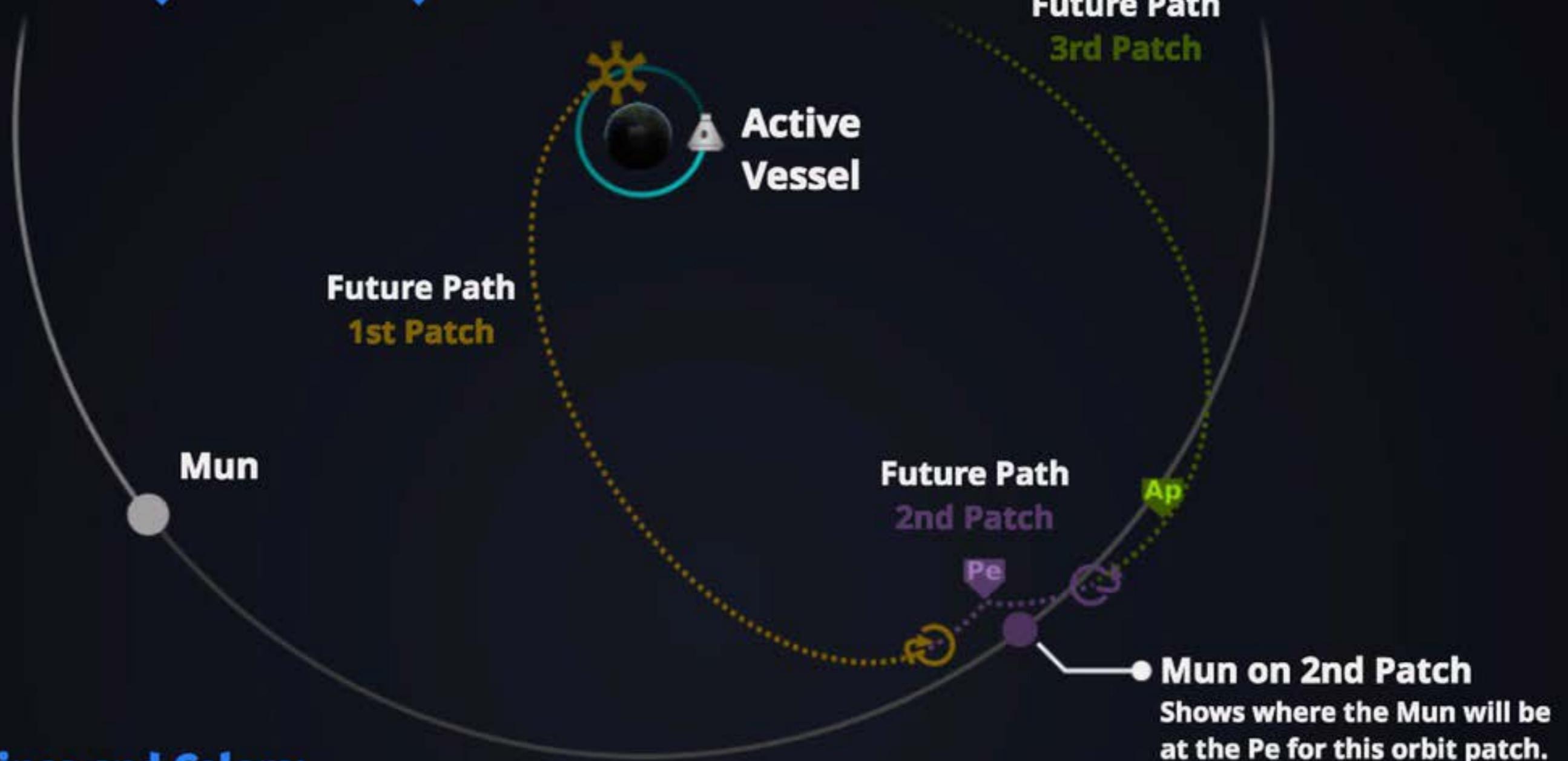
These show where the active vessel's orbital plane crosses the target vessel's. AN is where the active vessel goes from below the target plane to above it (and vice versa for DN).

Intersect Markers (Closest Approach):



These show where you will be closest to your target. The downward marker shows where the active vessel will be, and the upward one the target's position at the same time.

Orbit Nodes (continued)



Orbit Lines and Colors:

The color and style of orbit lines provides important information.

- On a vessel's orbit the gradient is a "trail" with the brightest part of the orbit where the vessel just was.
- Future orbit paths (after maneuver nodes) are shown with dashed lines.

Sphere of Influence Change (SOI):



Shows where the orbital path will leave one planet's SOI and enter another's. Each time an orbit changes SOI the orbit color changes. The color of the SOI node relates to the orbital path before the SOI node.

Maneuver Node:



Where a maneuver has been planned. The orbital path after the maneuver is the same color as the maneuver node.

Maneuver Nodes

This map tool is arguably the most important tool for getting to your chosen destination. With it, you plan the location, direction and orientation of a "burn," a firing of the engines.

Creating Maneuver Nodes

In cursor mode, press the  button anywhere on your orbital path - the actual orbit or future paths after existing maneuver nodes.

Adjusting the Maneuver



Gizmo Primary Mode

When the maneuver node gizmo is active you can adjust the planned burn using the six handles.

You can plan burns for the selected handle using  (change handles with  and 

Gizmo Alternate Mode

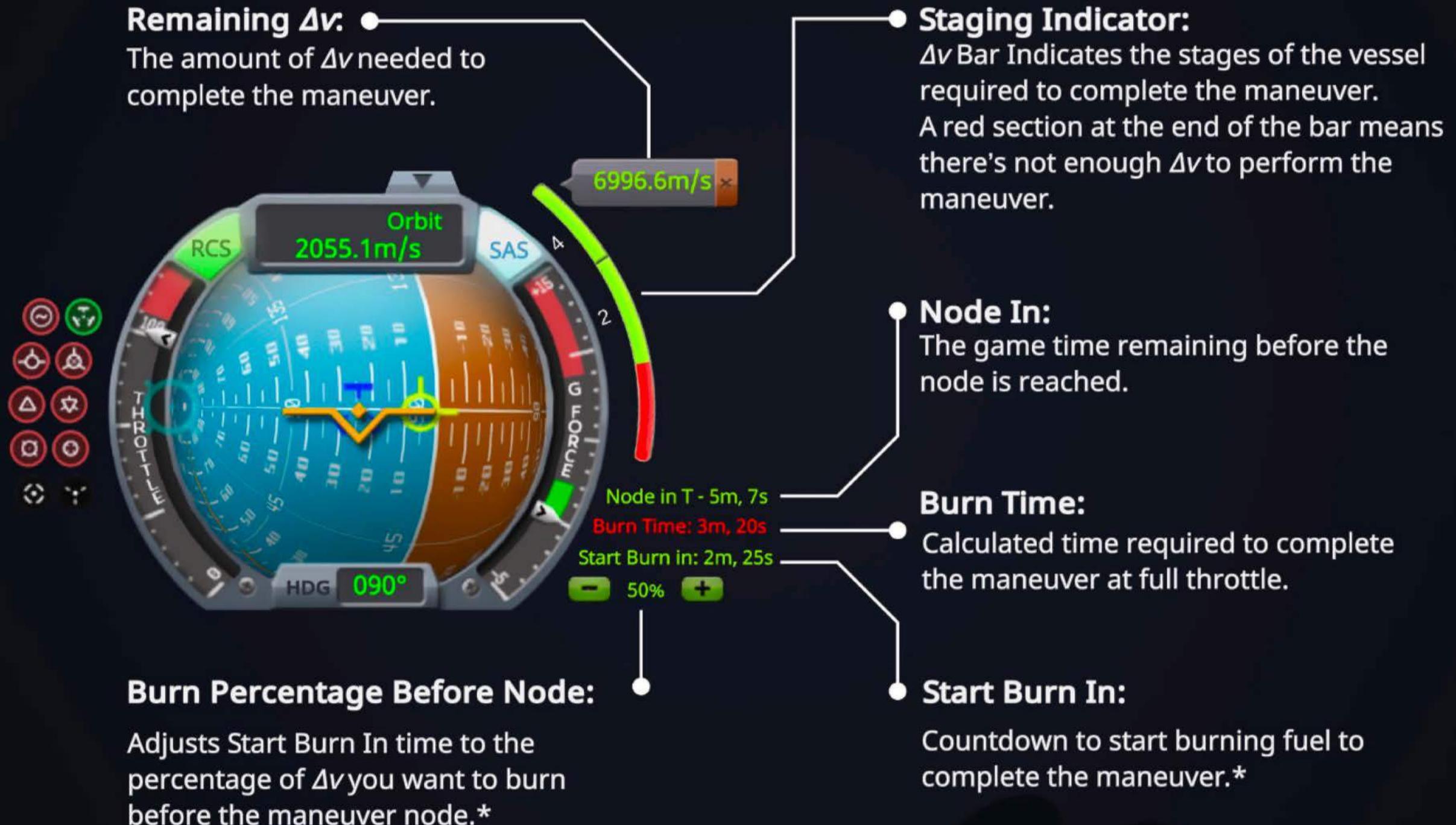
With the gizmo open you can press the  button to toggle between gizmo modes.

The alternate mode lets you move the node forward and backward whole orbits pressing the  or .

Delete the node if you need to clean up pressing the  button.

Burn Time Indicator

Allows you to monitor information on the Δv needed to complete the active maneuver.



* Displayed when Extended Burn Indicator setting is enabled.



Controls

How to control vessels and kerbals so you can build and explore.



Presets

Three different gameplay presets can be chosen to adapt to different playstyles, namely:

Cursor

Radial

Simplified

Changing Preset changes the flight and editor controls, as well as the UI navigation.

You can change the preset in use in the main menu Settings section, as well as through the minisettings available through the pause menu, in-game.





Manual / Controls / In-Game Help

Controls Help

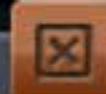
A list of the currently active controls can be accessed through both the pause menu...



... or the controls application.



Return to Game



Manual / Controls / Cursor Preset

Cursor

Cursor offers backwards compatibility with previous console installments of the game, and is played largely with the virtual cursor, which may be toggled on and off with **L3**.



Return to Game

Radial

Radial is a balanced preset that changes some of the bindings and moves slightly away from the virtual cursor.



Radial also uses a virtual cursor during flight and vessel editing.

Press **L3** to toggle the cursor on and off.

Radial relies heavily on the use of Radial Menus, which are available in all screens by pressing **△**.





Manual / Controls / Simplified Preset

Simplified

Simplified removes the virtual cursor and offers an entirely console-oriented game experience.



Simplified replaces radial menus with region navigation pretty much everywhere.

Hold to see available regions and to move between them.

Simplified replaces the virtual cursor with a Look-At system. Moving the camera changes your currently selected item; pressing allows you to peek around.

There are still some radials left to use the Action Groups.

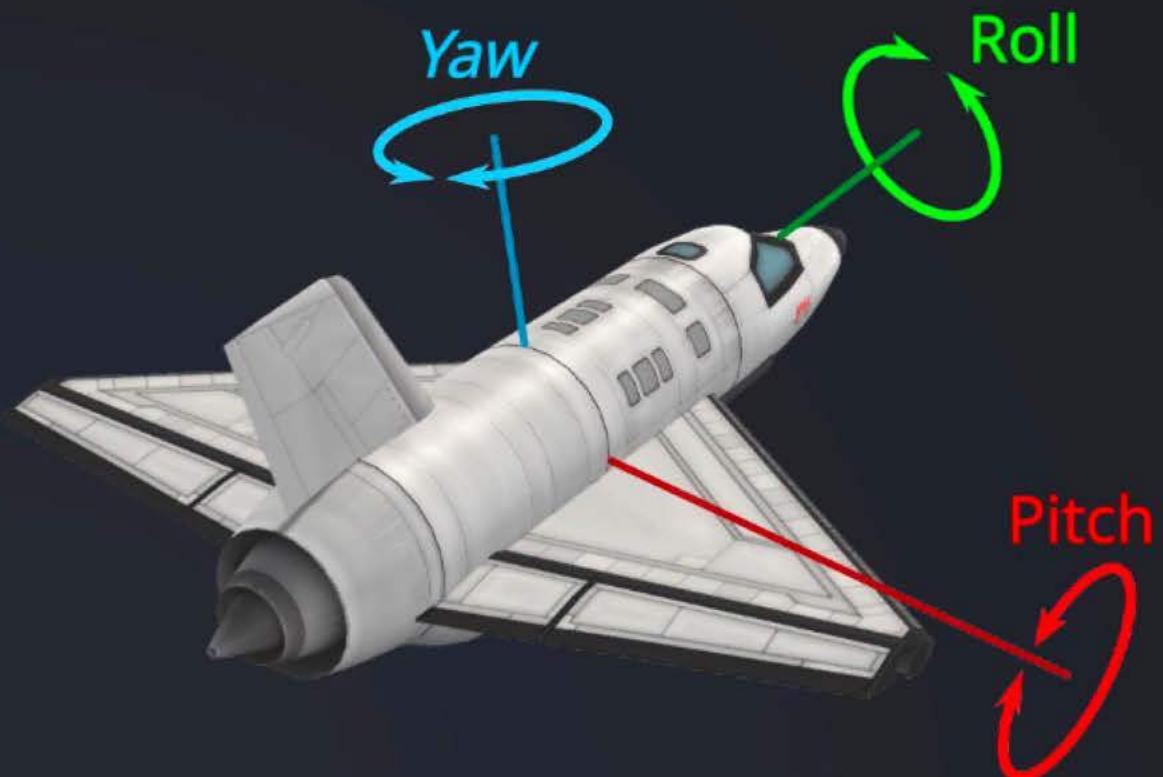


Return to Game

Directions in Flight

Pitch, yaw and roll are the three axes of control in flight. The diagram on the right shows the axes relative to an aircraft, which is a more familiar scenario for most.

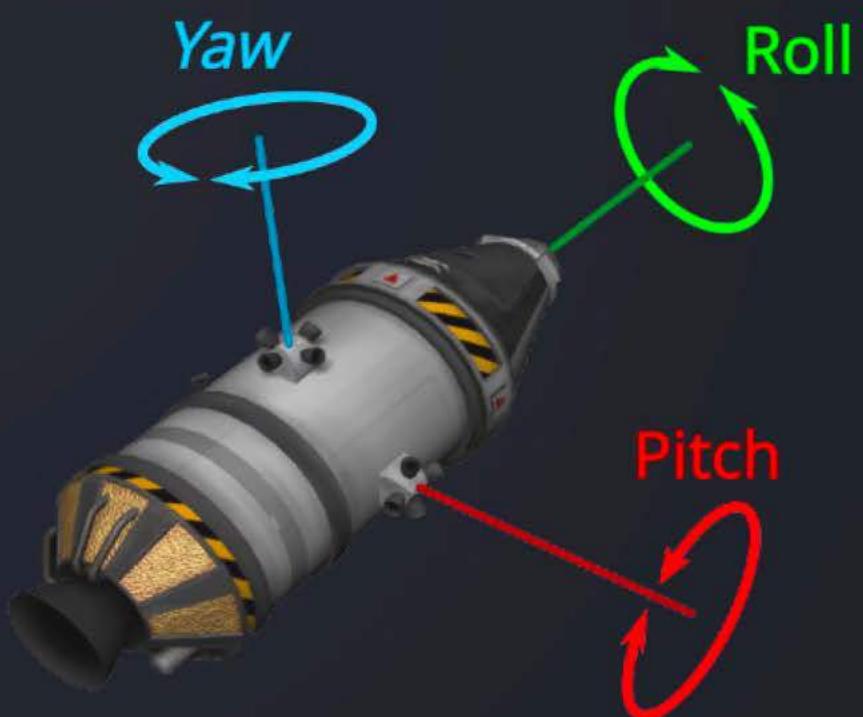
The diagram below shows how the same axes relate to a spacecraft with a Mk1 Pod (the pod being the defining part for the axes directions.)



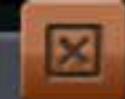
Using the NavBall to Rotate

While visually on many craft you can see where pitch, yaw and roll should be, it is not always the case.

The NavBall is there to help you visualize the rotation accurately for all craft.



The hatch on this pod identifies the "top" and can help you visualize the "up" direction.



Career Management

Learn the uses and methods of the facilities around the Kerbal Space Center so you can tailor your career for success.



Note: Champagne not included

The Kerbal Space Center

NAV

This is your home for all things KSP-Related. You'll see it a lot as you move between different facilities, getting all your kerbals organized for an epic space adventure.

Time Controls



**Building
Shortcuts**

App Launcher

The Astronaut Complex

NAV

This facility lets you manage your roster of astronauts.

Roster Tabs:

The three tabs here let you see available, assigned and lost astronauts. At the top you will see the maximum roster size you can have with the current level of the facility.



Applicants:

This is the list you can hire new staff from. You can see what role each applicant has specialized in as well as some basic info on their personalities.

In Career mode the cost to hire the applicants is shown at the top.

Lost Kerbals:

These kerbals have had an unfortunate "accident" during their career. Don't worry too much, as they will find their way home eventually.

The Administration Building

NAV

The admin interface has three main sections to use for managing your strategies.

- Available Strategies:

These are the strategies that the division heads have to offer you. Selecting one will show you more information.



- Active Strategies:

Here you can see the strategies that are currently active, as well as the maximum number you can accept at the current level of the facility.

- Strategy Details:

The selected strategy details and effects are shown here.

For offered strategies you can use the slider to adjust the commitment you wish to make before accepting. For active strategies you have a big red button to cancel them.

Mission Control

NAV

Mission Control has a mass of information on contracts -- whether offered, active or complete. You can pick and choose the goals for your space program and check prospective rewards.

Contract List:

The three tabs here let you see available, active and completed contracts. The number you can have active is related to how advanced the Mission Control facility is.



Contract Details:

The details of the selected contract and completion are shown here, along with the buttons to accept, decline and cancel (if you're not up to it).

The Research and Development Technology Tree

NAV

The R&D TechTree shows you the technologies and parts that are available. This career facility lets you see what is (and what can be) unlocked through the application of Science.

Toolbar:

Across the top (from left to right) are the Technology and Science Archives tabs; the current level of Funds, Reputation and Science; and the way out.



Tech Tree Nodes:

The color and lines of the nodes indicate what is unlocked and what is still to be researched. The number attached to the node shows how many parts are locked. Again, at harder difficulties you have to spend Funds to unlock these parts.

Technology Details:

The details of the selected tree node and associated parts are shown here. You can see the prerequisite nodes to unlock it (and the button to spend Science to do this if it's locked) as well as the parts that make up the technology. At harder difficulties you will spend Funds to unlock each of the parts.

The Research and Development Science Archives

NAV

The R&D Science Archives show your progress in scientific discovery. It stores all the valuable experiment results that you have collected.

Toolbar:

Across the top (from left to right) are the Technology and Science Archives tabs; the current level of Funds, Reputation and Science; and the way out.

Report Details:

This list shows details about the reports that match your selected filter. The progress bar shows you the amount of science you have collected for that particular report compared to the amount of science that can be collected. If the bar is full then there is no point repeating that activity.



Report Filters:

Here you can filter the reports to be shown on the right. You can filter by planet, experiment, situation and biome.

The Tracking Station

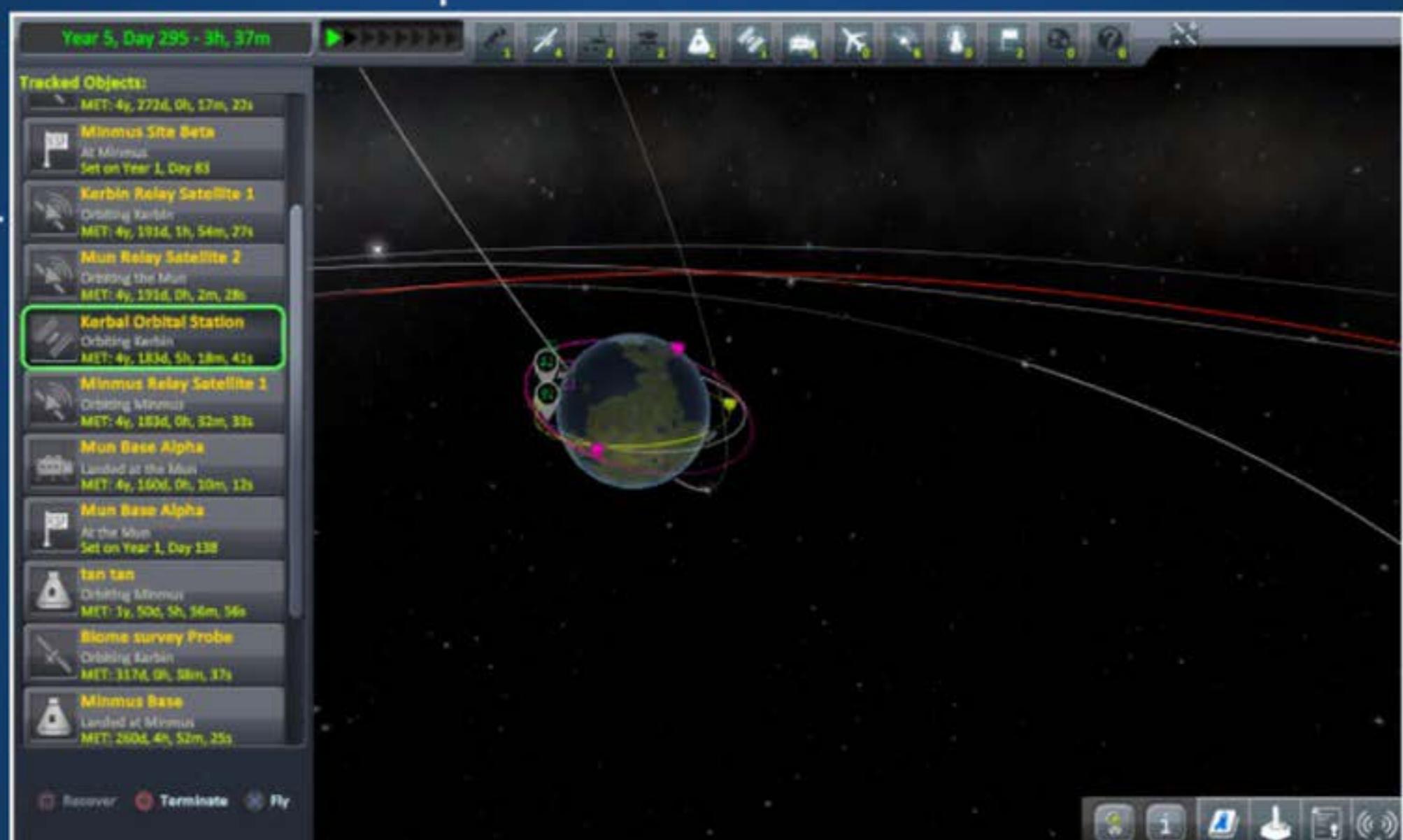
NAV

CURSOR

Here you will find active flights, nearby objects and be able to see all the places you've planted flags.

Toolbar:

The current date, time controls and a filter for vessel types are across the top.



Tracked Objects:

This is the list of all your active flights and tracked space objects. When selected you will focus on that object, and can manage it using the buttons below. You can also move the camera and interact with the objects in the main view.

App Launcher:

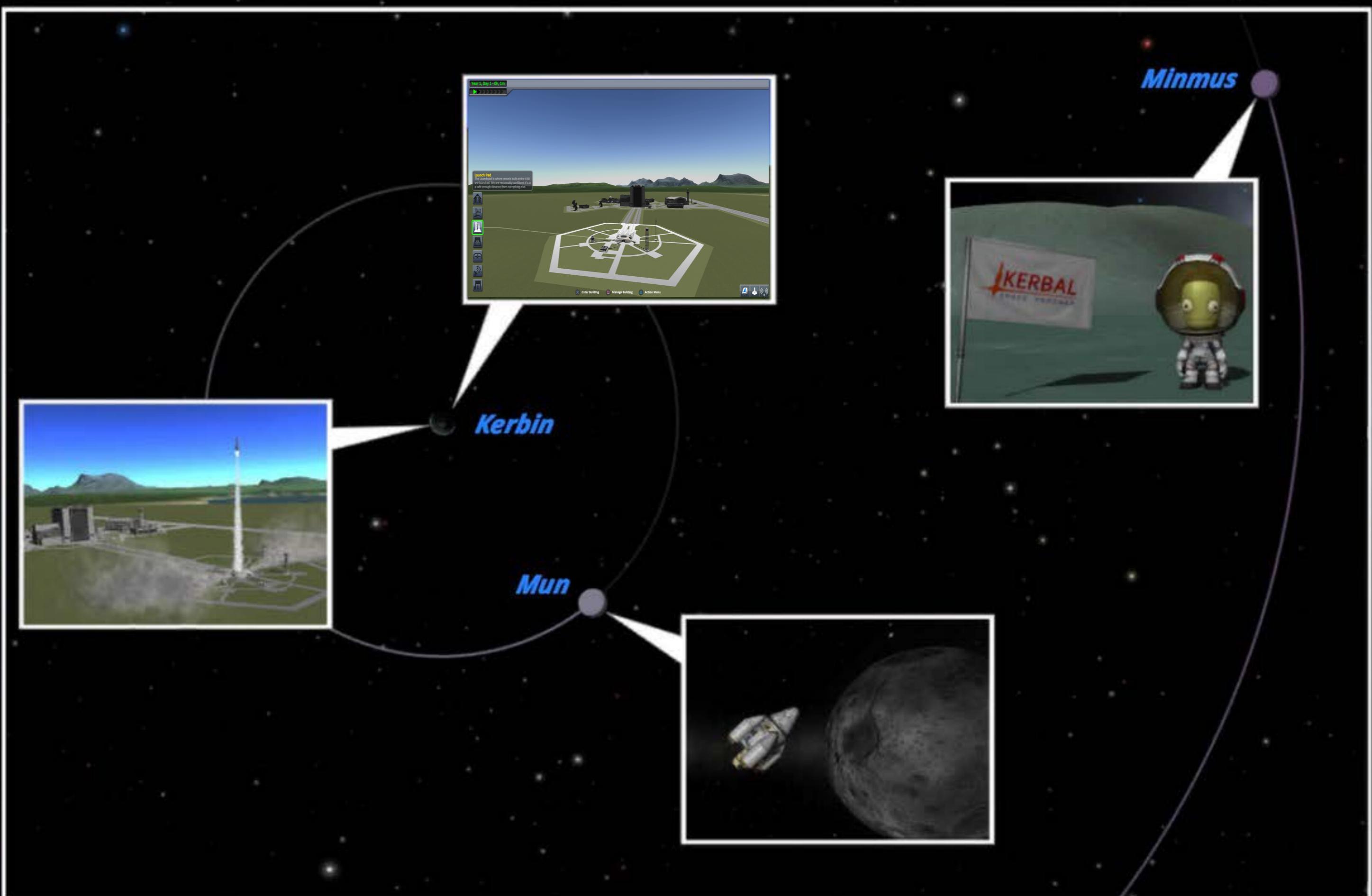
You will find lots of useful info about the selected object through these Apps.

Locations



Locations

With places to go and kerbals to see, you should get the help you need here.





The Solar System

The solar system consists of seven planets and nine moons. Kerbals have looked up since the dawn of time to figure out just how to reach and explore every one of these shiny dots in the sky.

Moho *Eve* *Kerbin* *Duna* *Dres* *Jool* *Eeloo*





The Sun

The light at the center of the universe, this yellow star provides light and heat for all Kerbalkind.

Kerbal Astronomical Society

The sun is the most well known object in the daytime sky.

Scientists have noted a particular burning sensation and potential loss of vision if it's stared at for long periods of time.

This is especially important to keep in mind considering the effect shiny objects have on the average kerbal.



Moho

Moho figures in kerbal mythology as a fiery place with oceans of flowing lava. In reality, however, it's much less interesting.

Kerbal Astronomical Society

Scientists speculate about possible ways to make it "Awesome like in the stories." Some of those ideas have led to new breakthroughs in aerospace technology.



Eve

Eve is certainly the purplest object in the solar system. It's one of the larger, most visible objects, mainly because of its very, very purple tint.

Kerbal Astronomical Society

It is considered by some to be an almost sister planet to Kerbin. Well, despite the purple, and the toxic atmosphere, and the extreme pressures and temperatures. Actually, it's not very similar at all, is it? Who are those people?

Gilly is a lumpy rock wandering around the orbit of Eve. It is by far the smallest natural satellite that the Kerbal Astronomical Society has discovered.



Gilly

Kerbin

A unique world, Kerbin has flat plains, soaring mountains and wide, blue oceans. Home to the kerbals, it has just the right conditions to support a vast, seemingly undepletable population of the eager green creatures.

Kerbal Astronomical Society

Reaching a stable orbit around Kerbin is one of the first things budding space programs strive for. It is said that a kerbal who can get their ship into orbit is halfway to anywhere.

There are two moons circling Kerbin: the Mun, which is a nearby trip for the adventurous, and Minmus... seems minty fresh somehow.



Mun



Minmus



Duna

Also known as the red dot that you can see if you squint at it really hard, Duna has long been a wonder to all kerbals.

Kerbal Astronomical Society

The planet has been held in much awe due to its striking red color and stark contrast to the color green.

Ike is Duna's only moon, with steep rocky slopes; it's a challenging crash... I mean landing.



Ike



Dres

Dres is a very small planet. It was the first planet considered to be a dwarf. Its orbit is highly irregular and, together with its size, it took a long time to discover since half the time it was not where scientists expected to find a planet.

Kerbal Astronomical Society

Due to its nature of frequenting the bad parts of space, this dwarf planet was officially labeled as "Not to be trusted" by the scientific community.

Some astronomers have noticed variations in gravitational measurements around Dres. While only slight, perhaps there is something more to this gray dwarf.

Jool

Jool is particularly known for being a rather large, predominantly green planet. Kerbalkind has longed to visit it since it was first spotted in the sky.

Philosophers reason that the swirling green planet must be a really nice place to visit, on account of its wholesome coloration.

Kerbal Astronomical Society

If you look at Jool through a telescope, it is fuzzy.

Jool has five moons orbiting it: Laythe, Vall, Tylo, Bop and Pol.



Laythe



Vall



Tylo



Bop



Pol



Eeloo

The furthest planet from the sun, Eeloo is like a riddle, wrapped in a mystery, inside an enigma, covered in ice.

Kerbal Astronomical Society

There's been a considerable amount of controversy around the status of Eeloo as being a proper planet or just a "lump of ice going around the sun."

The debate is still ongoing, as most academic summits held to address the issue have devolved into, on good days, petty name calling, and on worse ones, all-out brawls.

The Kerbal Space Center

This is the Kerbal Space Center (KSC). It is *literally* the center of the known universe (well, until you look up). Here we'll run through the facilities, their career levels and limitations.



The Vehicle Assembly Building (VAB)

The Vehicle Assembly Building (or VAB to those in the know) is the place where rockets and other vertically launched spacecraft are designed.

From here they are moved over to the launchpad for liftoff.



Career Limits

Level 1: 30 parts and no action groups

Level 2: 255 parts and basic action groups

Level 3: Unlimited parts and all action groups

Note: Ignition of rocket engines inside the VAB voids the KSC insurance policy.

The Spaceplane Hangar (SPH)

This facility is similar to the VAB, both being used for construction. The primary difference being the SPH is designed for building horizontally launched craft, that then use the attached Runway.

It is from here that many a plane has been designed to investigate the home planet.

Career Limits

Level 1: 30 parts and no action groups

Level 2: 255 parts and basic action groups

Level 3: Unlimited parts and all action groups



Level 1



Level 2



Level 3

The Tracking Station (TS)

At the Tracking Station, all ongoing missions can be viewed and flown. Landed craft can be recovered from here as well.

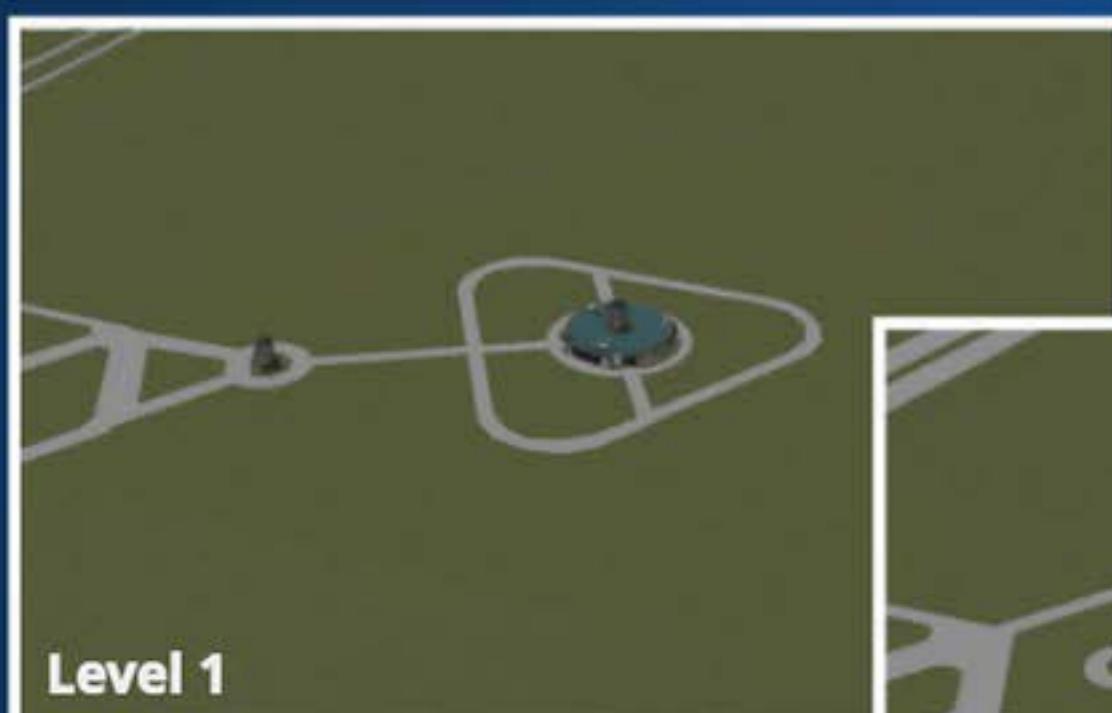
It's a great place to get an overall view of your space program and who is out exploring.

Career Limits

Level 1: Orbits in map and flight planning (with upgraded MC)

Level 2: Patched conics visible in map

Level 3: Patched conics in map and unknown object tracking



Level 1



Level 2



Level 3

The Astronaut Complex (AC)

The Astronaut Complex contains the living and recreation spaces for all your crewmembers. New applicants also apply here to be recruited.

From this facility you can manage your crew roster and check the status of any kerbals who may have unfortunately gone missing.

Career Limits

Level 1: Roster limit of 5 and no off-Kerbin EVA

Level 2: Roster limit of 12 and off-Kerbin EVA allowed

Level 3: Roster unlimited and off-Kerbin EVA allowed



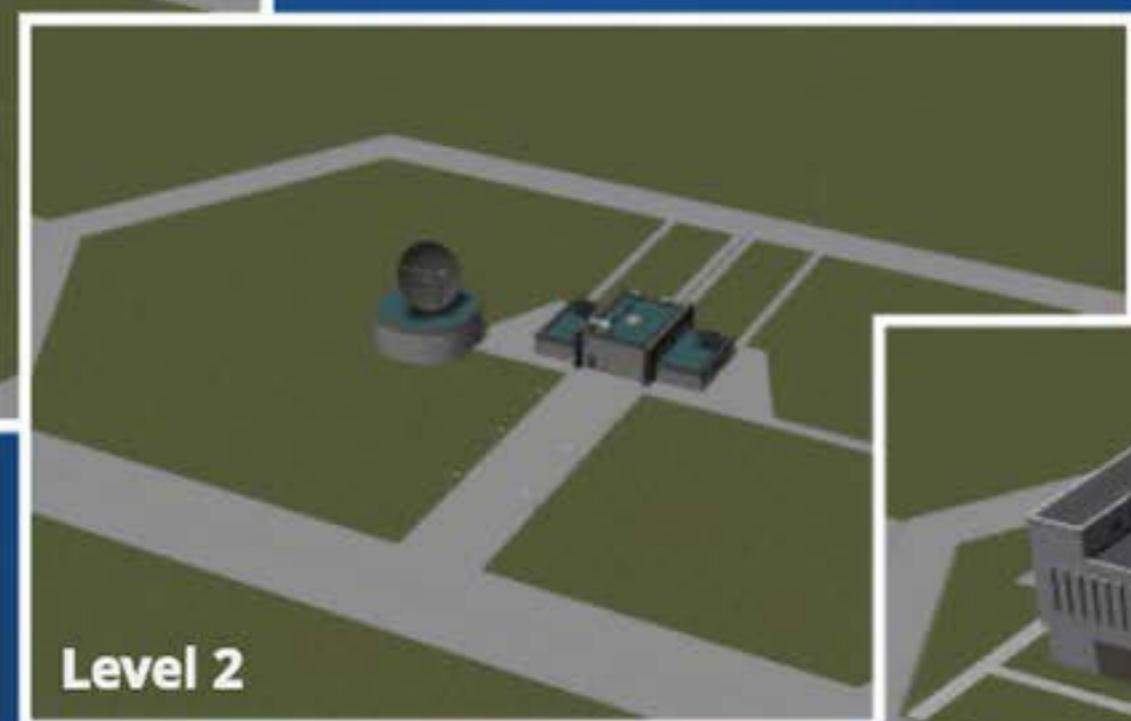
Mission Control (MC)

At the Mission Control facility, all available contracts can be managed. It also offers a very nice view of the launch sites, for any brave enough to be so close to a launching vessel.

You can pick and choose the next goals for your space program, and check out the prospective rewards.

Career Limits

- Level 1: 2 active contracts, flight planning unavailable
- Level 2: 7 active contracts and flight planning
- Level 3: Unlimited active contracts and flight planning



The Administration Building (Admin)

The Administration Building may not seem like a very exciting place at first, but here is where all the strategic decisions are made.

These strategies can help to focus your space program towards specific rewards and goals.



Career Limits

Level 1: 1 active strategy and 25% commitment

Level 2: 3 active strategies and 60% commitment

Level 3: 5 active strategies and 100% commitment

Research and Development (R&D)

At the R&D facility, the team of scientists works hard to crunch the data received from mission experiments. Here, all researched technologies can be viewed, and new ones researched.

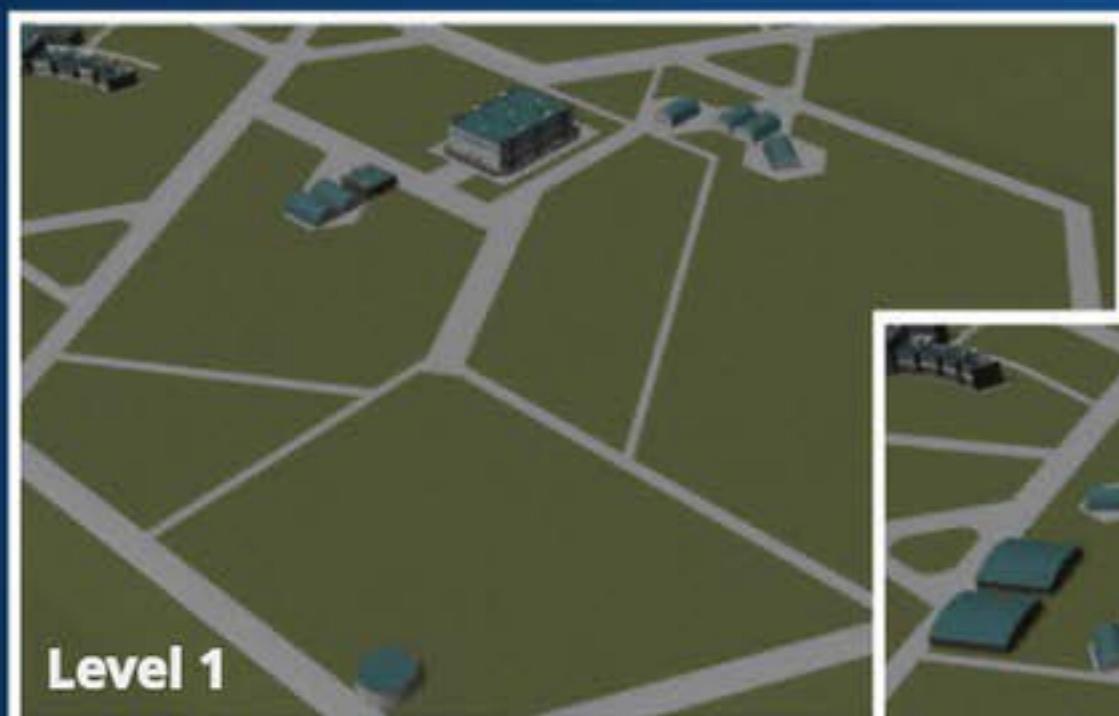
You can also review your experimentation history in the archives -- if you're feeling nostalgic.

Career Limits

Level 1: 100 Science point limit and no surface samples or resource transfer

Level 2: 500 Science point limit, surface samples and resource transfer allowed

Level 3: Unlimited science points



The Runway

At the Runway, craft built in the SPH have a long flat surface to reach take-off speed. Conceivably, such aircraft could even land back on it...

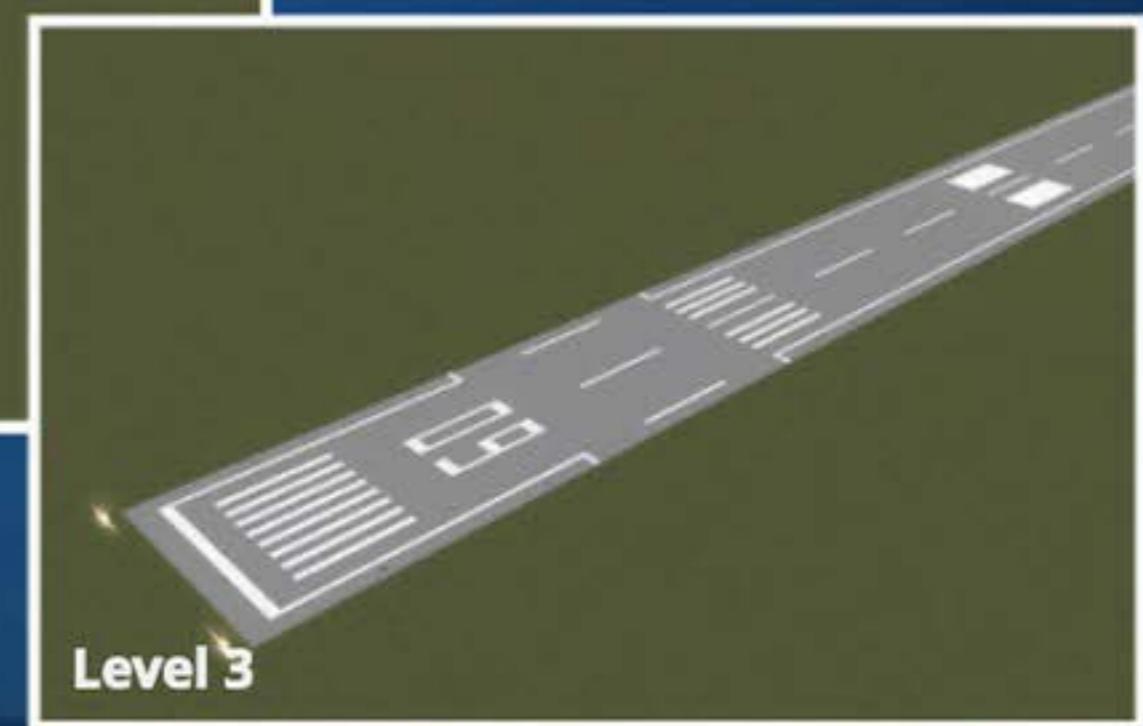
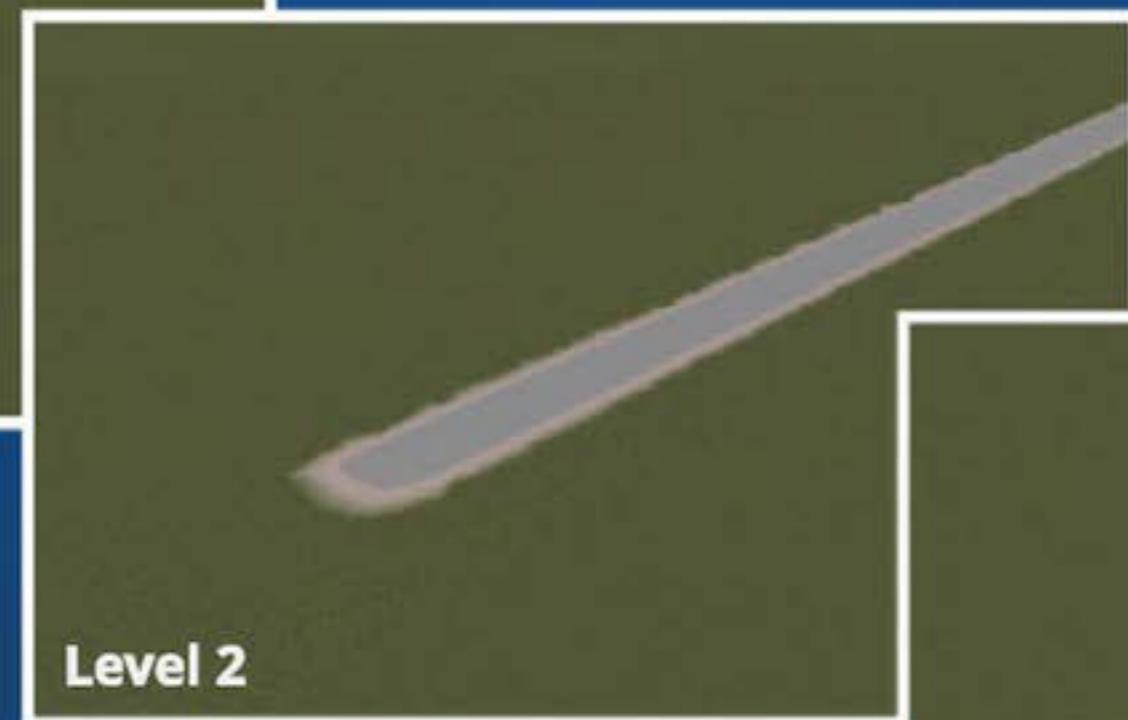
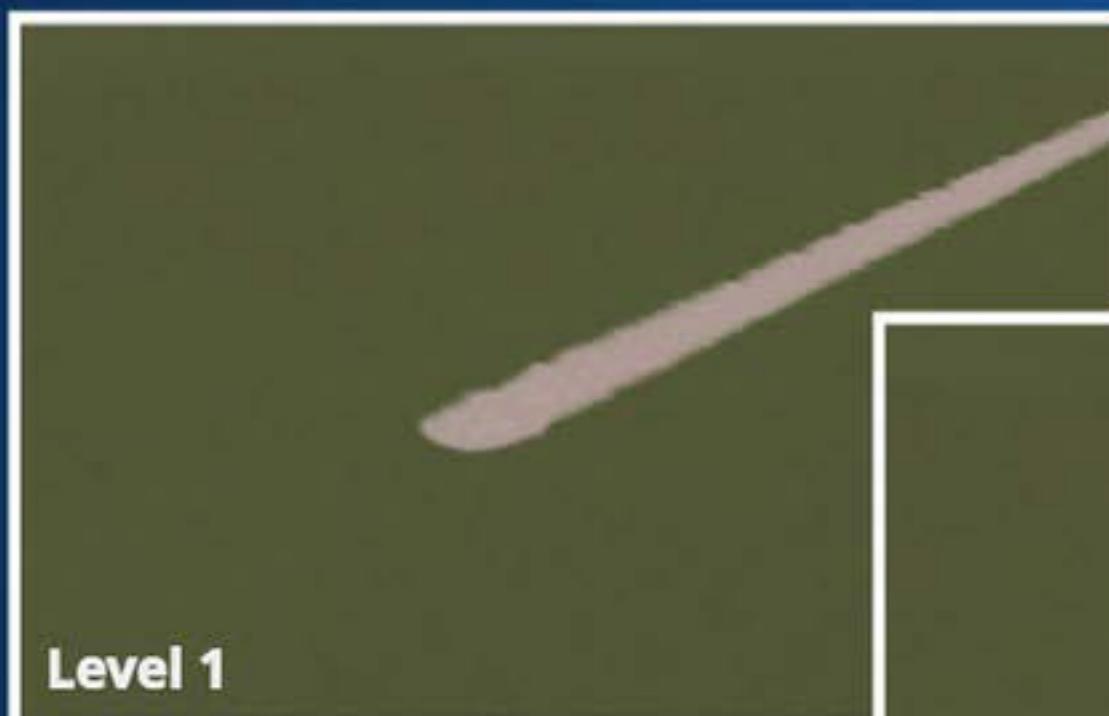
The 2.5km length is sufficient for a range of designs and sizes, making it the perfect place for all kinds of tests.

Career Limits

Level 1: 20.0 x 15.0m - 18.0t

Level 2: 36.0 x 28.0m - 140.0t

Level 3: Unlimited



The Launchpad

The Launchpad is where vessels built at the VAB start their flights. We are reasonably confident it's at a safe enough distance from everything else.

It is primarily designed for vertical launches, but don't let that stop you from trying variations.

Career Limits

Level 1: 20.0 x 21.2m - 18.0t

Level 2: 36.0 x 39.6m - 140.0t

Level 3: Unlimited





Locations / Facilities / Facilities Menus

Facilities Management

You can access extra information about any of the facilities in the KSC by pressing on it.

In this menu you can see information about its current state, capabilities and in career mode you can also manage upgrades.



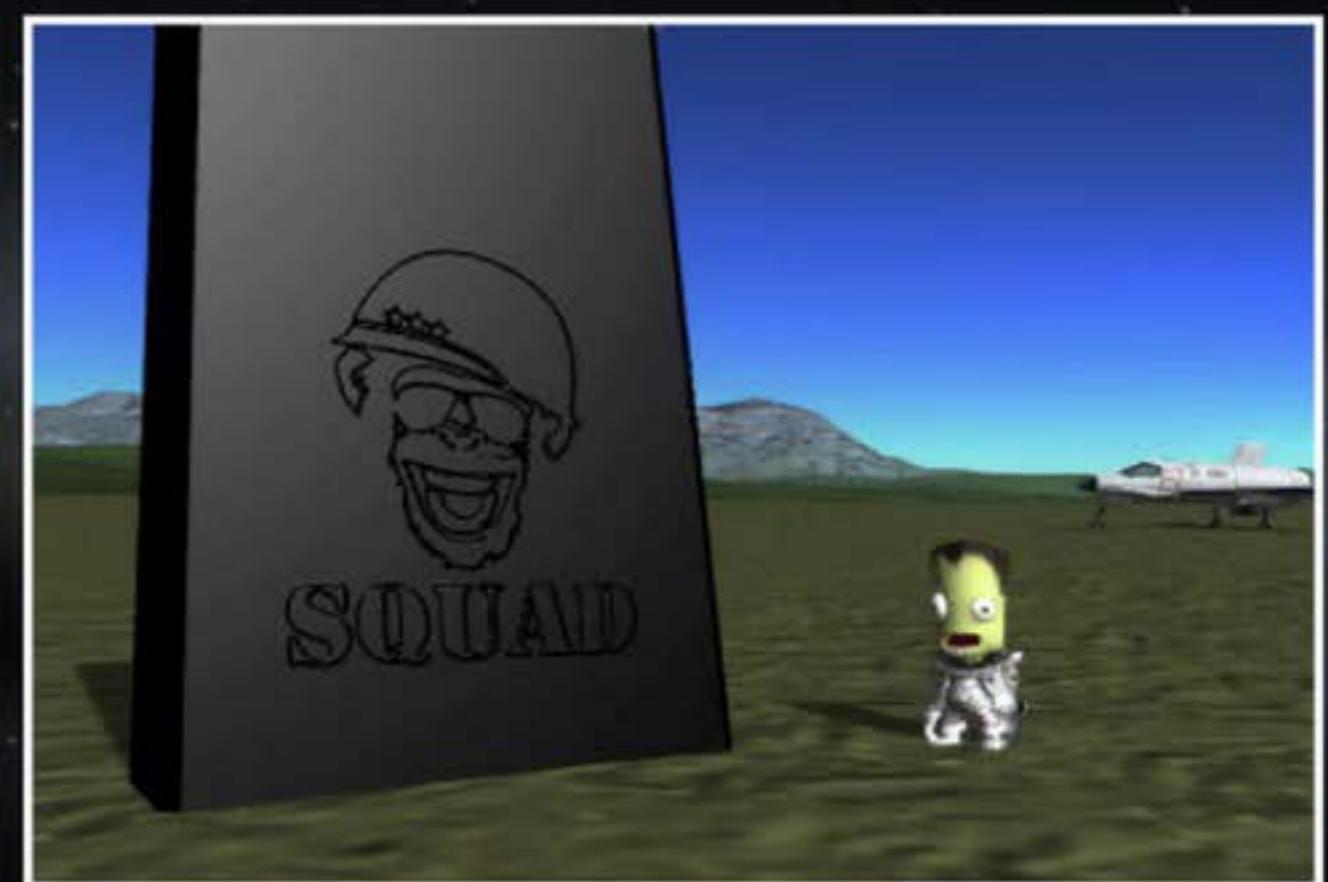
Aftermath of early right turn from the runway

Repairing Facilities

If due to some unforeseen rocket, I mean circumstance, a facility is damaged - this is where you access the repair function as well.

Other Places of Interest

Throughout the solar system there are many places to see and visit. This includes a number of unusual objects and places of interest.



I wonder how many you can find?



To Boldly Go Where No Kerbal Has Gone Before

At the heart of every space program is the drive to get out there and explore what's beyond the home planet. Here you'll find information to help you succeed in travelling through space.



Orbital Definitions

Without knowing how an orbit is described you might find it hard to get a vessel to the right destination in space. That's why it is important to understand the components of an orbit that will help you on the way to a successful space program.



In this section the parts of orbits, and orbital mechanics, that will help you to shoot for the stars will be explained (and maybe even some of the mathematics involved).

Orbit Direction

Orbits are described as prograde or retrograde relative to the planet's rotation.

Orbiting the planet in the same direction as its rotation direction is a prograde orbit.

Prograde Orbit



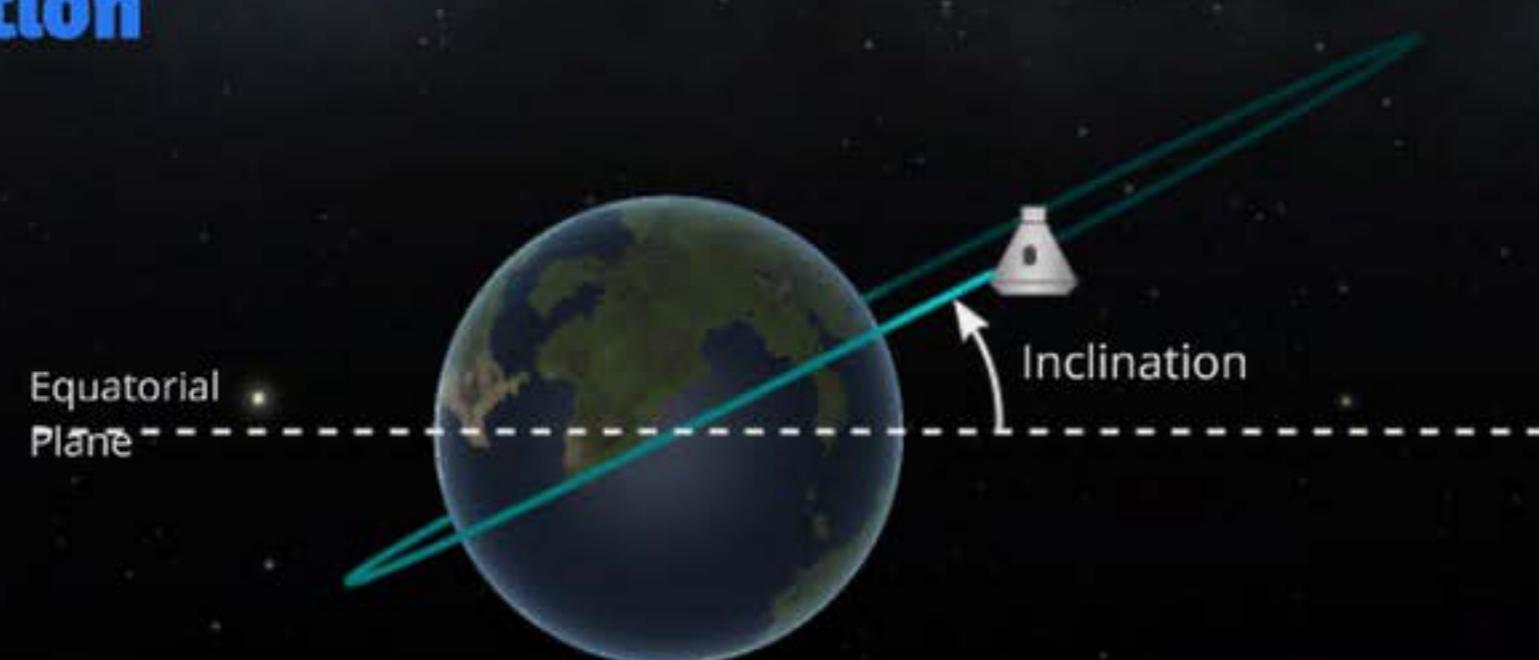
Retrograde Orbit



Note: the color gradient of the orbit line shows the direction of rotation

Top view of Kerbin

Inclination



Side view of Kerbin

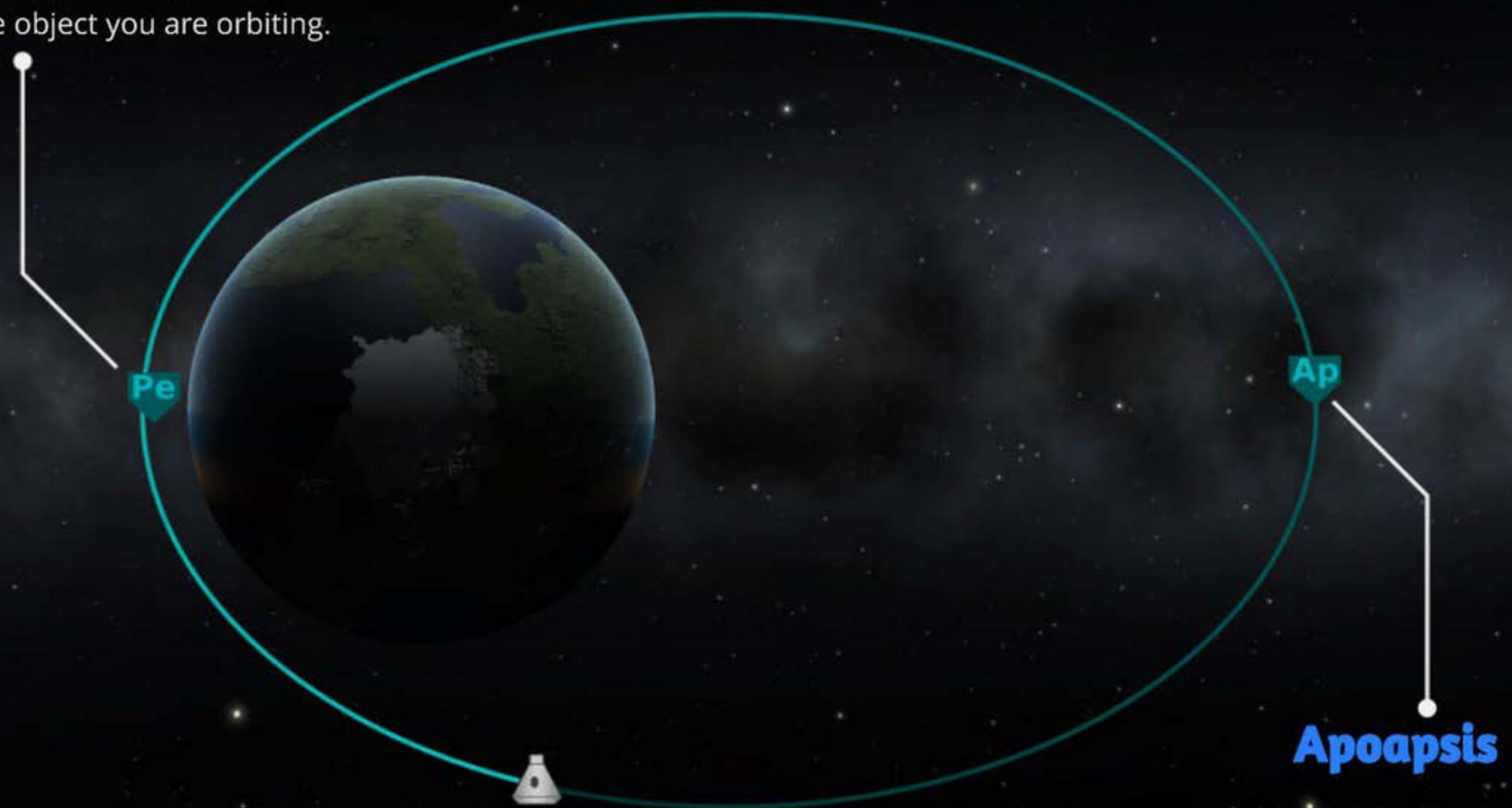
Inclination is the angle an orbit differs from the equator of the object it's orbiting.

Shaping Up Your Orbit

The two apsides (apoapsis and periapsis) are important points in describing an orbit.

Periapsis

The point on an orbit *closest* to the object you are orbiting.



Apoapsis

The point on an orbit *furthest* from the object you are orbiting.

Top view of Kerbin

What Is Eccentricity?

Orbit eccentricity describes how far from a circular orbit you are.

Circular

$Ecc = 0$



Parabolic and Hyperbolic

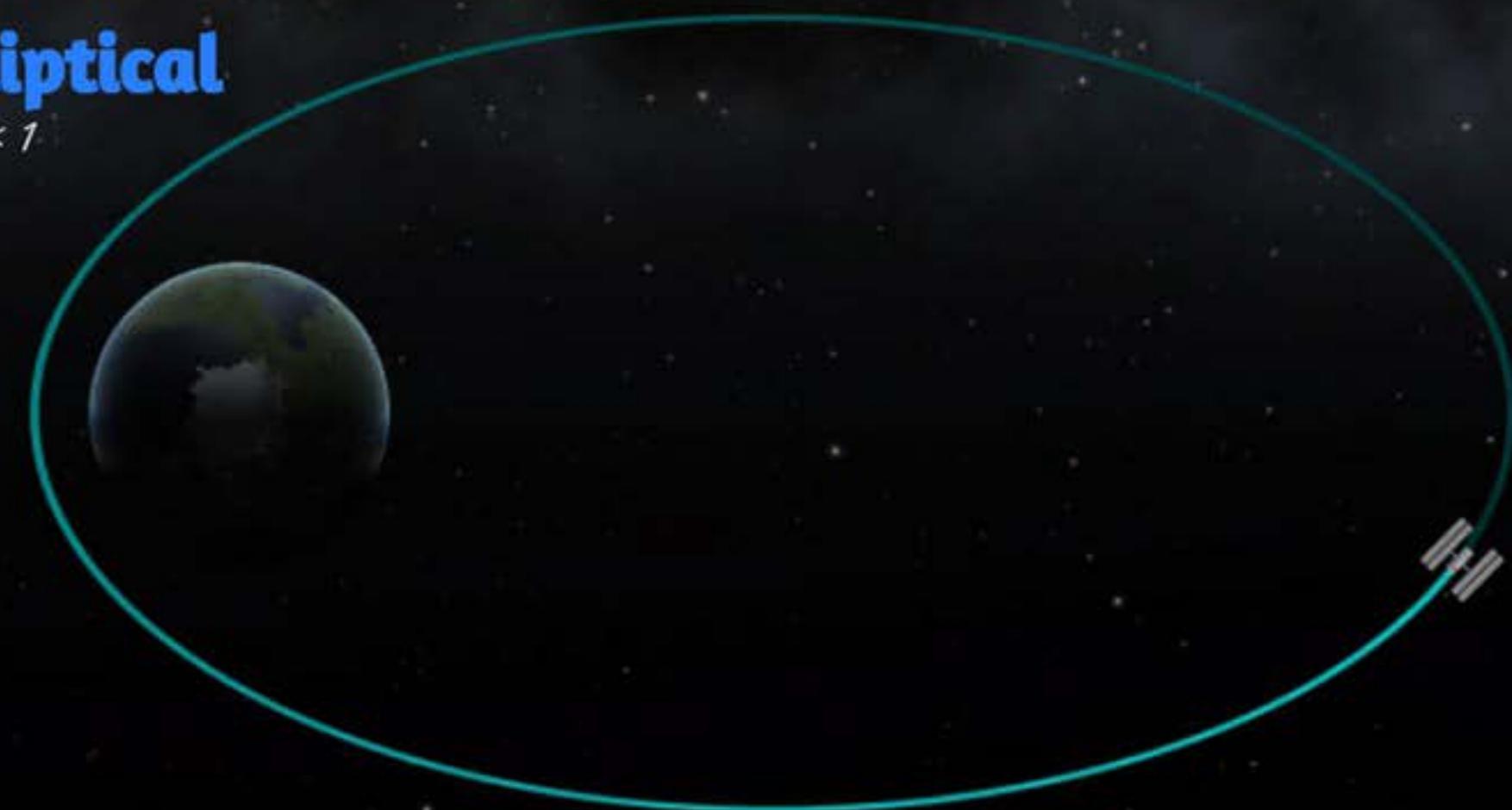
Parabolic : Ecc = 1

Hyperbolic : Ecc > 1



Elliptical

$Ecc < 1$

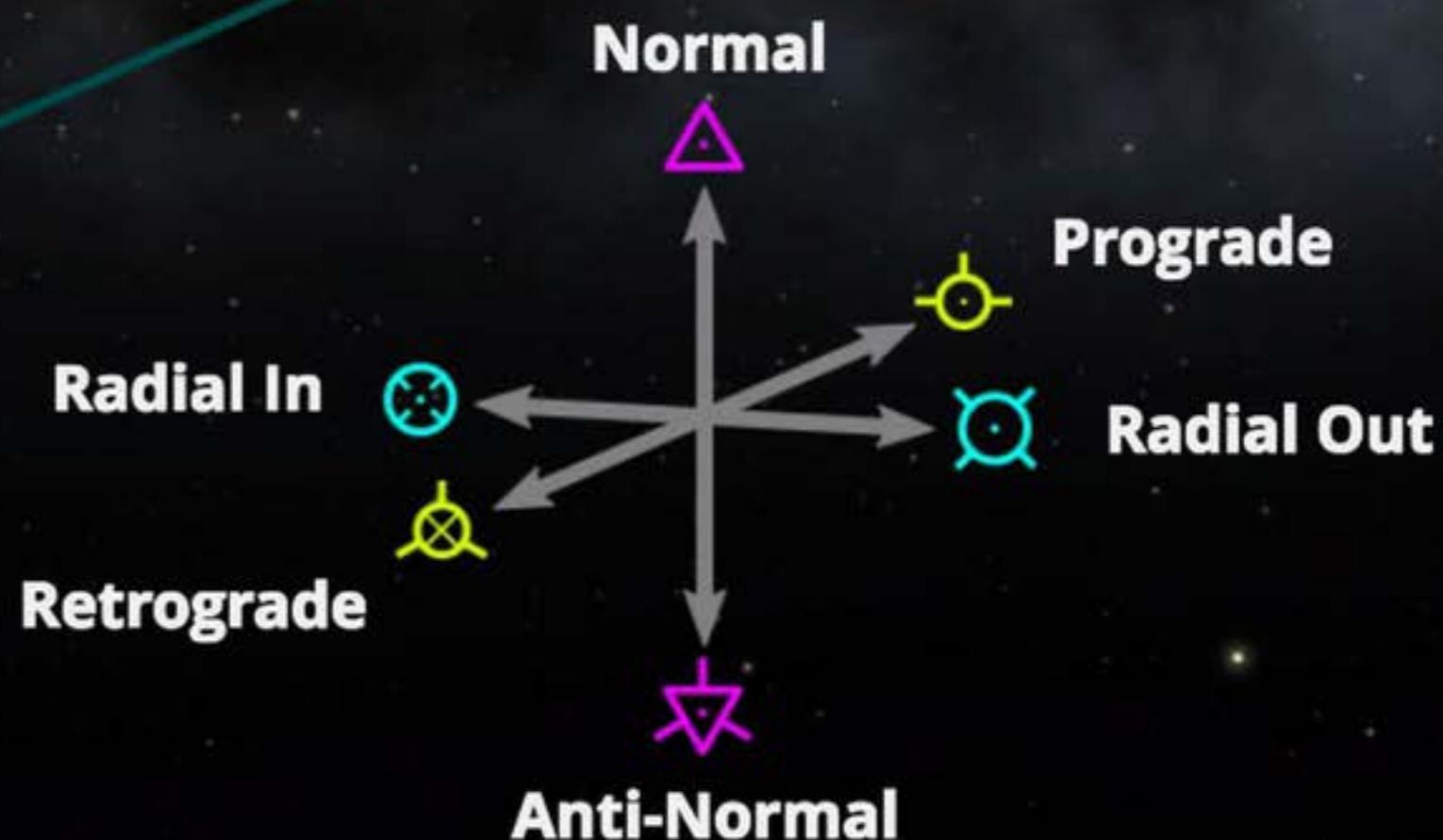


Top view of Kerbin

Directions in Space

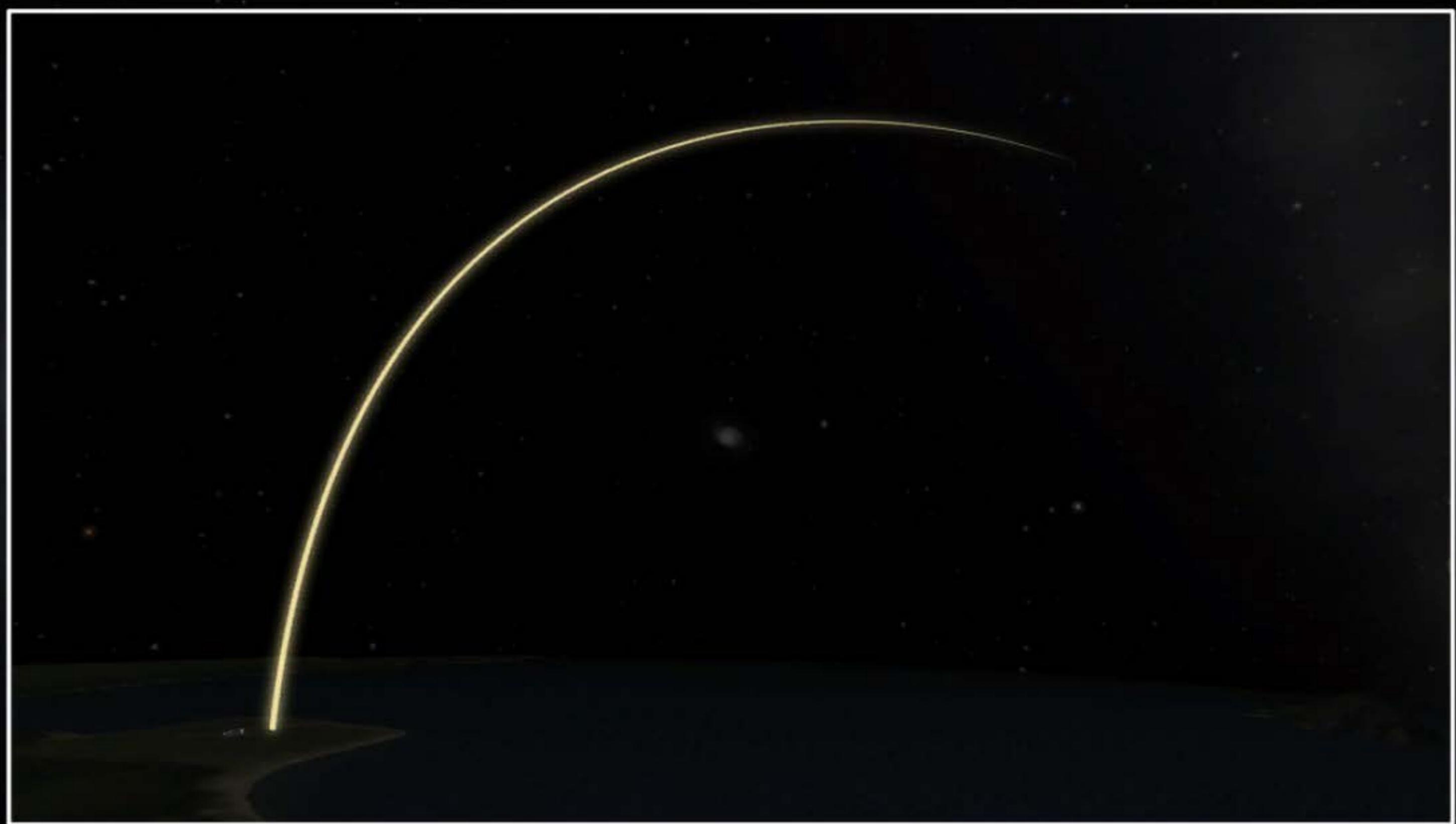
There are six directions when looking at a spaceship. These directions are relative to the orbit of the ship, so they will "move" as you burn or when you change Sphere of Influence (SOI).

You can see their symbols and directions in relation to this satellite below.



So What Is the Goal Here?

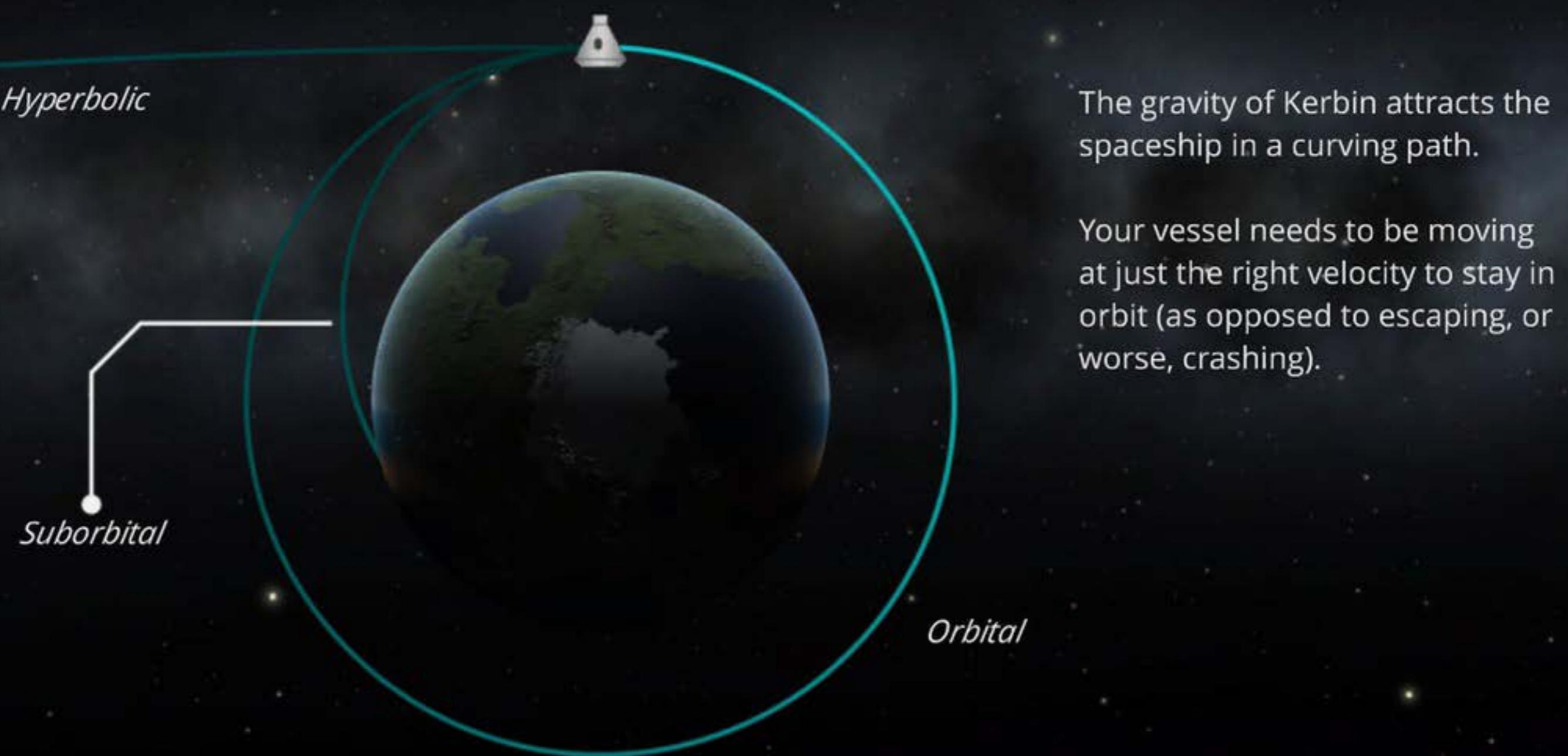
We will start with the basics of getting to orbit and back.



What is an Orbit?

An orbit is sometimes described as "falling and missing the ground." In the context of space travel it's the way one object goes around another in space, and here it is about getting your vessel to travel around a body.

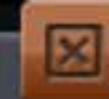
The most basic goal of any Kerbin-based space program is to get into orbit and return back to Kerbin.



The gravity of Kerbin attracts the spaceship in a curving path.

Your vessel needs to be moving at just the right velocity to stay in orbit (as opposed to escaping, or worse, crashing).

Top view of Kerbin



The Atmosphere and You

Around Kerbin there is a thin layer of atmosphere. This layer is densest near the ground and thins out to nothing as you get to space. Kerbin isn't the only planet like this, but for this section it is what's important.

To stay in orbit you need to be in space or the drag from the atmosphere will slow you down. If you were to try orbiting in the atmosphere, you would need to have the engines running all the time - which isn't really orbiting.

Around Kerbin the atmosphere extends 70km from sea level, to where space begins.

Going Straight Up - Your First Mistake

So let's look at the simplest method. Going straight up, then turning East once you reach your orbit altitude.

This plan has two big problems:

1. To hit your desired altitude you need to "stop" your ascent at the right height.
2. You then need to add all the horizontal velocity to be orbiting.



Turning "With" Gravity

The shape you see below is called a gravity turn. In this ascent you use gravity to translate some of the thrust into horizontal velocity.

This means you need far less fuel at apoapsis to accelerate to the orbital velocity.

A key here is to ensure you do not accelerate too fast, wasting fuel fighting the atmosphere.

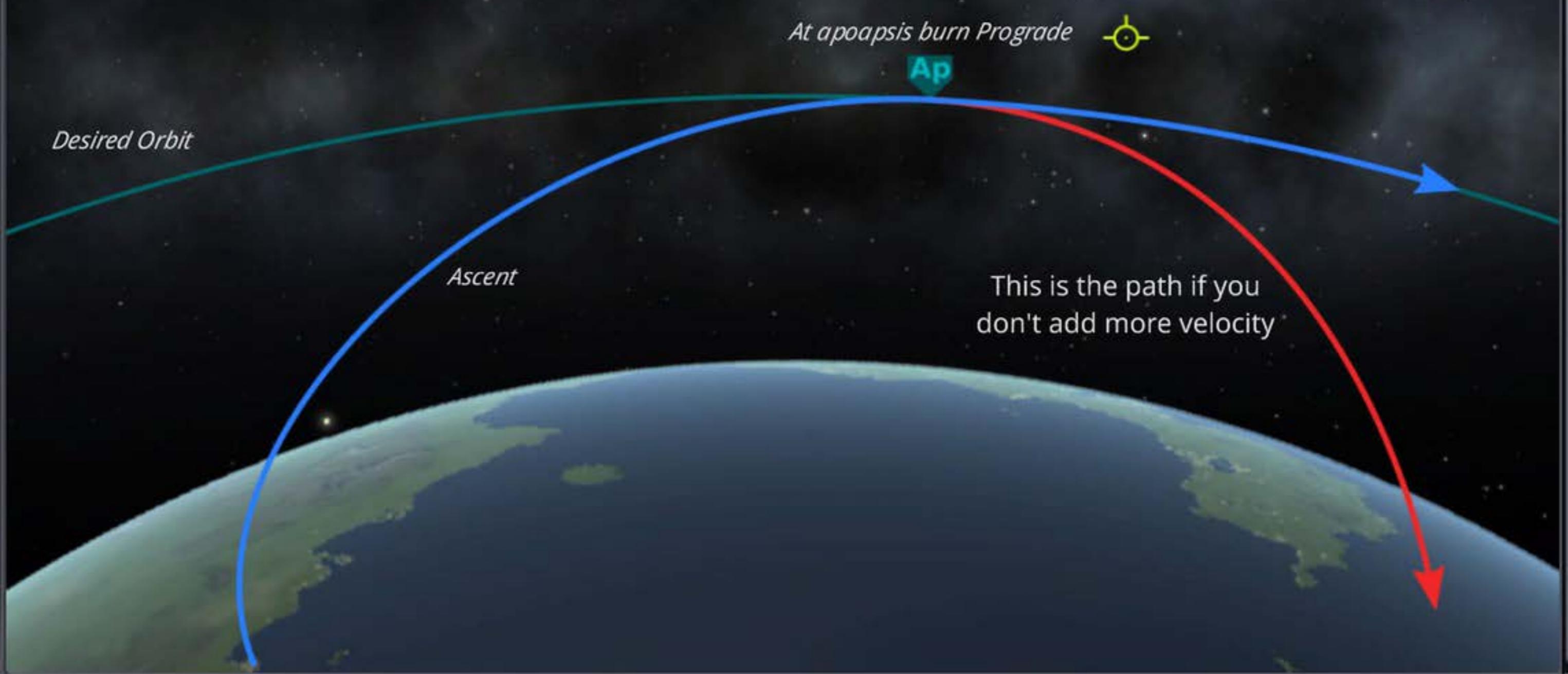
Desired Orbit



Staying Up There

The gravity turn ascent will get you to orbital height, but it's not enough to keep you up there.

Once you reach the target altitude, you need to burn prograde to increase your velocity. You burn until you are fast enough to stay in orbit.



Let's See How to Get Back Down

Getting back down is relatively simple. You burn in the retrograde direction which will slow the vessel enough to return to the surface.

You only need to slow the vessel enough to get inside the atmosphere, aerodynamic drag will slow you a lot as well.

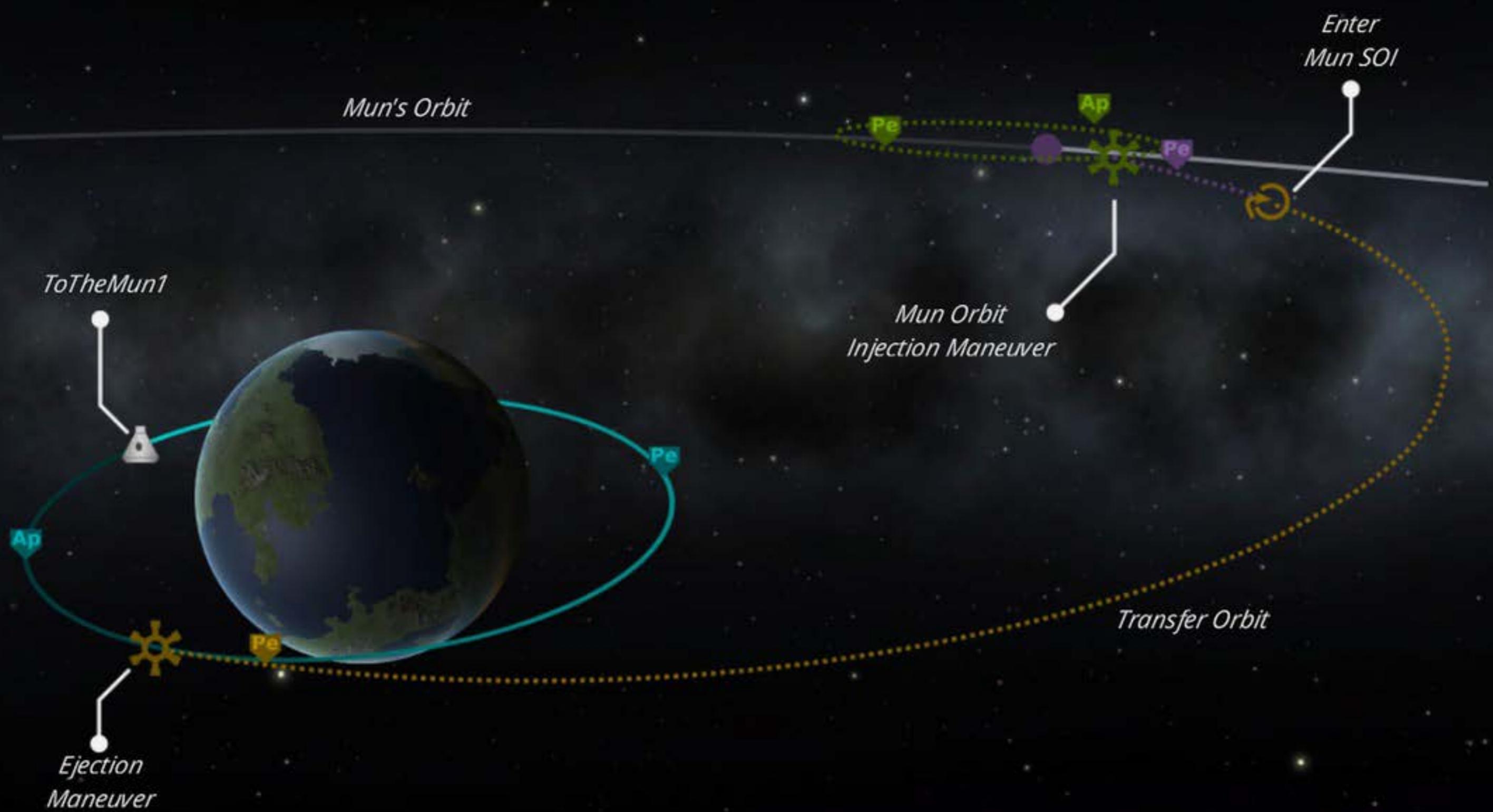
Oh, and hope you packed the chute...



Space Travel / Orbital Maneuvers

Orbital Maneuvers

How to make maneuvers that adjust your vessel's orbit. Bringing all these together you can end up planning - and executing - a flight like below to visit other worlds.



Delta-V

Everything about moving in space is about changing your vessel's velocity. Each maneuver is an equation where you trade fuel for velocity, and this is measured in delta-v.

Delta-v (or Δv for short) is a measure of the impulse needed by a vessel to perform a maneuver.

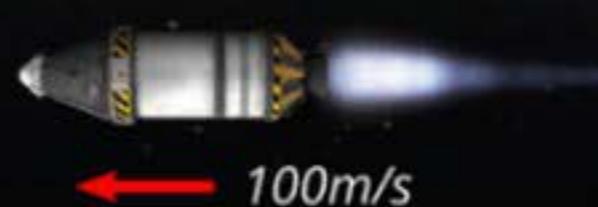
Doing the Maths

Thinking in simple straight lines, a vessel that is at 0m/s requires a change in velocity of 200m/s, a Δv of 200m/s. To slow the vessel (because there are no brakes in space) we need to add more velocity, but in the other direction. So to reach 100m/s we require another Δv of 100m/s.

Acceleration Maneuver



Braking Maneuver



Getting Three Dimensional

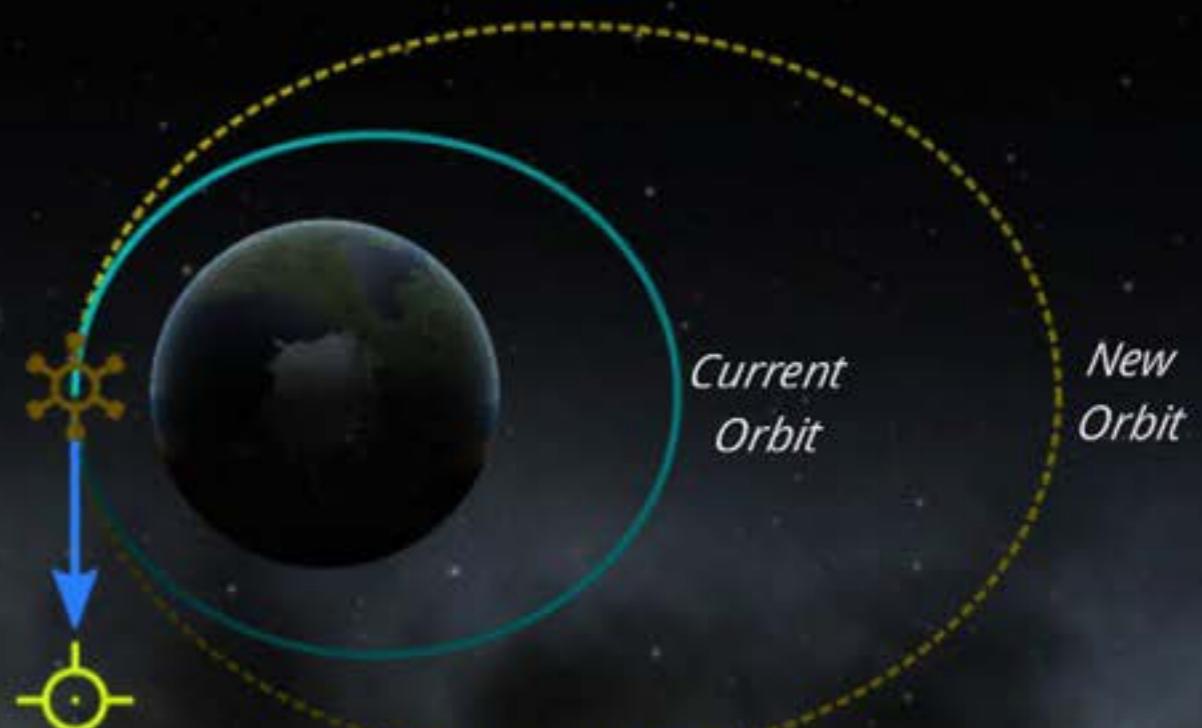
The simple straight line example makes it seem easy, but space has more dimensions. Over time you will see the correlation of this basic principle in every facet of orbital maneuvering.

Adjusting Eccentricity

You thrust in the prograde and retrograde directions to adjust the eccentricity of an orbit.

Prograde

Burning prograde will *increase* your orbital velocity and *raise* the altitude on the opposite side to your burn.



Retrograde

Burning retrograde will *decrease* your orbital velocity and *lower* the altitude on the opposite side to your burn.



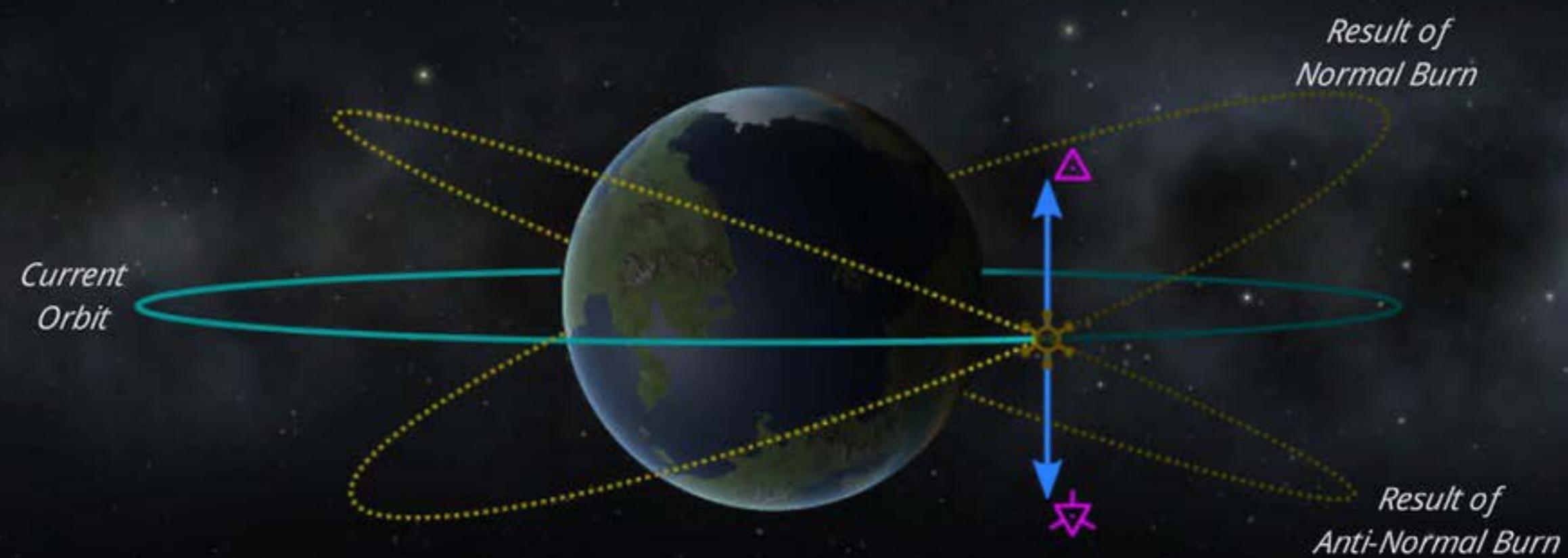
Top view of Kerbin

Adjusting Inclination

Normal / Anti-Normal are the directions at 90 degrees to the current path of travel, perpendicular to the orbit's plane.

Normal

Burning in the normal direction pushes your future orbit to the "North."



Anti-Normal

Burning in the anti-normal direction pushes your future orbit to the "South."

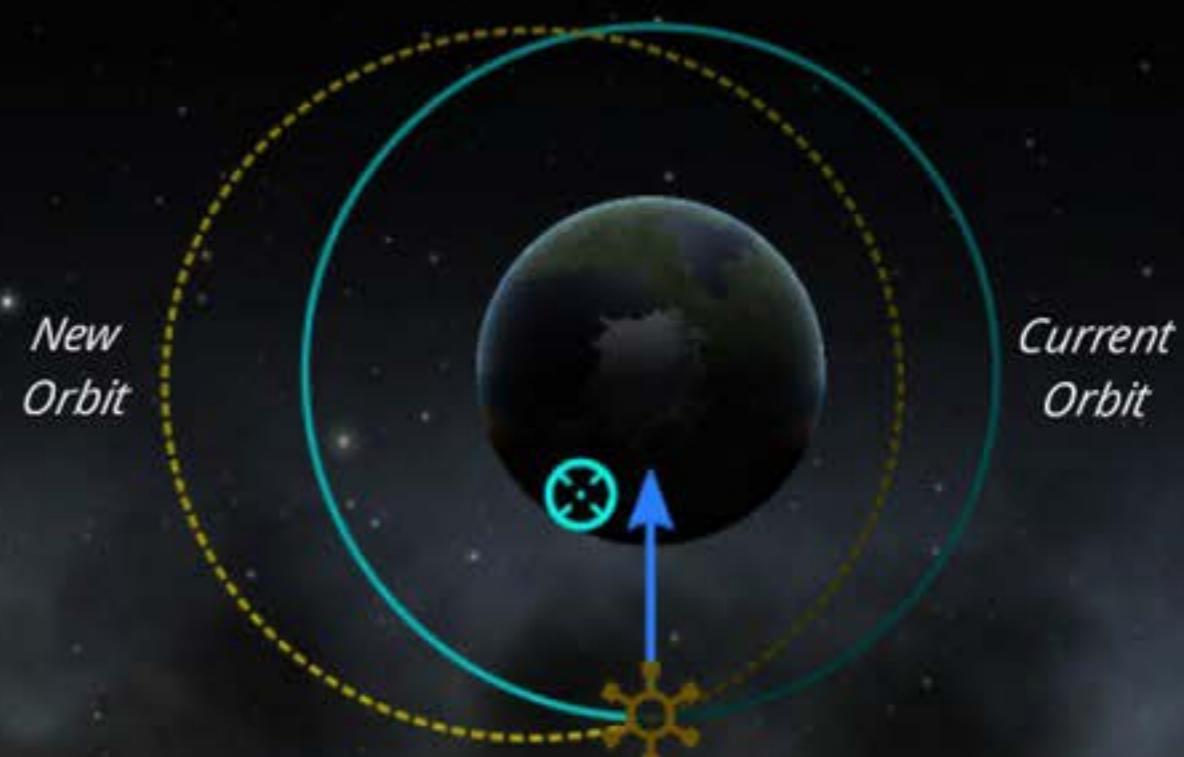
Side view of Kerbin - Orbit direction (prograde) can be seen from gradient.

Adjusting Your Orbit Radially

Radial-In / Radial-Out are the directions at 90 degrees to the current path of travel, pointing in and out. Burning these directions "rolls" the orbit as you can see below.

Radial-In

Burning in towards the planet will lower the orbit ahead of your vessel.



Radial-Out

Burning out along the plane will raise your orbit ahead of your vessel.



Top view of Kerbin

The Hohmann Transfer - Raising Your Orbit

An orbital maneuver that transfers the vessel from one circular orbit to another. Here is how to use Hohmann's design to move our orbit away from the planet (raising the orbit).



Hohmann Transfer

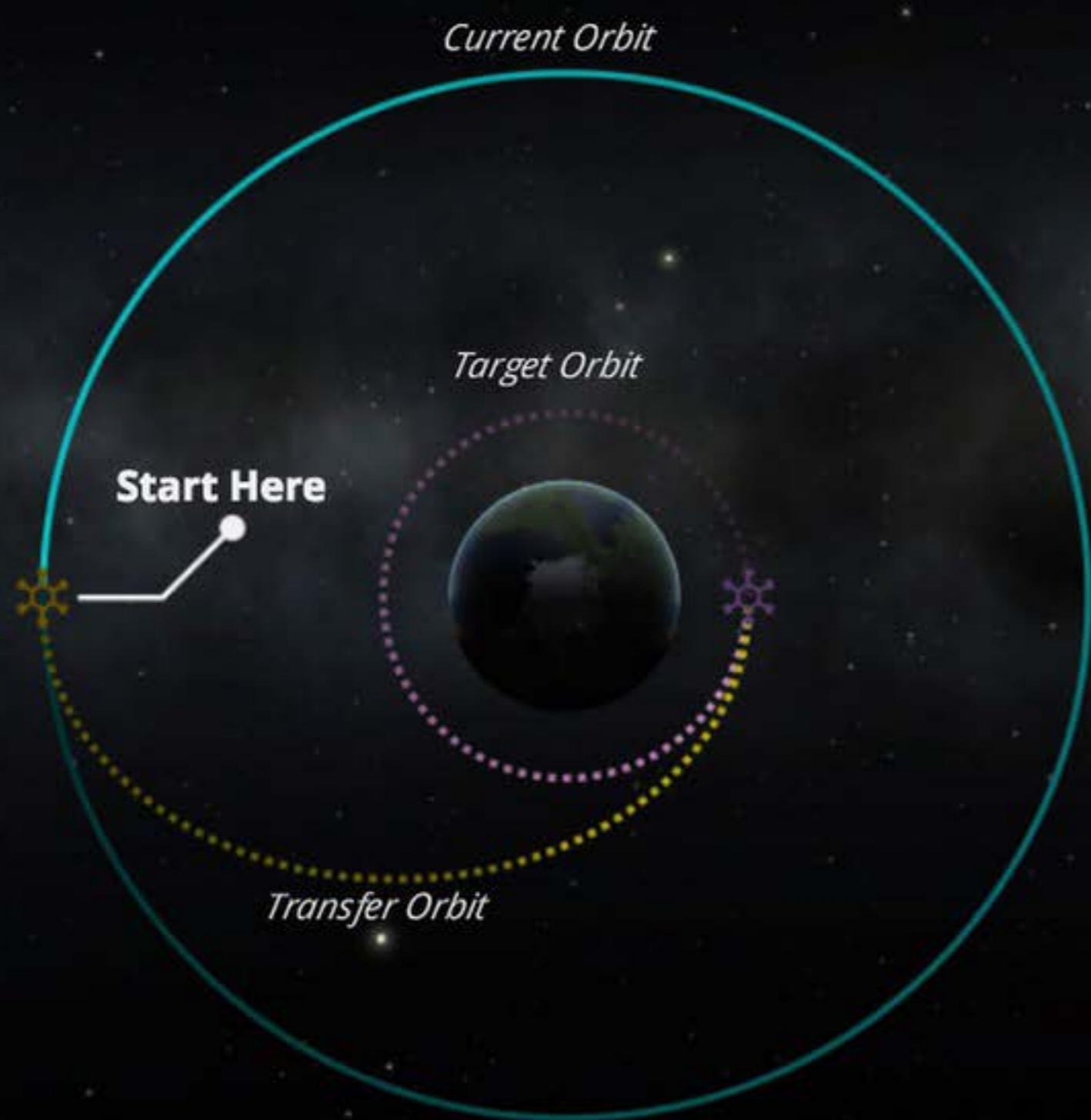
To raise your orbit you follow steps like:

1. Burn prograde;
2. Watch for the apopsis point to reach your desired altitude;
3. Wait till you reach the new Ap;
4. Now burn prograde to circularize your orbit;

For an elliptical orbit the best place for Step 1. is the Pe of the current orbit.

The Hohmann Transfer - Lowering Your Orbit

This is the opposite of the last maneuver. Using Hohmann's design to move our orbit closer to the planet (lowering the orbit).



Hohmann Transfer

To lower your orbit you follow steps like:

1. Burn retrograde;
2. Watch for the periapsis point to reach your desired altitude;
3. Wait till you reach the new Pe;
4. Now burn retrograde to circularize your orbit;

For an elliptical orbit the best place for Step 1. is the Ap of the current orbit.

How to Maneuver Efficiently

Every maneuver you make uses propellant, and rockets have a finite supply. Choosing the best time (or place) to make maneuvers determines whether you complete your mission, or have to get out and push. Maneuver nodes are really useful in this situation, they help you see the "cost" of maneuvers before executing them.

Adjusting Apoapsis/Periapsis

Adjusting the Ap/Pe is most efficient at the opposite node. This means burning at the Ap to change the Pe and vice-versa.

Using a maneuver node we can "see" this in an example. The delta-v (Δv) required to lower this orbit's Pe to 50km at three points is shown below.

Orbit Point	1	2	3
Delta-v	260 m/s	128 m/s	62 m/s



Adjusting Inclination

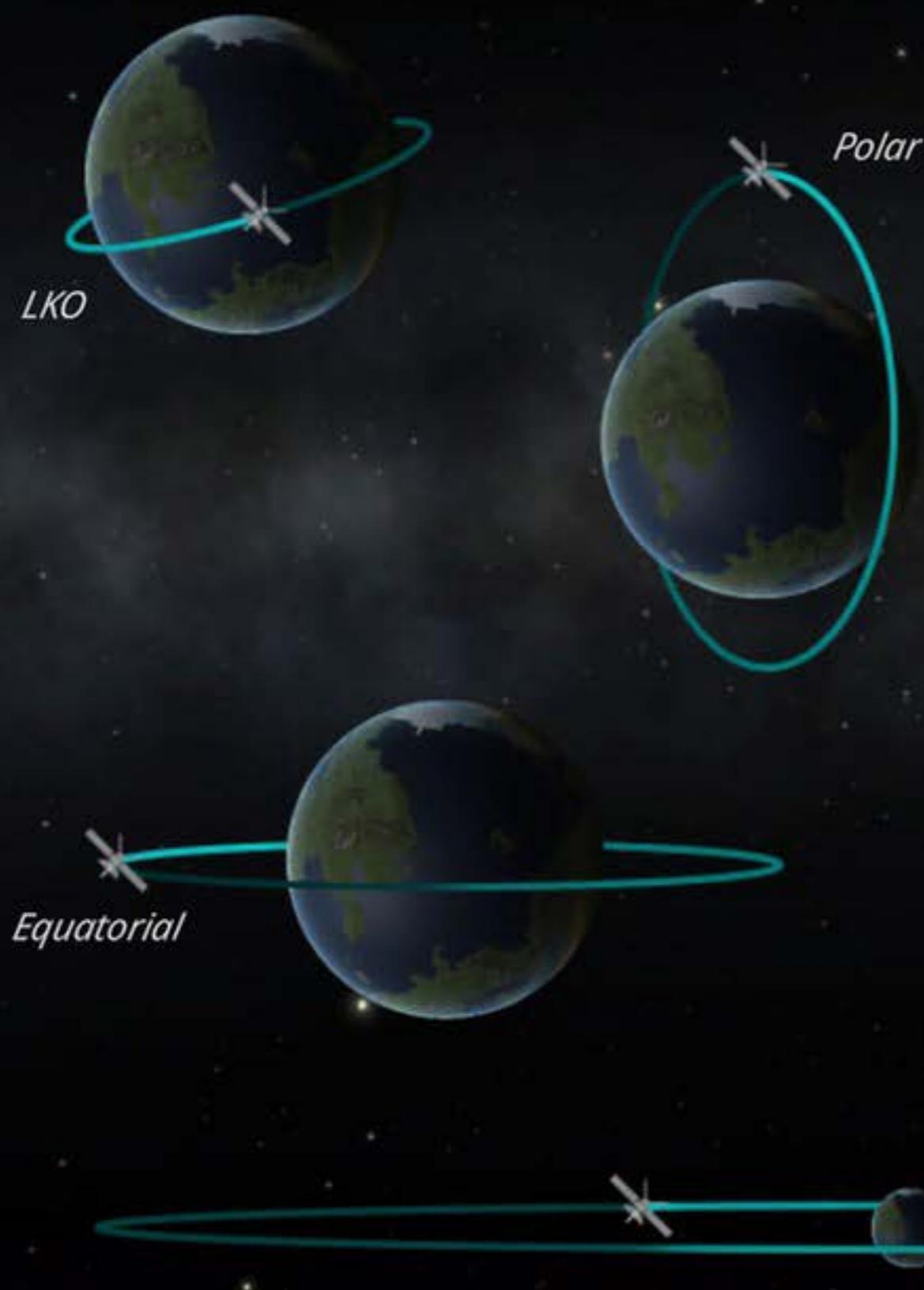
Changing inclination is most efficient where your orbit crosses the equator of the planet.

Matching Orbital Planes

Matching planes is a key maneuver involved in docking. The best place to do this is at the orbit nodes labelled Ascending/Descending Node (AN/DN). When you select a target object these indicate where your vessel and the target's orbital planes cross.

Name That Orbit - Common Types

There are an infinite number of orbits around a body. Here you'll see the names of some of the more common types.



Low Kerbin Orbit (LKO)

Orbit with both the Pe and Ap below 200km.

Polar Orbit

Orbit with inclination of 90°, taking the vessel over the poles.

Equatorial Orbit

Orbit with inclination of 0°, keeping the vessel over the equator.

Geostationary Orbit

Equatorial orbit with a period equal to the planet's rotation. This means the vessel stays above the same point on the surface.

KerbiSynchronous Equatorial Orbit (KEO)

Geostationary orbit around Kerbin.

(Period: 6hrs , Altitude: 2863km)

Rocketry

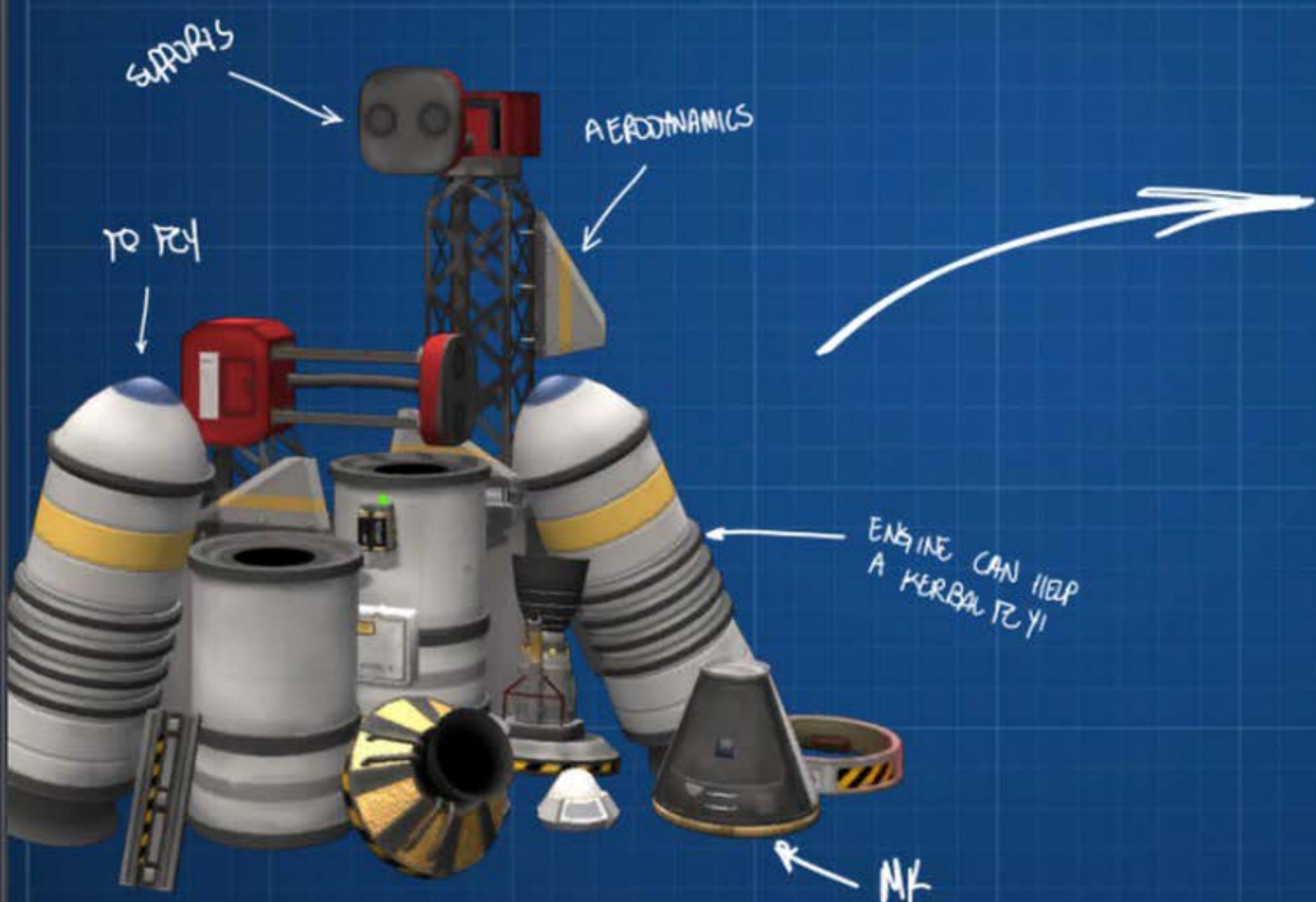
All things rocketry related, and maybe a little more as well.



The Basics of Rocketry

The kerbal race has always wanted to get into space. Here is some information on how to make this a reality.

This information should help you to go from a pile of parts, like below, to a controllable rocket.

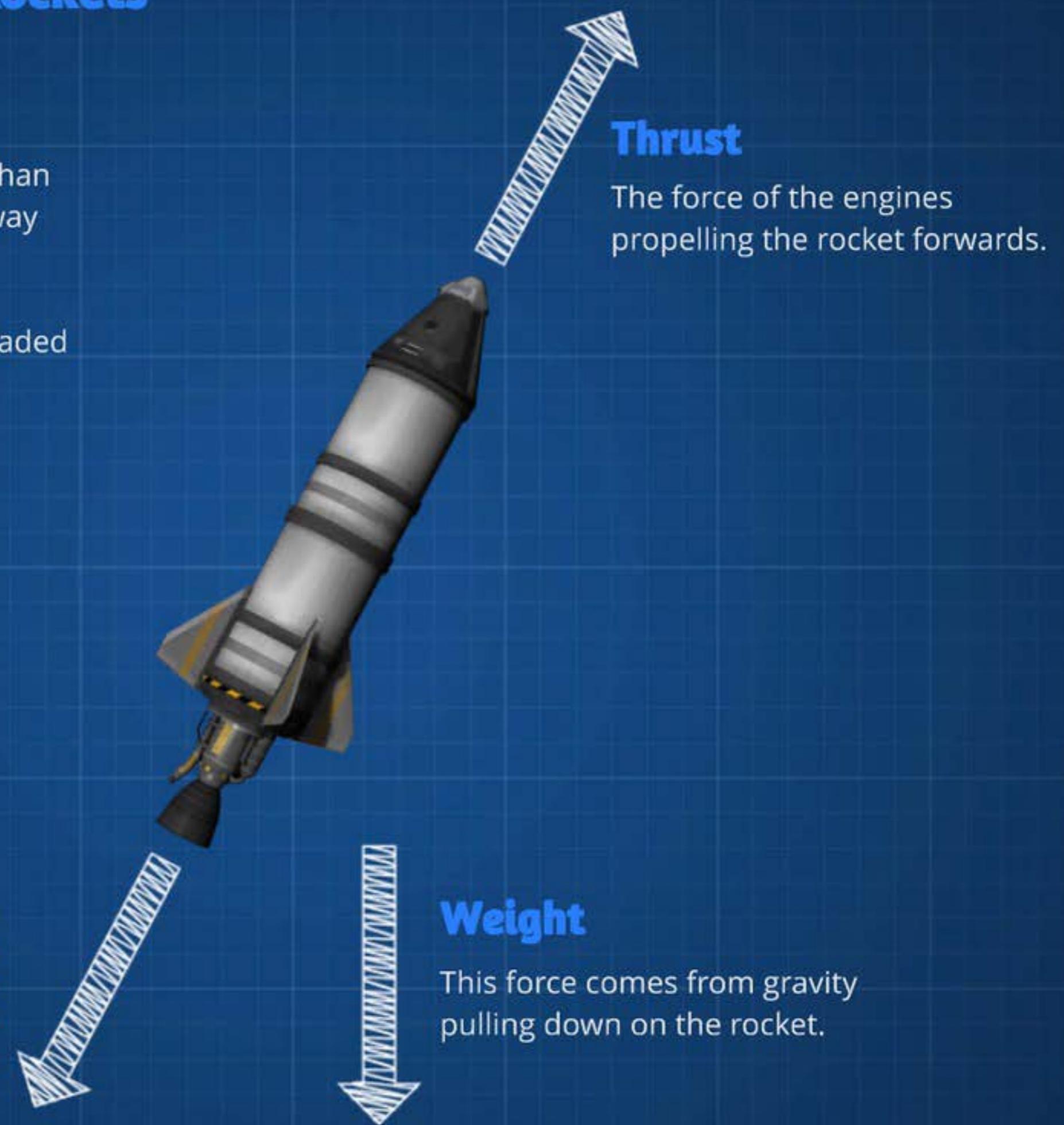


Forces That Apply to Rockets*

* Excludes ground impact force

When your vertical thrust is greater than your weight + drag you are on your way to the stars.

If it's the other way around you're headed for less "stellar" destinations.



Drag
This aerodynamic force is caused by air resistance as the rocket moves through the air.

Weight
This force comes from gravity pulling down on the rocket.

Let's Get Things Nice and Stable

Designing a rocket so that it will "want" to fly straight is one of the first challenges you face.



Center of Lift vs. Center of Mass

By building so the center of lift (CoL) is behind the center of mass (CoM), the aerodynamic forces on the rocket will help to keep it stable.

UI Helpers (in Editor)



Center of Mass



Center of Lift



Center of Thrust

Static Stability

This method is using some of the principles of static stability to help keep you going in the right direction.

Keeping to the Center

Keeping your thrust centered will also help to keep things going where you want.



UI Helpers (in Editor)



Center of Mass



Center of Lift



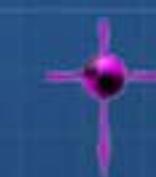
Center of Thrust

Center of Thrust vs. Center of Mass

To do this, build your rocket keeping the center of thrust (CoT) pushing through the center of mass (CoM).

This means that the engine will not apply rotation to the rocket under thrust. Misaligning this is like using a fire extinguisher in an office chair.*

Aligned



Off-Center



Rotated



**Note: Mission Control does not endorse the use of fire extinguishers as office chair propellant.*

Symmetrical Sensibility

When attaching components to vessels, the symmetry tools can help you keep things aligned with the CoM, CoT and CoL.

Using radial symmetry and snap you can quickly add 2, 3, 4, etc parts around the center of the rocket, to maintain good balance.

Symmetry Helpers

Angle Snap



Level of Symmetry



Note: There is also mirror symmetry, which is especially useful for building planes.

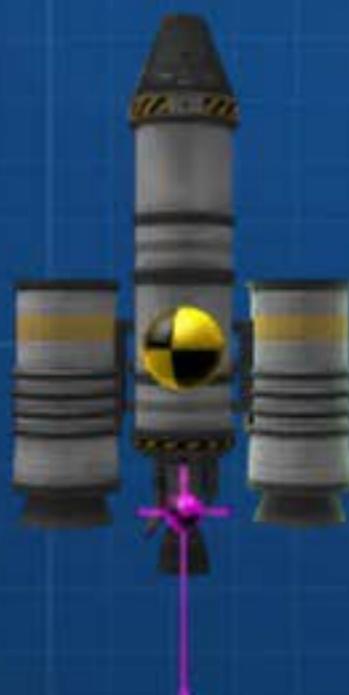
No Symmetry



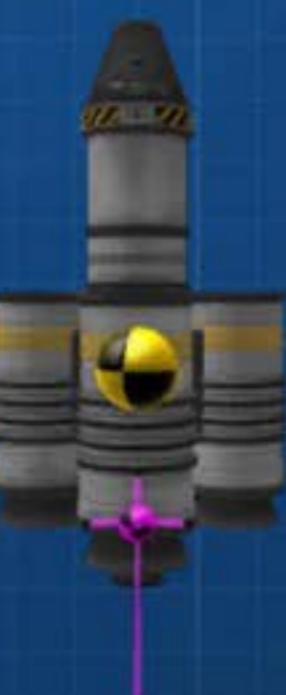
Note: the misaligned thrust here.



2x



3x



Trying to add these manually is possible, but it will never be exactly balanced. If you do it manually you will likely require constant inputs to stay on course.

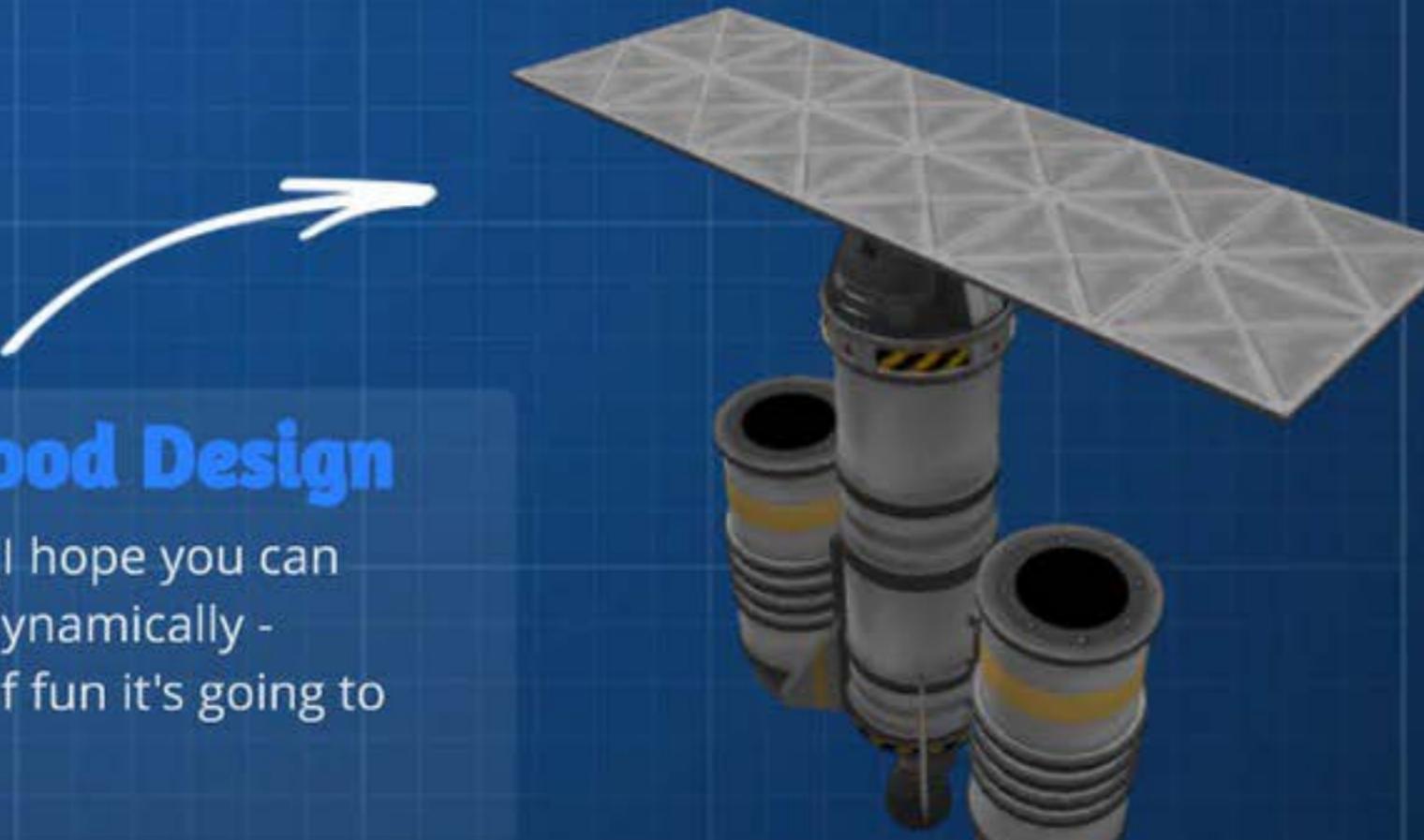
Why Do You Need to Care About Aerodynamics?

Designing your rocket with aerodynamics and drag forces in mind can help you with efficiency and stability.



A Good Design

The design here is streamlined with nosecones and parachutes on the flat end plates. These help reduce the drag force as it heads for space.



A Not-So-Good Design

The design here is (I hope you can tell) very bad aerodynamically - however in terms of fun it's going to be a laugh.

Let's Get Some Control

When building a vessel you will use a number of control parts, and there are two types of parts to consider. Having one type and not the other will leave you floundering for control.

Player Input

These parts allow you to input controls to the vessel.



Probe Cores



Manned Pods



Reaction Wheels



Control Surfaces



Gimballed Engine



RCS Thruster

Control Sources

These parts apply force to the vessel - via airflow over surfaces, torque from gyroscopes, gimballed engine movement and direct thrust from thrusters.

Types of Rocket Engines



Liquid Fuel Engine (LFE)

The primary engines for rockets. These have variable thrust and require tanks of liquid fuel (LF) and oxidizer (OX) attached.



Solid Rocket Booster (SRB)

As the name suggests these engines are typically used as boosters to get things moving. They carry their own fuel and once lit cannot be throttled or shut off.



Ion Engine

This family of low thrust engines are particularly useful for probes. They run on Xenon Gas and Electric Charge (EC) and are particularly useful for long low thrust burns.

Rocket Fuels

Surely the most common of resources. Liquid Fuel (LF) And Oxidizer (OX) are used together to power the majority of rocket engines.



MonoPropellant (MP)

Used mostly by the RCS, this is the fuel for "control" thrusters.



Electric Charge (EC)

EC is used by all electronic parts and is critical for unmanned craft.



Xenon Gas

The fuel that is used by highly efficient ion engines. Ion engines also need EC to run.



Protecting Delicate Science Equipment

When considering that we are literally hurling stuff into space here, sometimes there is a need for protection from the elements - both during liftoff and re-entry.



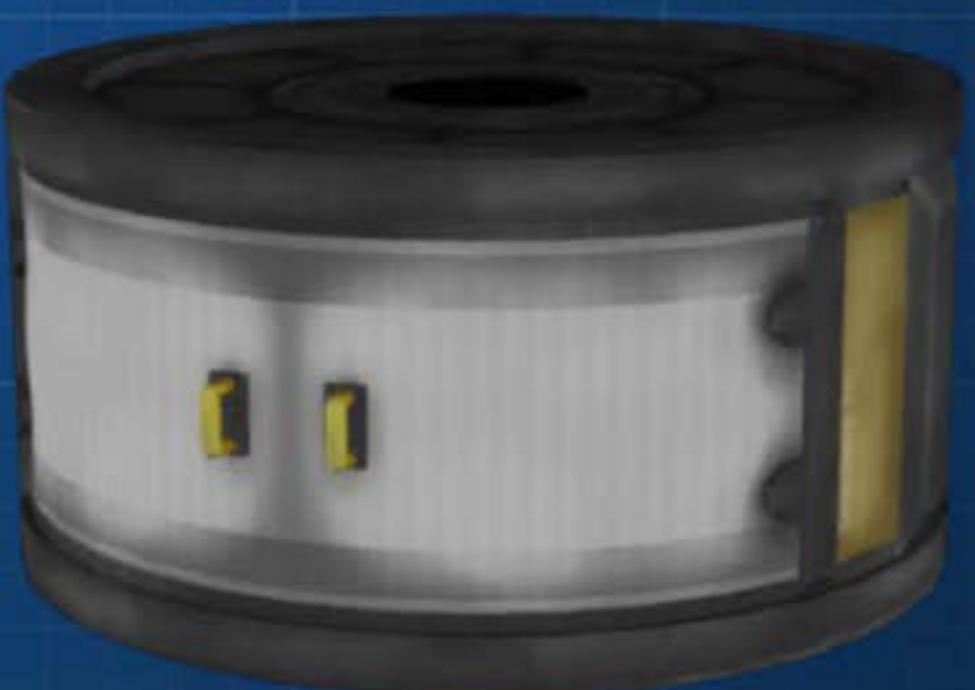
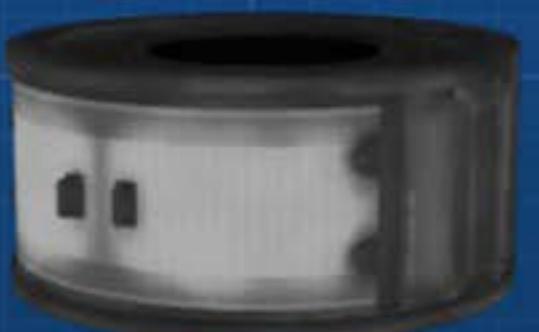
Science Parts

There are a range of experiments you can perform with equipment ranging from full blown labs down to delicate gravioli detectors.



Service Containers

These utility parts can hold a number of small components to protect them from drag, heat and minor collision.



Recharging Electric Charge

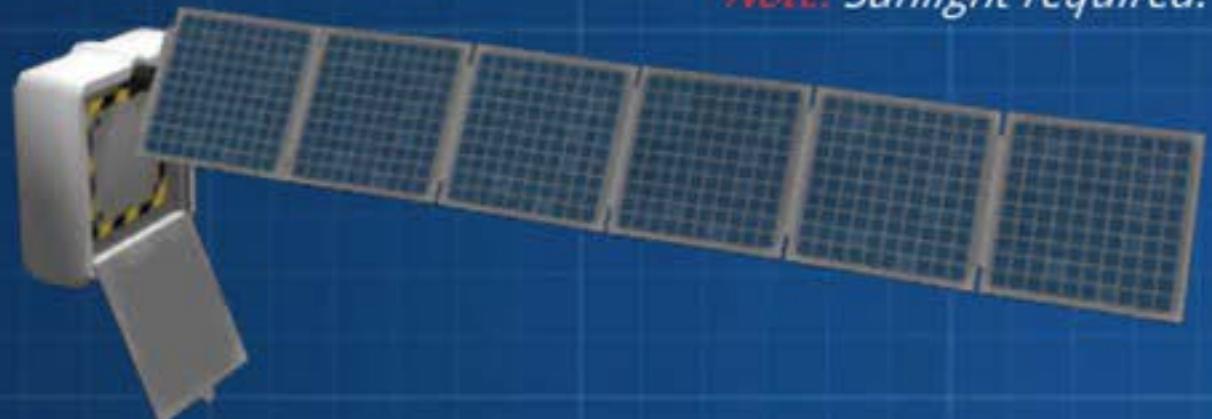
EC is used for many purposes, but batteries are heavy for a single use item. Luckily EC can be generated in a number of ways.



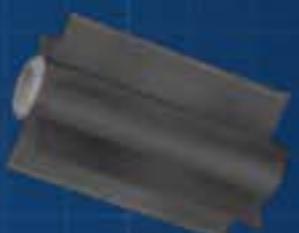
Solar Panels

Lightweight and reliable, these come in a number of sizes and shapes.

Note: Sunlight required.



Thermoelectric Generator



A constant and reliable source of EC, but significantly heavier than other options.

Engine Alternators

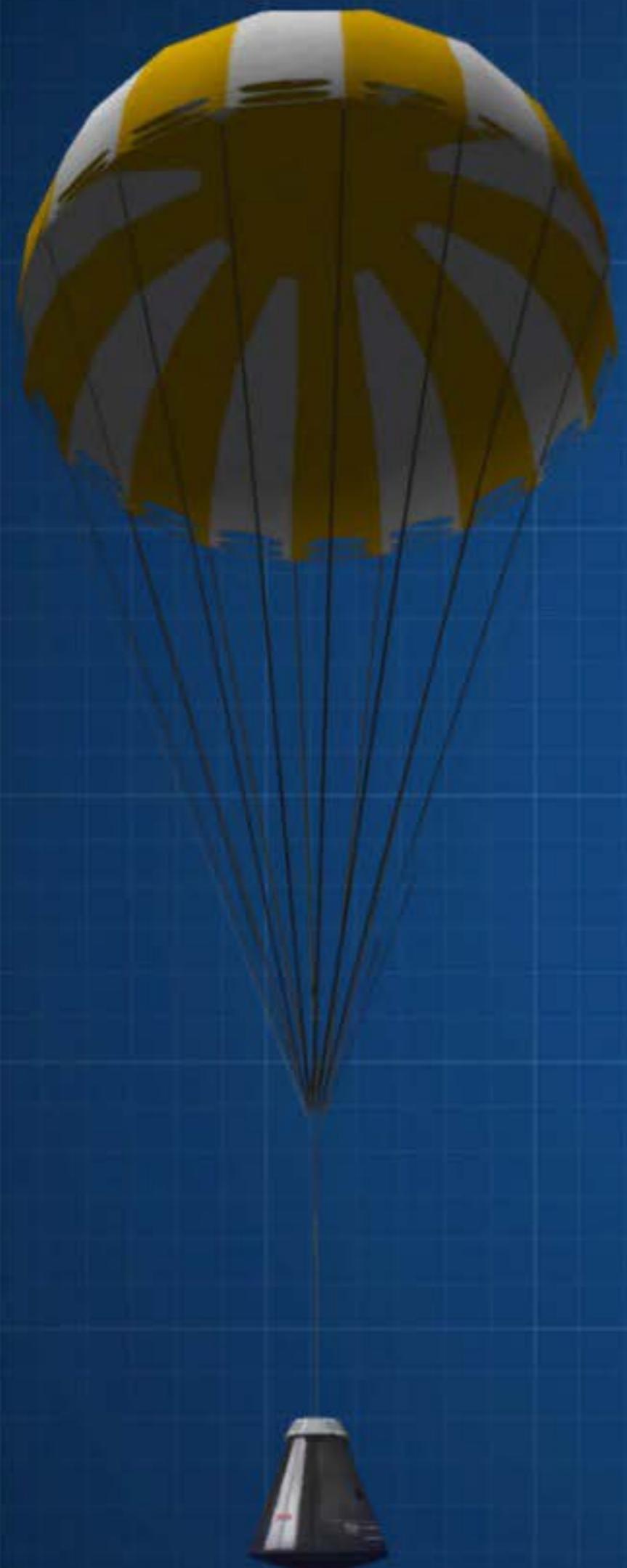
Many engines have built in alternators that will generate varying amounts of EC, depending on the throttle setting.



Fuel Cells

Consuming LF and OX, these cells generate EC when active.





Landing Softly

What goes up *does* come back down. It is much easier, and more efficient, to use parachutes when landing on bodies that have an atmosphere. Compared to an engine burn that is.

Just keep in mind that not all the places you visit have atmosphere.

The Parachute Indicator

The staging stack icon displays the state of each parachute. The color of the background shows how safe it is to stage. The icon's color shows the state of the staged chute.

Packed Chutes

- Safe to Deploy
- Risky to Deploy
- Unsafe to Deploy

Staged Chutes

- Activated
- Semi-Deployed
- Deployed
- Cut / Shredded



Getting In and Out

Kerbals leave and enter vessels through the hatches on their vessels. The hatches are not always in the same spot, but they are clearly marked.

Be sure not to land on or obstruct a hatch if you want to use it.

Climbing Aboard

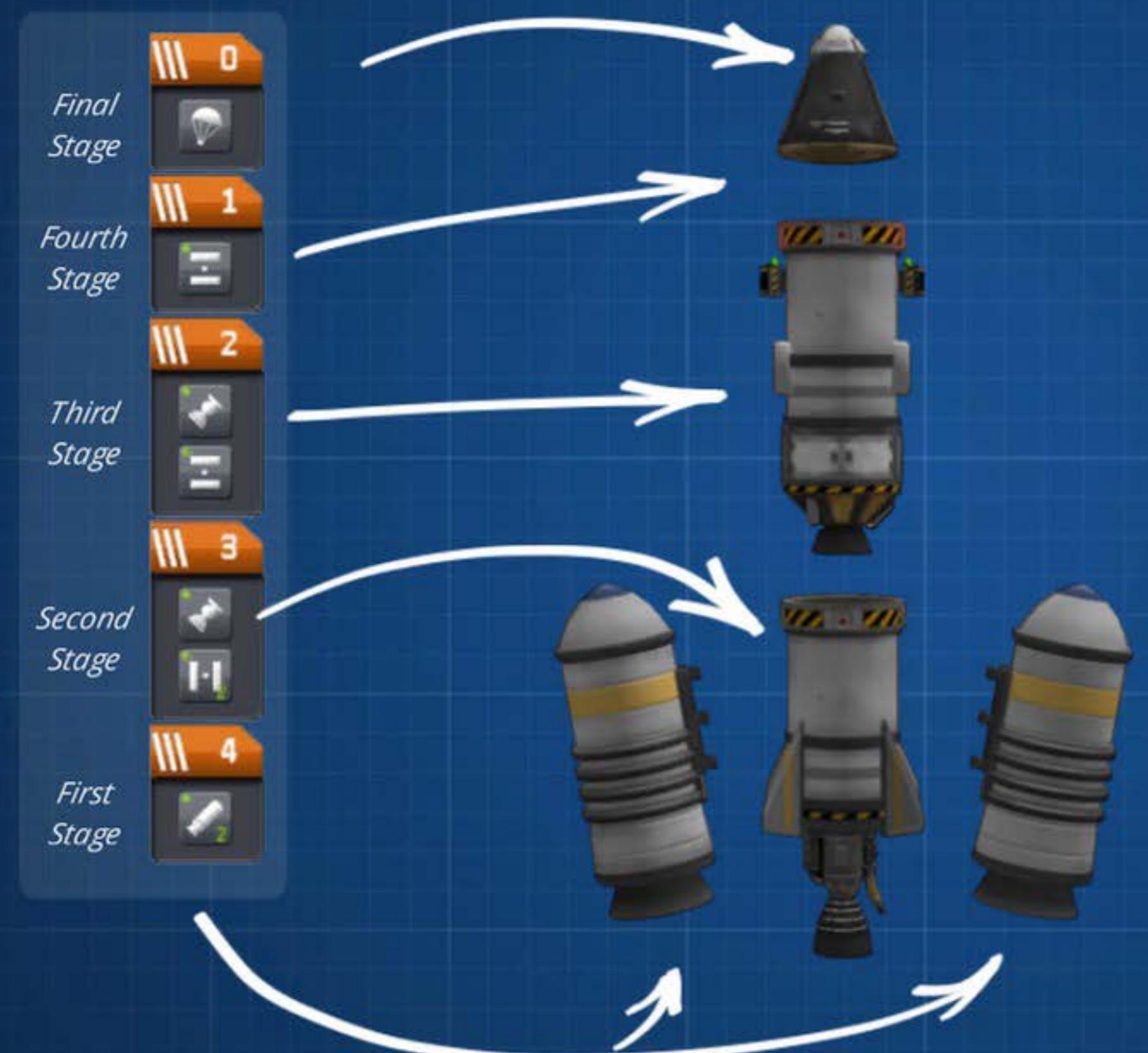
There is a range of ladders to help you get aboard for that return leg. Sometimes the hatch is just out of reach without some helpful steps.





What's Up With Staging?

Carrying unneeded equipment with you uses much more fuel. Most rockets use stages to get rid of used SRBs, engines, fuel tanks or other parts that are no longer required.



Staging starts at the highest stage number. Each time you "stage" it activates the next one.

Another benefit is that you are not going to try and land the whole launch vessel. Just the important parts.

Note: Staging while engines are still running can have explosive consequences.

Assistance to Stay Stable

Kerbal pilots and many probes can use the Stability Assist System (S.A.S.). This can help to keep your vessel pointed in the desired direction. The S.A.S. modes can be seen to the left of the NavBall here.

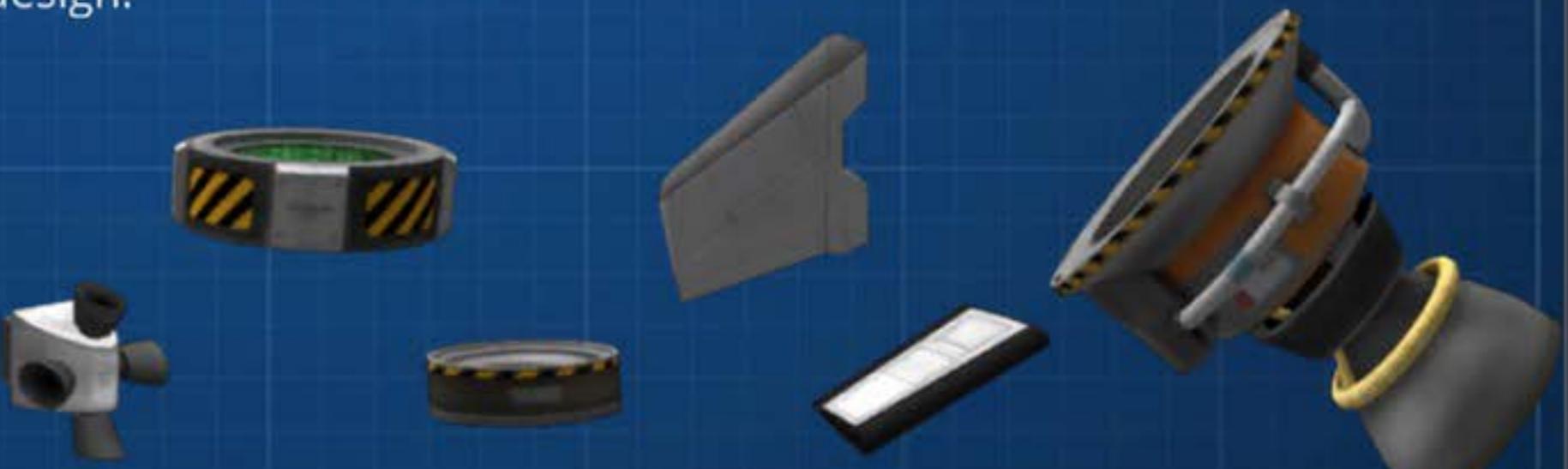
At its most basic, S.A.S. will hold the heading of your vessel, this is called stability mode.

More advanced modes allow you to target other directions, as shown with the matching NavBall markers.

Stability			Maneuver
Prograde			Retrograde
Normal			Anti-Normal
Radial			Anti-Radial
Target			Anti-Target

What's Pushing That?

S.A.S. uses control sources to apply force to get you back on target. If there's not enough force you may need more control parts, or a different design.



Note: These will consume resources, you need to be mindful if you leave S.A.S. engaged for a long time.



Hibernation Mode

This probe core mode helps to save the electric charge in your batteries by reducing the electricity usage of the core. The trade-off is that when you hibernate a probe core, it loses some functionality and goes into Limited Control Mode. Hibernation is activated via the Part Action menu; enabling Advanced Tweakables also allows you to set hibernation to happen automatically during timewarp.



For most probe cores, power usage drops to 1% of normal in hibernation mode. A few high tech probe cores can do even better than that! So hibernating can really help when taking a trip to the dim outer reaches of the system and your EC generation rates are low to none.

Limited Control Mode

Being in this mode means* that the probe core loses the ability to set maneuver nodes. It also can't steer (except by choosing SAS modes) or use fine throttle control. Of course, if you have Kerbals aboard (or additional probe cores) then they may still provide some of these functions for the vessel.

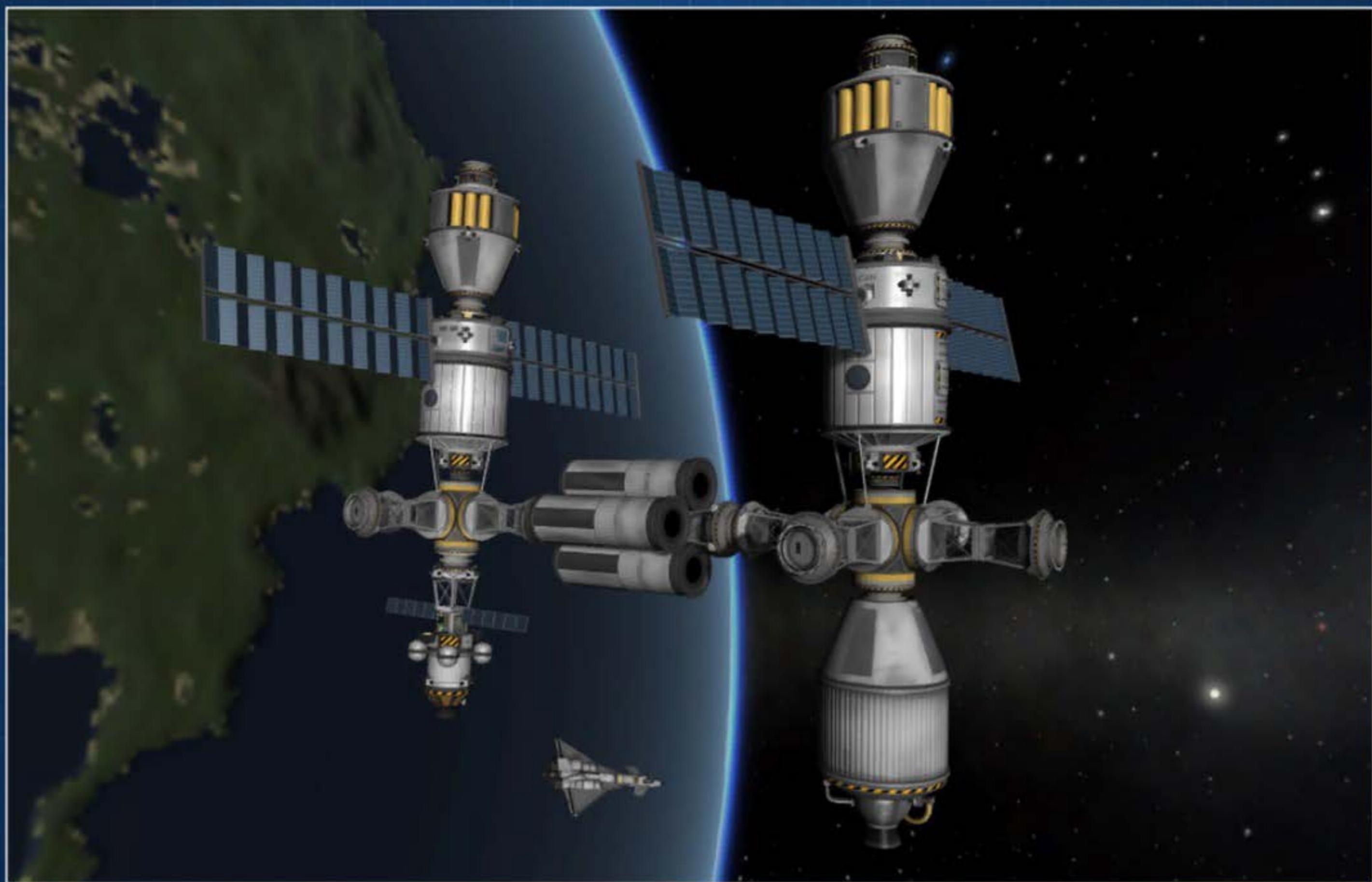


* For more information about control modes, see: Communications Network/CommNet/Control Links



Advanced Rocketry

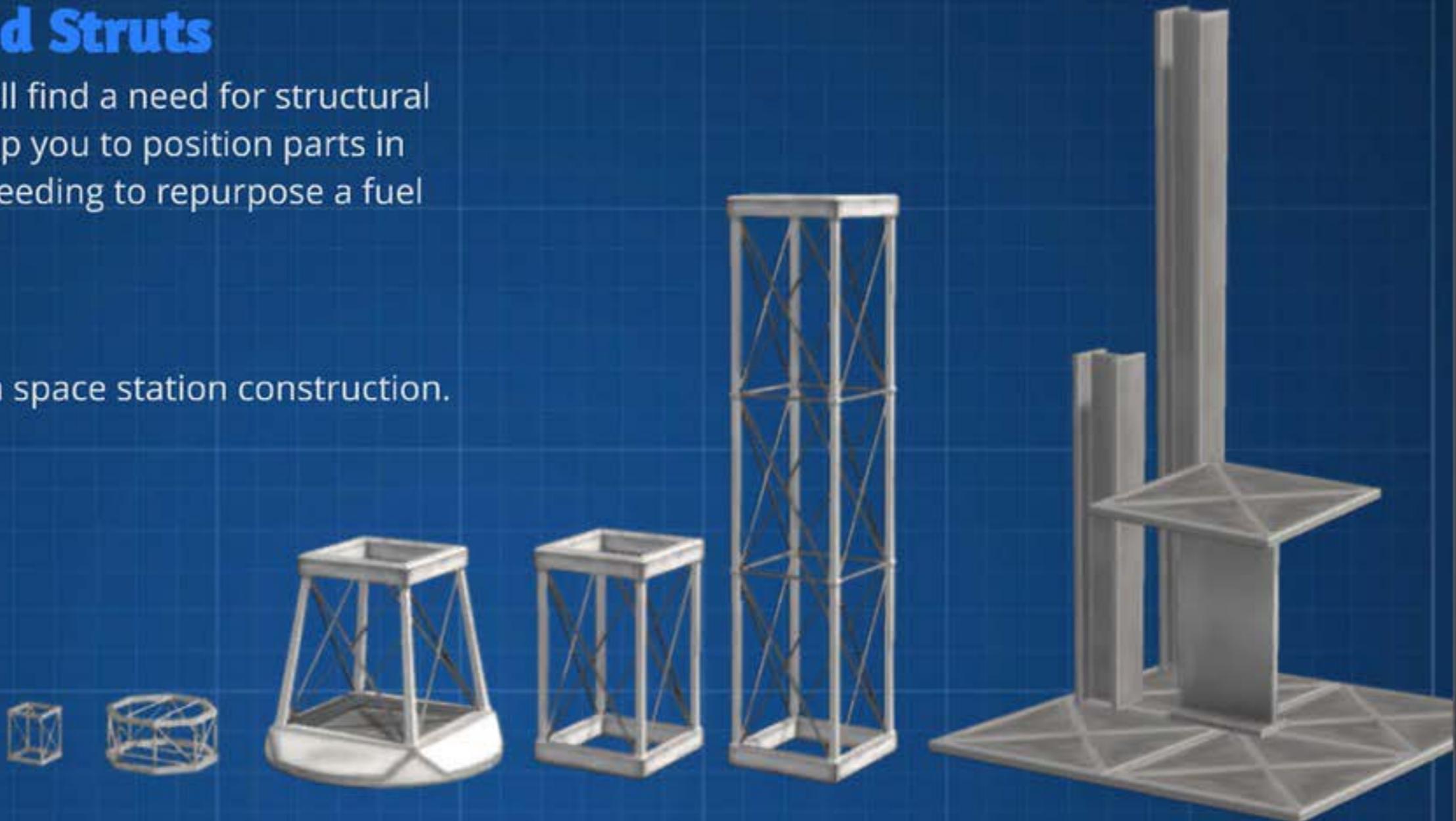
With enough practice and a little luck you'll be doing things like this in no time.



Girders, Plates and Struts

As vessels grow larger you will find a need for structural components. These parts help you to position parts in just the right place without needing to repurpose a fuel tank.

These are especially useful in space station construction.



Strutting Your Stuff

The EAS-4 Strut Connector is the kerbal universe equivalent of duct tape. You can use it in just about any situation to join parts together.

If the connector goes between parts in different stages in a vessel, then it will "break" by design when that stage is activated.



Fairings for Aerodynamic Improvements

Once a vessel clears the atmosphere aerodynamics become unimportant, unless you are landing on some planets. This means that things like the satellite shown here do not need to be streamlined once they reach space.

To protect a vessel from aerodynamic forces on ascent we can use fairings.



Storing a Satellite

Once a fairing base is placed you "draw" the shape of the fairing panels with the mouse. Below you can see how this satellite was stored.



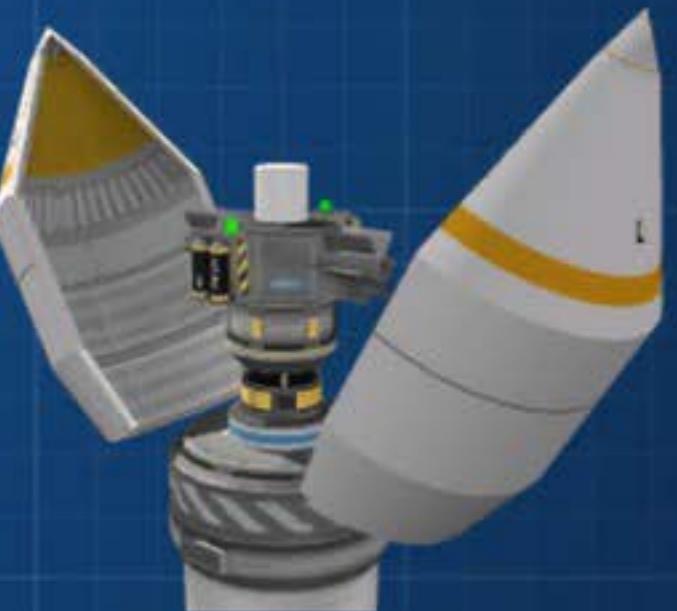
Attached to the top of the rocket on the fairing base.



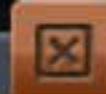
Building the fairing with the cursor to wrap the satellite.



All packed in snug and tight.



Staging the fairing to reveal the satellite.

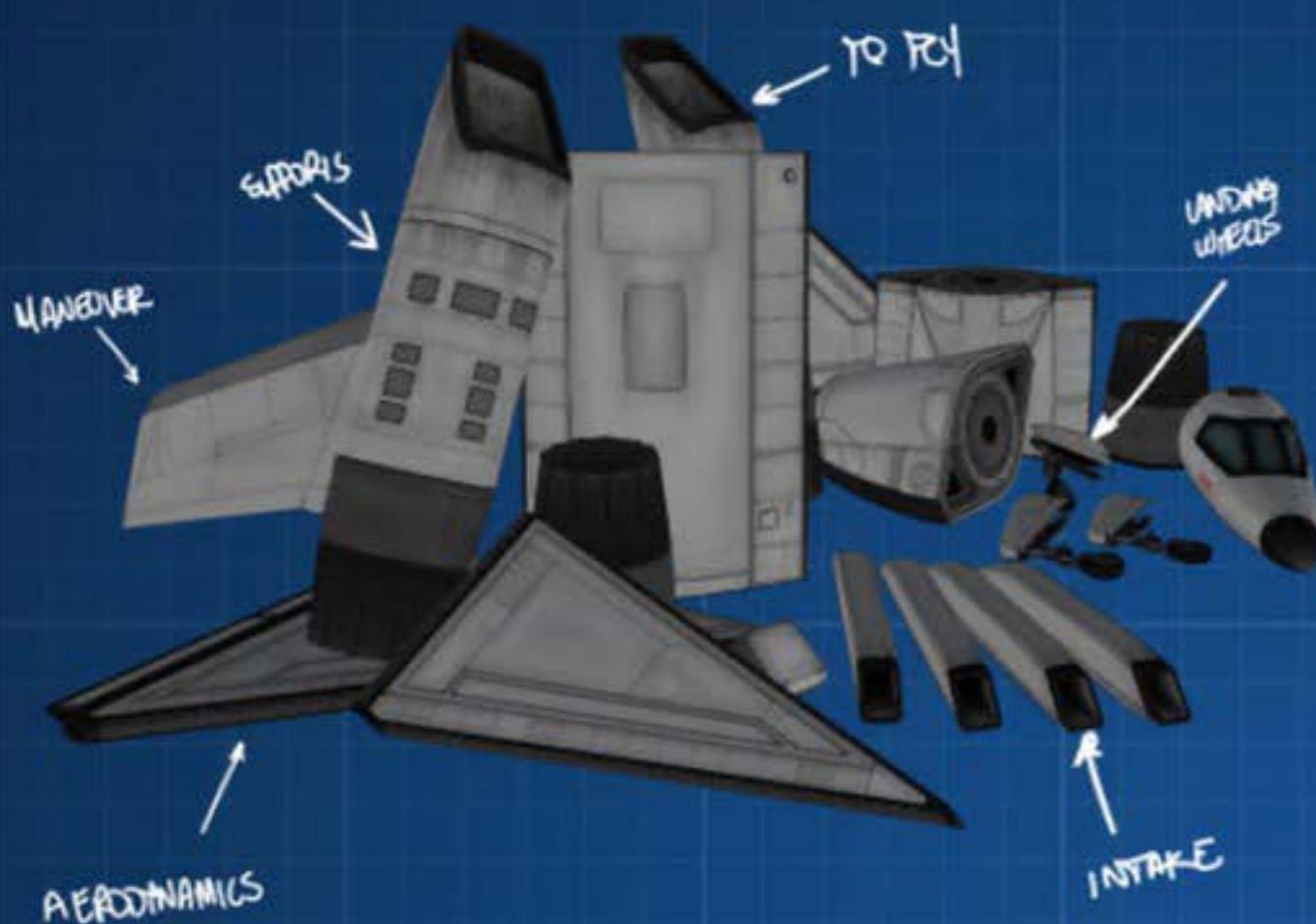


Aircraft

Those magnificent kerbals in their flying machines, and other aircraft information.

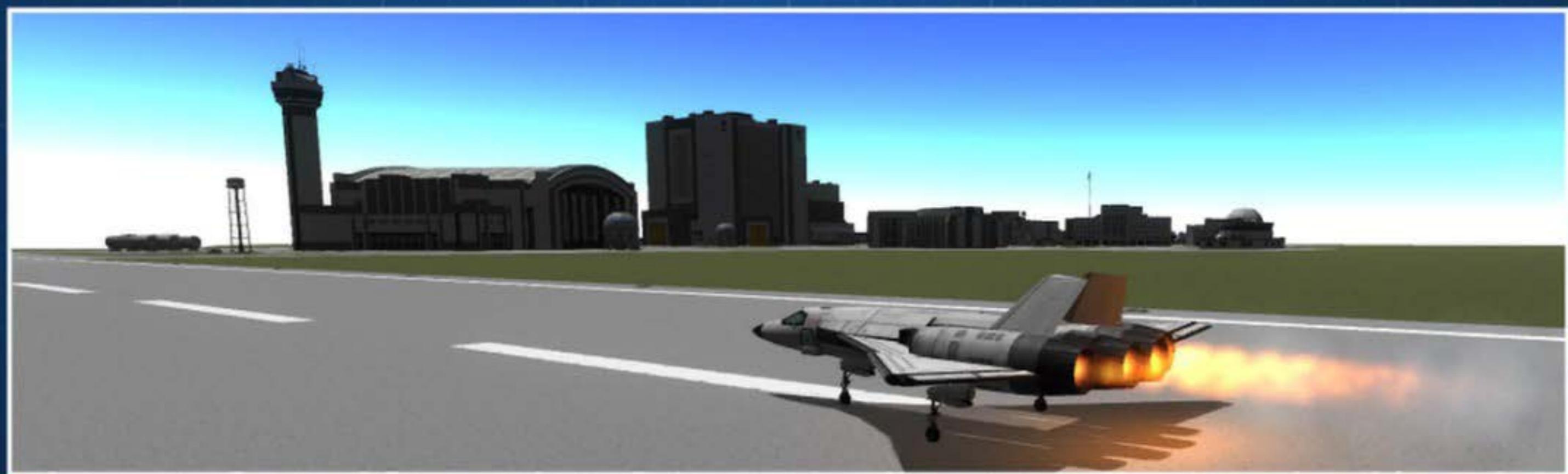


The Basics of Aircraft



While kerbals spend a lot of time reaching out into space, getting around on Kerbin is another of their pastimes.

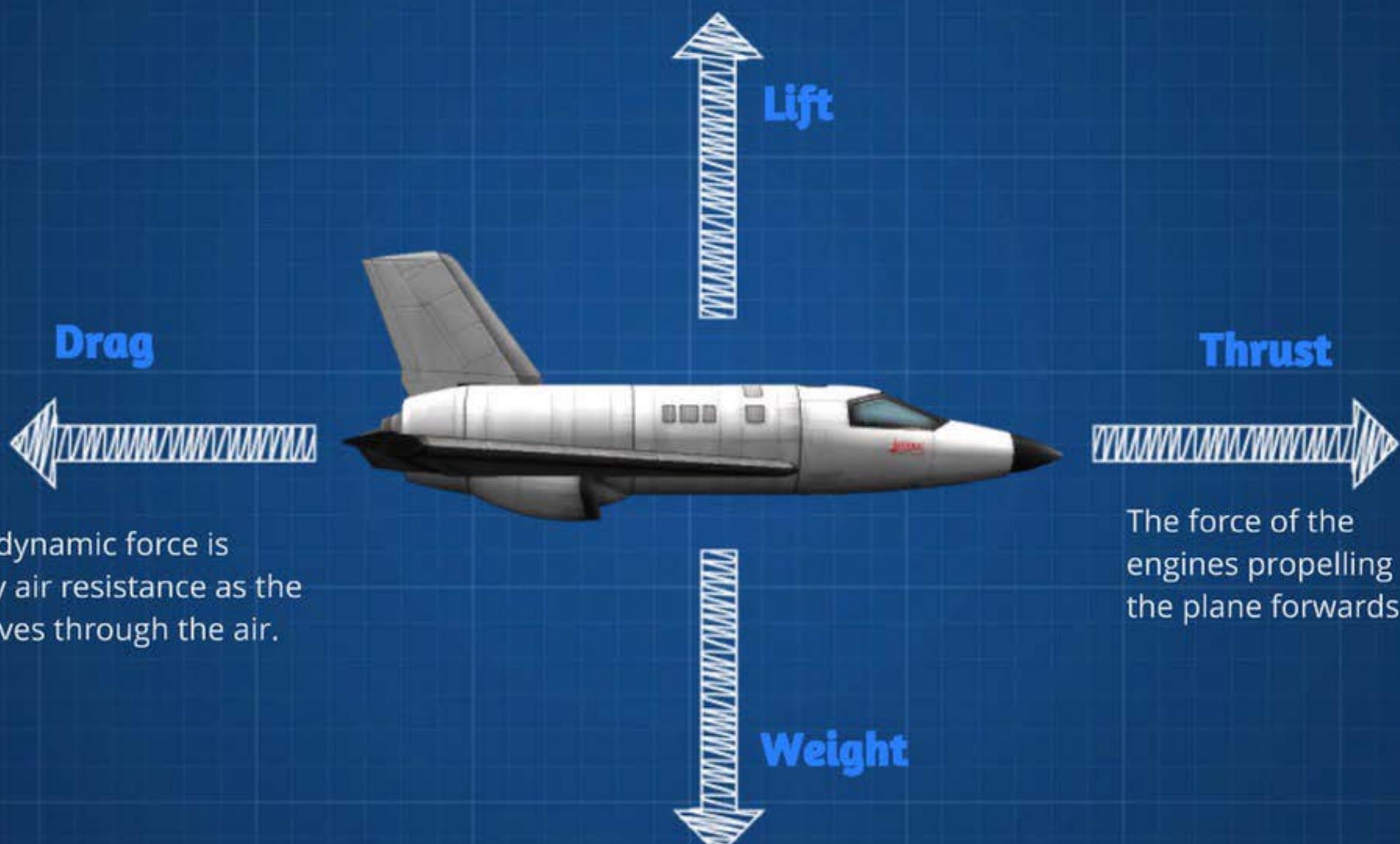
You'll hopefully learn some tricks in this section to go from this pile of parts to the below levels of awesome!



Forces That Apply to Planes*

* Excludes ground impact force

This aerodynamic force is generated by airflow over the wings.



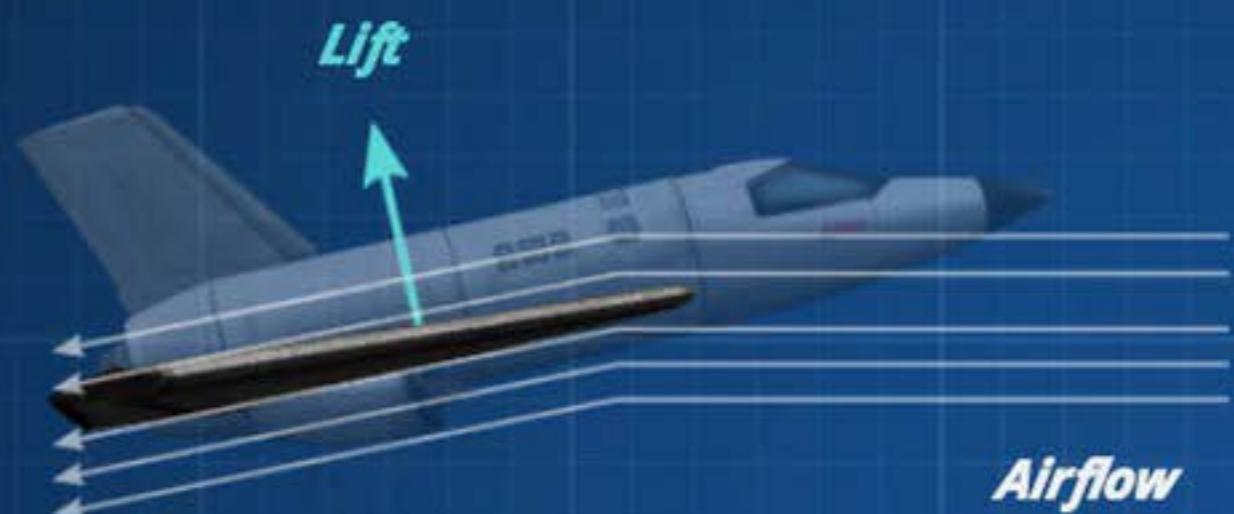
This aerodynamic force is caused by air resistance as the plane moves through the air.

The force of the engines propelling the plane forwards.

This force comes from gravity pulling down on the plane.

Getting a Lift Up

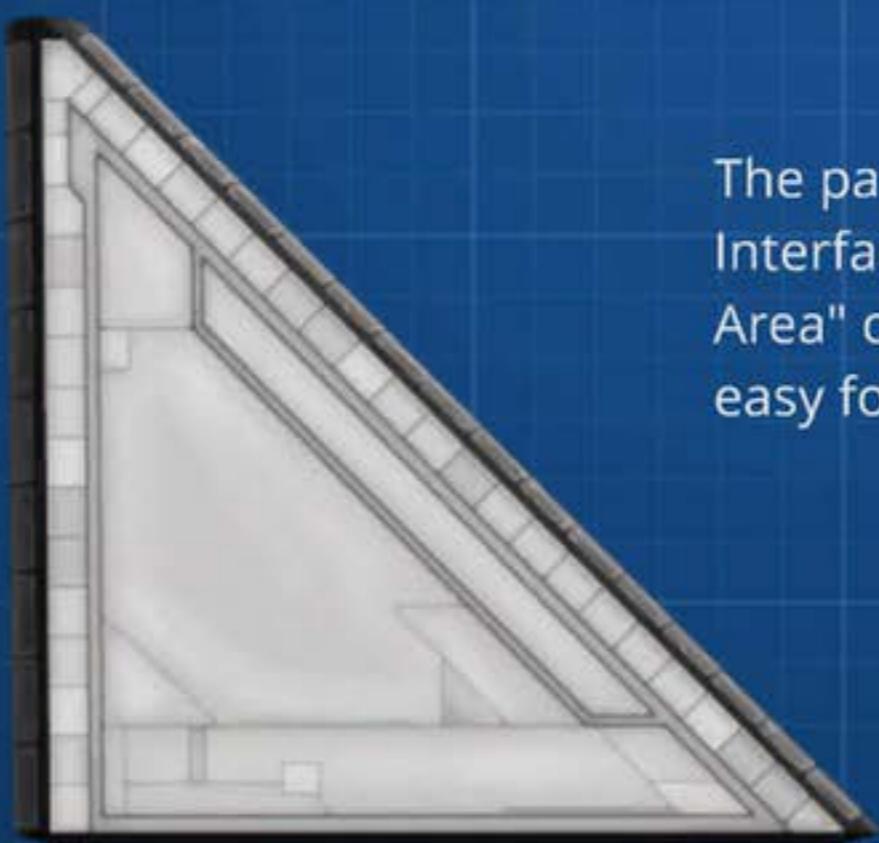
With a plane, lift is generated by air being shaped as it passes around the wings. Wings in KSP are symmetrical, if there is no angle of attack (angle into the airstream), there is no lift generated by wings.



With a plane, the lift is generated by air being shaped by the wings. Air deflected downwards adds force upwards.

Basic rules of thumb are:

1. Larger wings generate more lift.
2. Faster airflow generates more lift.
3. If the angle of attack is too great the wing stalls and produces next to no lift, only drag.



The part details in the Construction Interface show the "Relative Wing Area" of each part, which makes it easy for you to compare them.

Delta Wing
RWA = 2.0

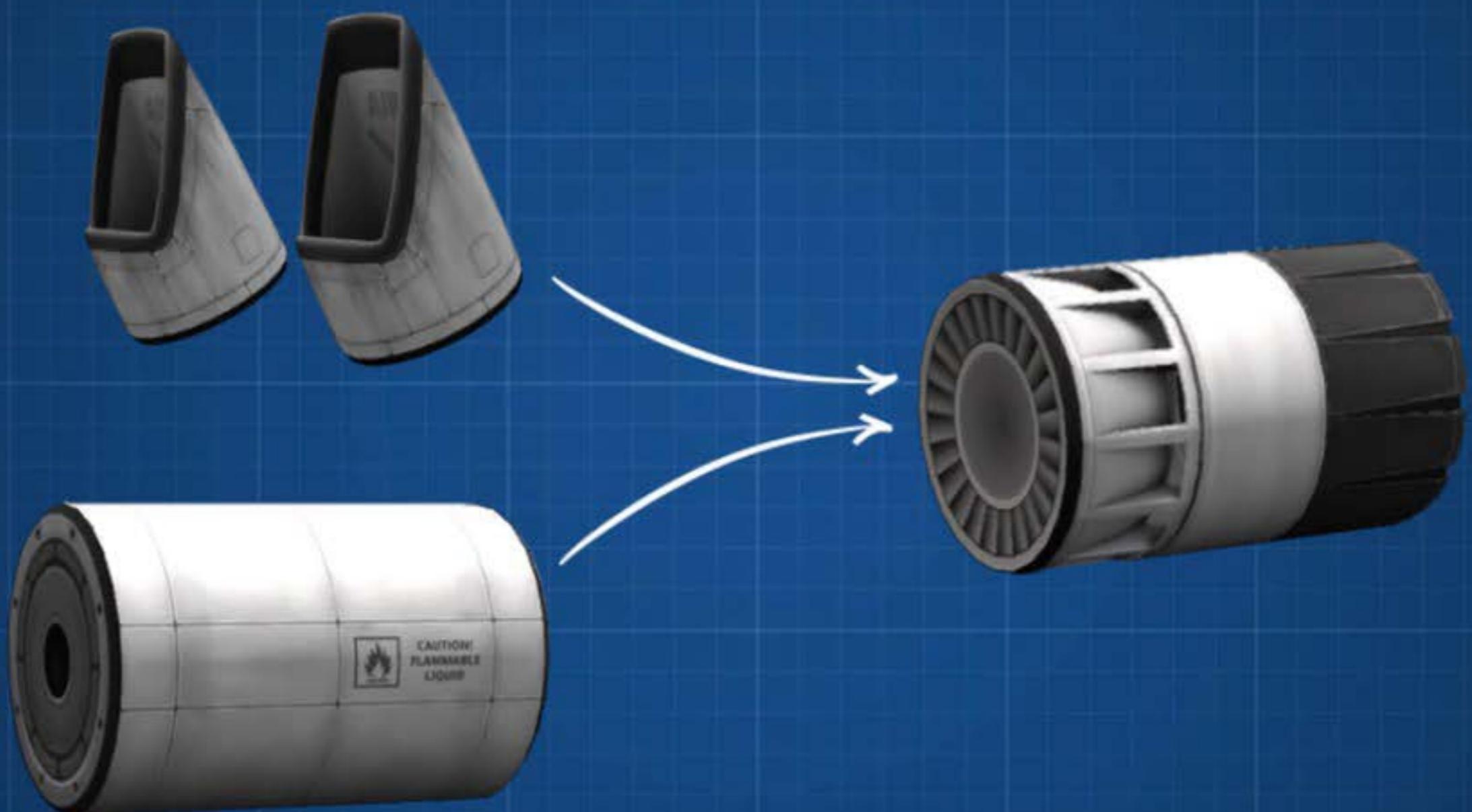


Small Delta Wing
RWA = 0.5

What is Different About Jet Engines

Jet Engines provide the *thrust* for our aircraft. These engines use intakes to get their oxygen. This means you don't have to carry oxidizer along, but you can only operate where the atmosphere is thick enough.

Your aircraft needs air intakes and liquid fuel to feed the jet engine.



If you are trying to build a Single Stage to Orbit (SSTO) craft then you might use jet engines to ascend to the upper atmosphere and then use rockets to push from there to orbit.

Needing to Breathe

Intakes, like engines, come in many shapes and sizes. The key thing to remember is that they grab air for jet engines, and the amount varies depending on speed and altitude.

The faster you go, the more air is captured; the higher you go, the less air is captured (because the atmosphere is thinner at higher altitudes).

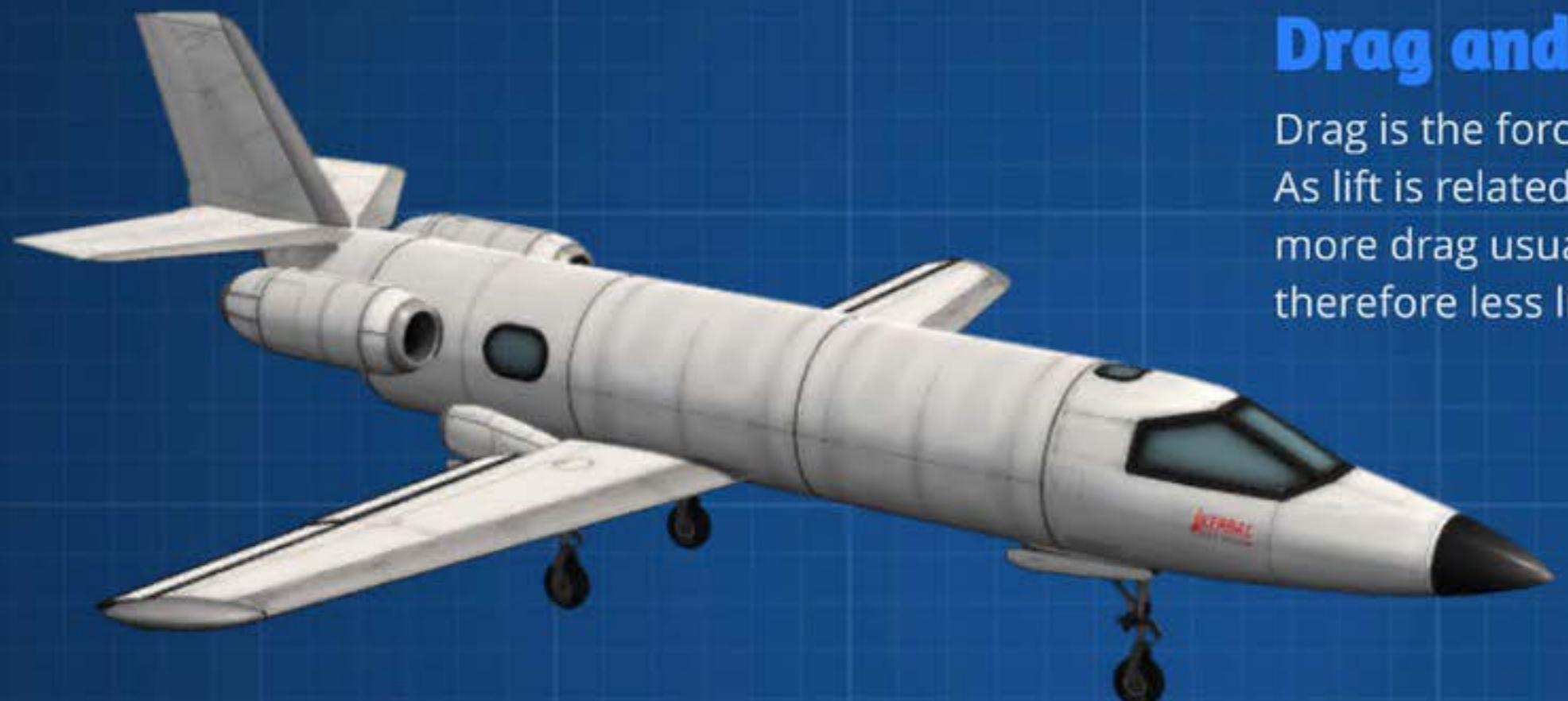


Picking the Right Intakes

While all intakes perform the same function, you will find that some are better suited to your design, visually or functionally. It's important to pick the right part for the job, and pay attention to the specs when building.

This Is Such a Drag

As your plane travels through the sky, the drag force caused by air resistance slows it down. You overcome the effect of this force by adding thrust - "moar engines" - or improving aero shape.



Drag and Its Effect on Lift

Drag is the force that's slowing you down. As lift is related to the speed you're travelling, more drag usually means less speed and therefore less lift.

Xzibit Kerman pimped this version of the Velocitize to pick up every station on Kerbin. Unfortunately it's going to be very slow with all that drag.

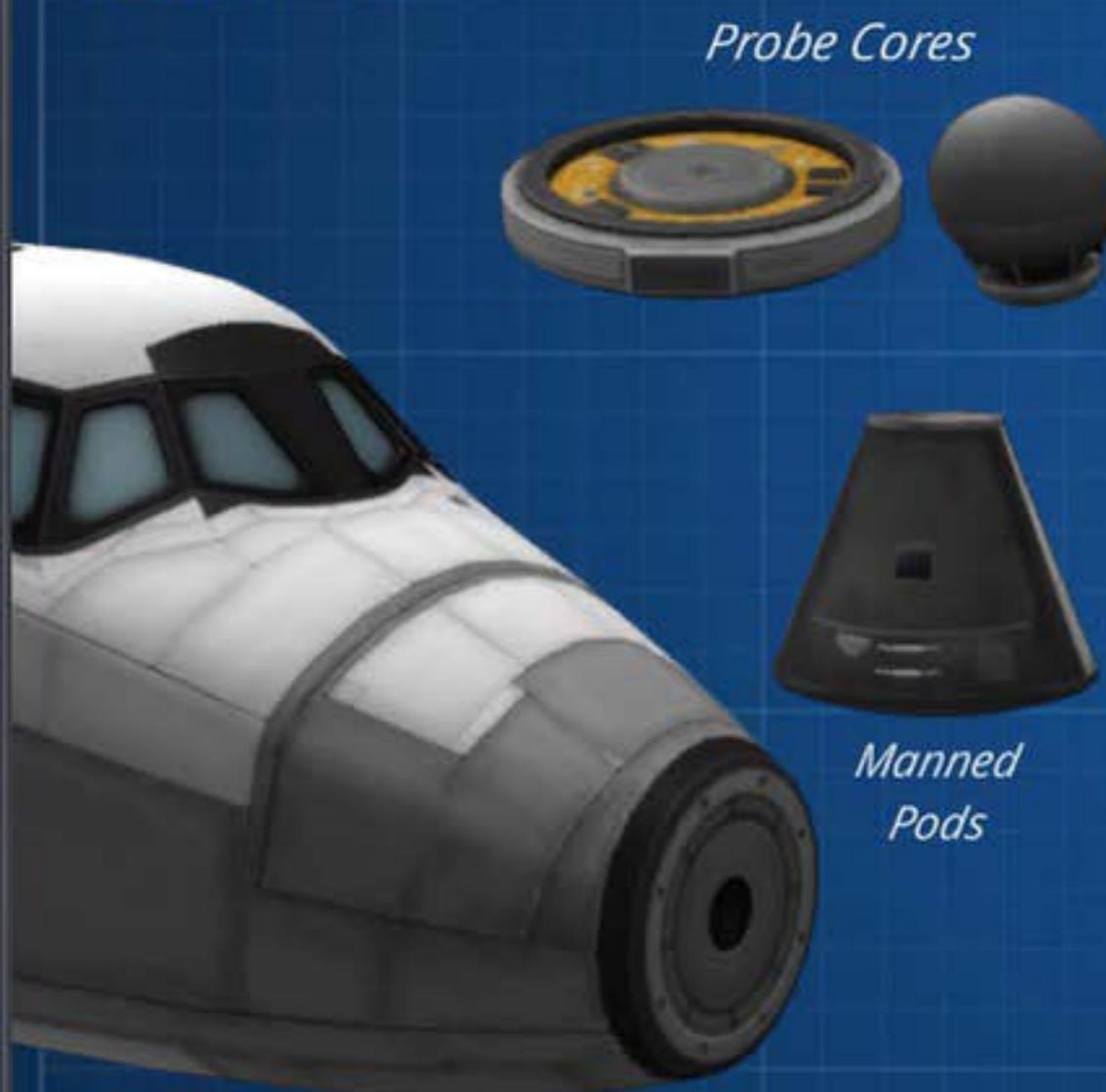


Let's Get Some Control

When building a vessel you will use a number of control parts, and there are two types of parts to consider. Having one type and not the other will leave you floundering for control.

Player Input

These parts allow you to input controls to the vessel.



Probe Cores



Manned Pods



Reaction Wheels



Gimballed Engine



Control Surfaces



RCS Thruster

Control Sources

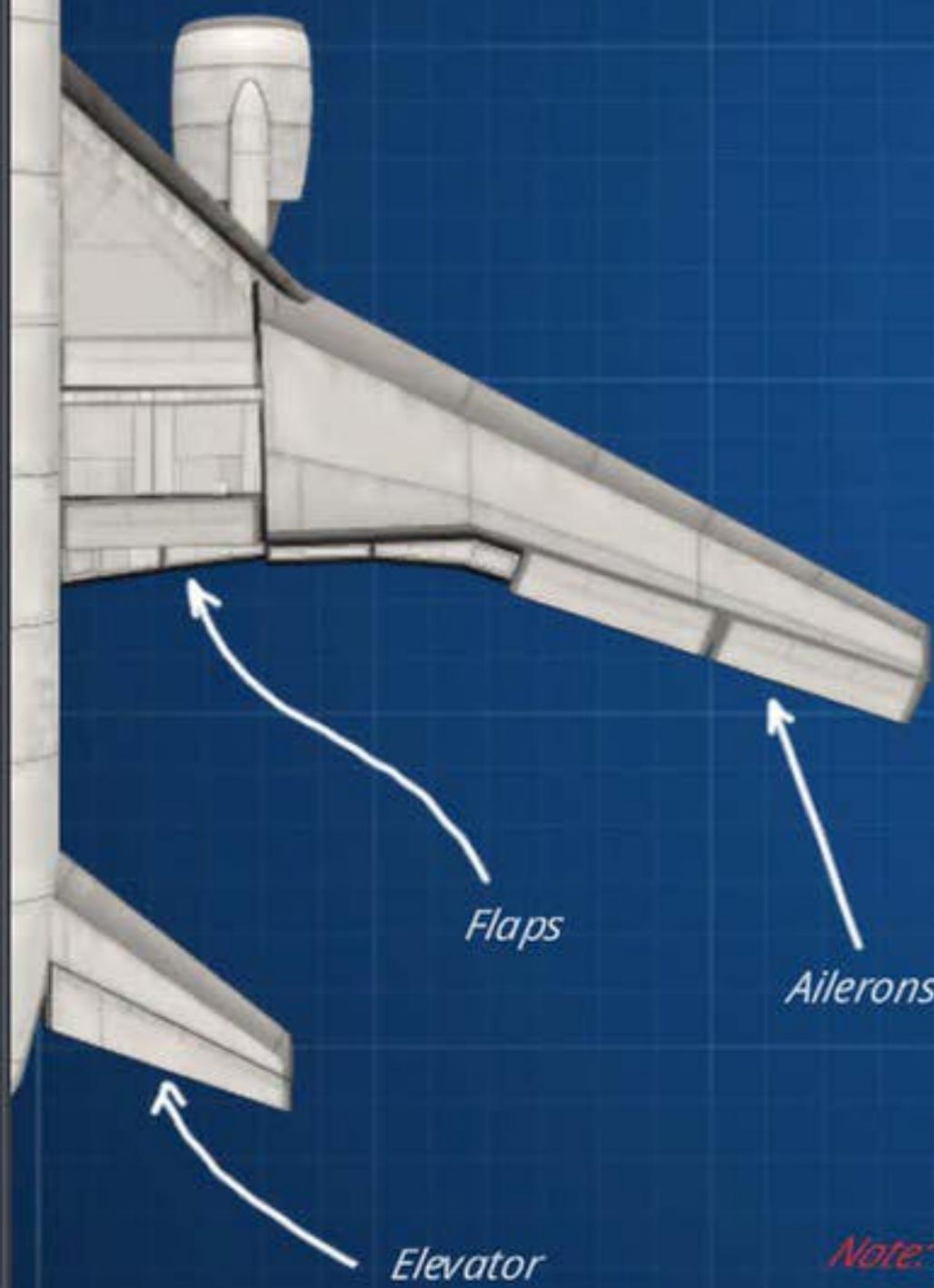
These parts apply force to the vessel - via airflow over surfaces, torque from gyroscopes, gimballed engine movement and direct thrust from thrusters.

Controlling Airflow

In the atmosphere you can use control surfaces to redirect the airflow. The change in airflow will change the attitude of aircraft. There are many parts that will help you to do this.

Below are some very simplistic effects of each type of control:

Alleron:	Affects Roll
Elevator:	Affects Pitch
Rudder:	Affects Yaw
Airbrake:	Affects Drag
Flap:	Affects Lift



Note: You create flaps using ailerons and disabling the three control axis. You then deploy them using part actions or action groups.

Where Lift Is Applied

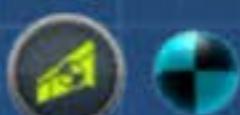
When designing an aircraft one of the key indicators is the center of lift (CoL). Its location is crucial to the balance of the plane.

The CoL is found by adding the individual lift components from all parts of the craft. Lift is generated by wings, control surfaces and even some fuselage parts (via an effect called body lift).

UI Helpers (in Editor)



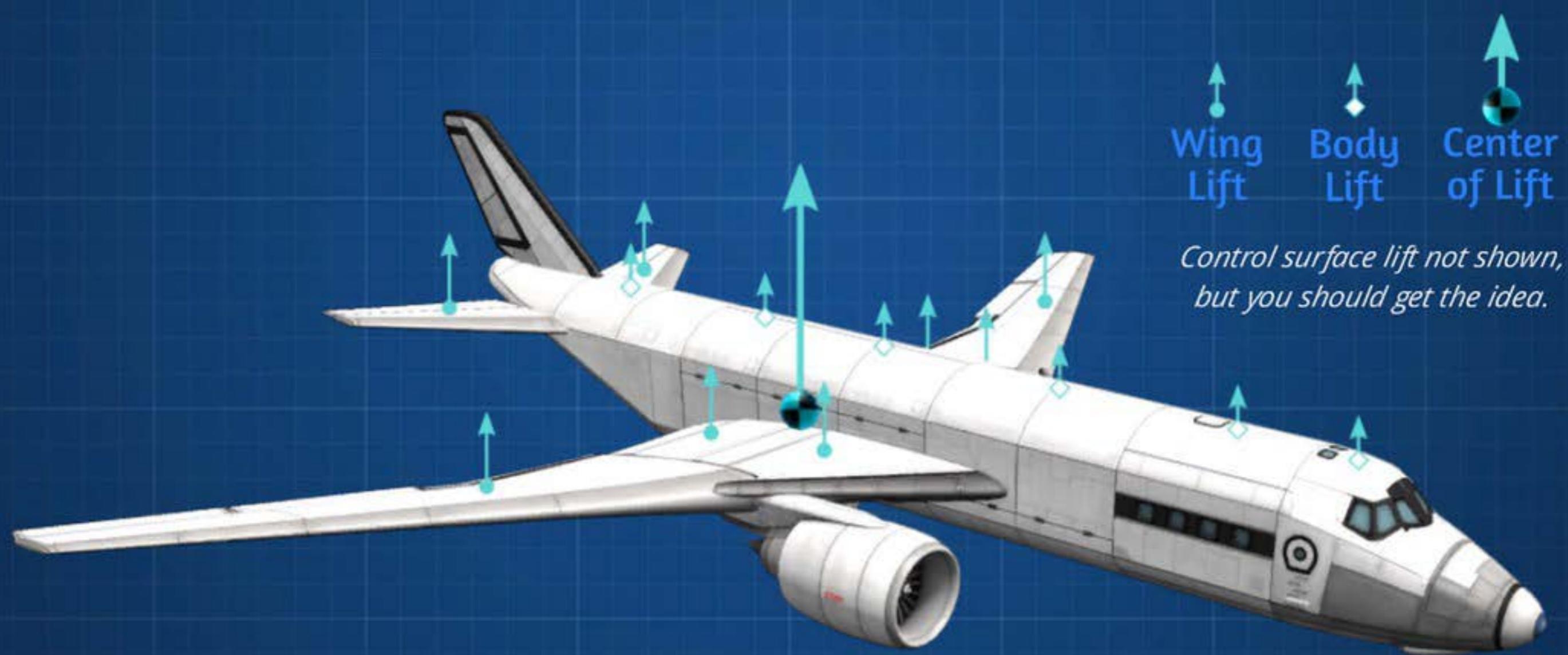
Center of Mass



Center of Lift



Center of Thrust



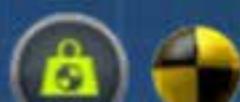
Note: In game you will only see the CoL marker in the construction interface.

It's All About the Balance

Designing a plane that will fly is all about balancing the four aero forces. In construction you can use the UI helpers to apply some common ideas to help you succeed.

Here are some basic themes that help build simple planes.

UI Helpers (in Editor)



Center of Mass



Center of Lift



Center of Thrust

Of course, once you have a firm grasp of flight, imagination (and physics) are the only limits.



Use Symmetry:

Build your plane around a "center line."

Push Along the Center:

Line up the CoT to push through the CoM.

CoM Near CoL:

The center of lift should be near the center of mass.

Balancing Act

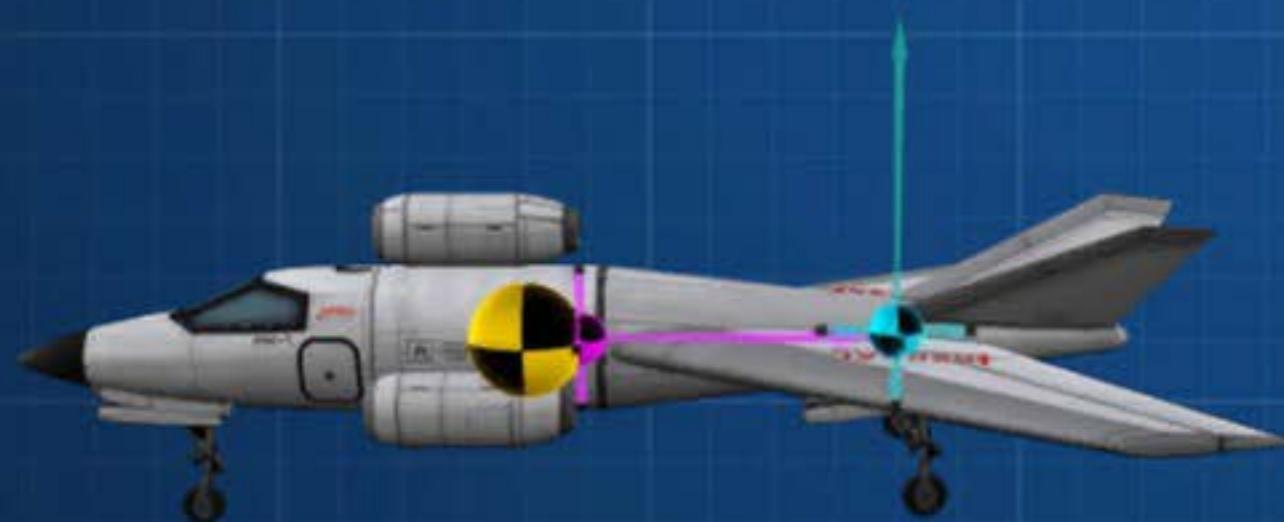
Here are some examples of planes that suffer from balance issues.
Hopefully you can learn a thing or two from our mistakes.



The thrust in this design is pushing the plane around the CoM, not through it. This is a CoT issue.



*Here the center of lift is off the center-line.
This plane will roll left quite badly.*



Lastly the CoL here is well behind the CoM, this plane will pitch down hard.

UI Helpers (in Editor)



Center of Mass



Center of Lift



Center of Thrust

Let It Roll

As you aren't taking off vertically you will need some stylish wheels to help with takeoff. These have also been known to help with that pesky landing thing too.



Having Good Separation

You need to make sure there are wheels front and back, and at least one set are spaced wide apart for stability.



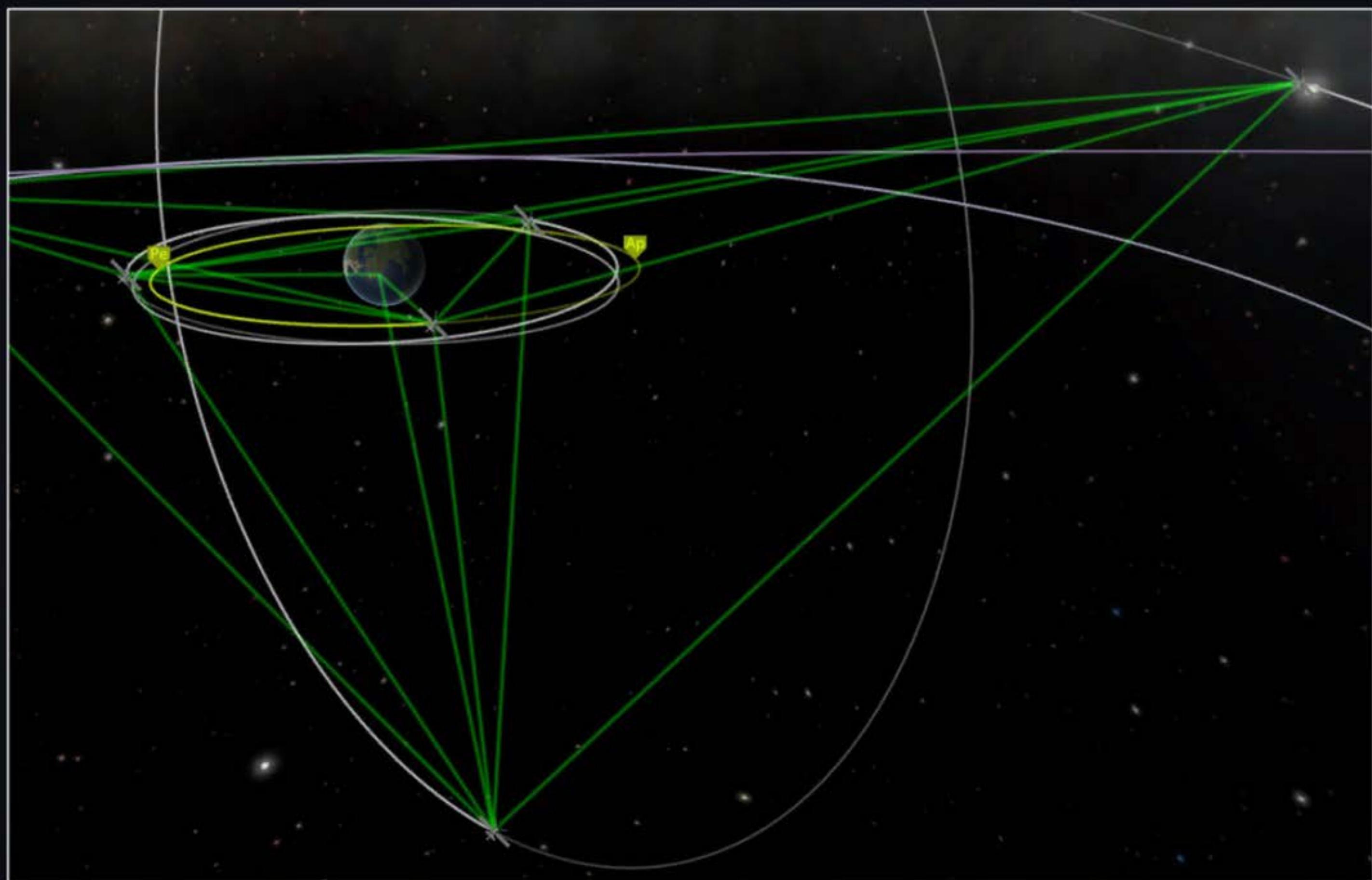
Nice spread for balance and stability.



This configuration is less likely to stay upright in many situations.

Communications Network

Here you will find out about CommNet and KerbNet functionality.

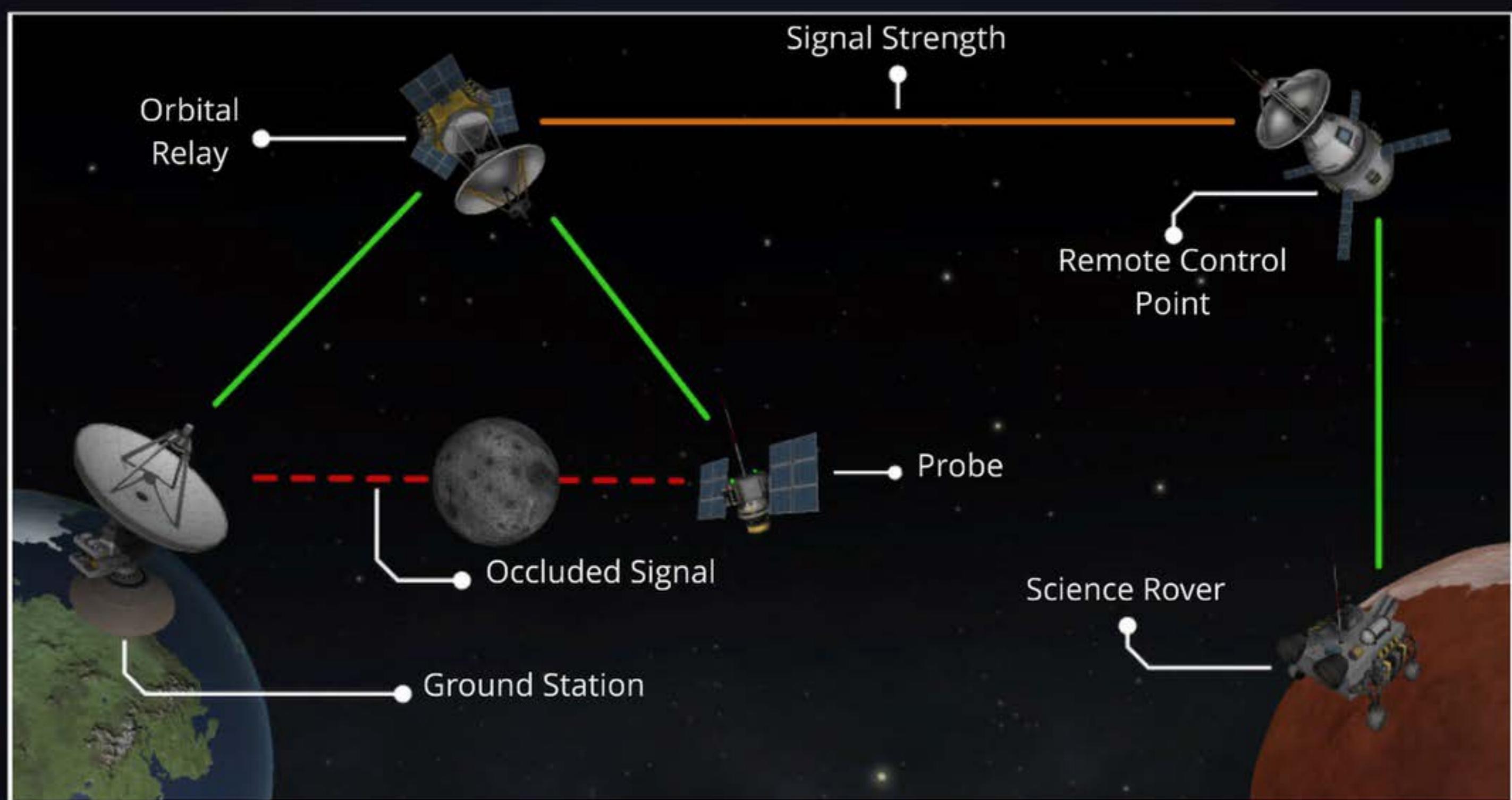


Communications Network / CommNet

CommNet

Communication Networks allow your vessels to transmit data between each other and Kerbin. You can create a CommNet with antennas which connect back to Kerbin's Deep Space Network (DSN).

These links are used for Control and for Science. You can extend the range and Signal Strength of DSN connections by upgrading the Tracking Station and can increase coverage and Signal Strength further with Relays.



CommNet Interface

The current control path, as well as all potential links, and the whole network can be visualized in map view and the tracking station. A panel shows relevant CommNet information including control level, signal strength, and destination type.



RA-2 Relay Antenna


Mass: 0.15 t
Tolerance: 8.0 m/s Impact
Tolerance: 50 Gees, 4,000 kPa Pressure
Max. Temp. Int/Skin: 2000/2000 K

Manufacturer: Ionic Symphonic Protonic Electronics

A relay antenna with automatic store and forward capabilities as well as advanced pathfinding algorithms.

Cost: 1,800.00 [RMB]: Pin, Lens

Date Transmitter

Antenna Type: Relay
Antenna Rating: 2.00G (Combinable)
vs L1 DSN: 2.00Gm
vs L2 DSN: 10.0Gm
vs L3 DSN: 22.4Gm

Packet size: 1.0 Mbit
Bandwidth: 2.8571 Mbit/sec

When Transmitting:
Requires:
- Electric Charge: 68.6/sec.

Relay II

Info	
Sphere of Influence	Kerbin
Situation	ORBITING
Flight time	T+ 109:02:30:17

Orbital Characteristics	
Velocity	999.1 m/s
Altitude	2,907,775 m

Craft Stats	
Max. Acceleration	N/A
Burn Time to 0m/s	N/A

CommNet	
First Hop	Kerbin: KSC
First Hop Distance	2.94Mm
First Hop Signal	1.00
Overall Signal	1.00

You will also see relevant CommNet info in the editor and map views as shown here

O Return to Game

Control Links

A control link is a connection from the vessel back to a control source. This control source is either a Pilot Kerbal in a vessel that offers remote control, or any of the ground stations on Kerbin (which are presumably staffed by ace pilots). A vessel which requires but lacks a control source will suffer reduced control abilities.

	Full Control	Partial Control (Crewed)	Partial Control (Probes)	No Control
Part Action Window	✓	✓	✓	
Staging	✓	✓	✓	
Autopilot	✓	✓	✓	
Existing Maneuver Nodes	✓	✓	✓	
Full/Zero Throttle	✓	✓	✓	
Toggle SAS/RCS/Lights/Gear	✓	✓	✓	
Yaw/Pitch/Roll	✓	✓		
Throttle Up/Down	✓	✓		
Add/Edit/Maneuver Nodes	✓			

Any vessel which lacks a Pilot Kerbal requires a control source for full control. Other kerbals can add some control ability but cannot provide full control.

Science Transmission

With the correct equipment, a vessel can transmit its science data back to Kerbin via CommNet. The higher the signal strength, the more science results from the transmission. It's always better to return the data than to transmit it, but a strong Signal can make a lot of the difference.

Signal Strength

The signal strength is the product of the signal strengths of all links on the path back to the DSN or to a Control Point. For example:



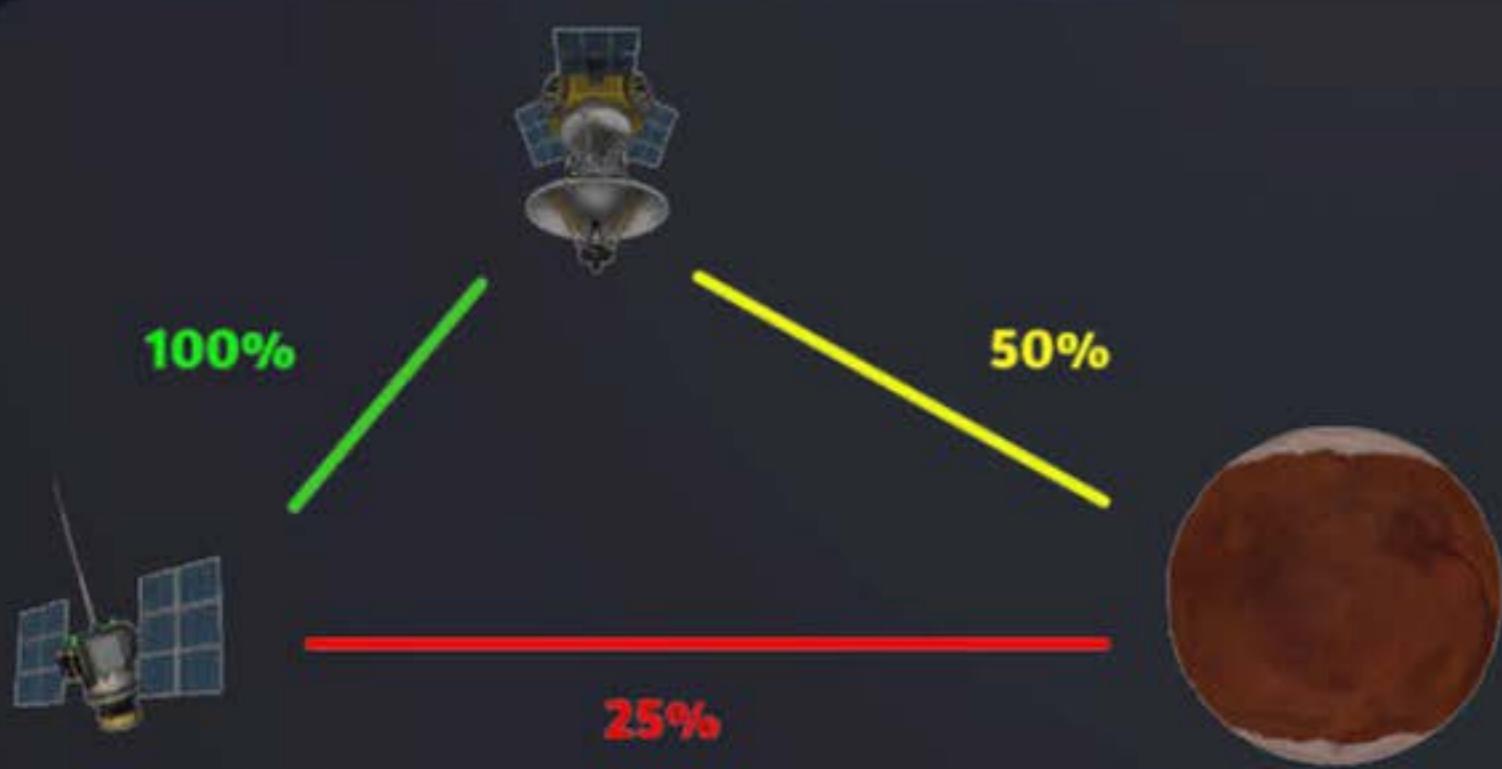
Occlusion

CommNet uses soft occlusion where signals are not cut off immediately when the destination goes over the horizon. In addition, atmospheric bodies allow bouncing the signal through the atmosphere, furthering the distance below the horizon a destination can be.

Relays

Sometimes, you are unable to get to a control point either due to extreme range, or because something is in the way (terrain, or another orbital body). Relay antennas allow a signal to be 'bounced' from a vessel, to a relay, then onto a control point or even another relay!

This can solve occlusion problems.



Or boost signal strength by having a low power antenna transmit via a high power relay.



Communications Network / CommNet / Range

Range

The maximum range at which two antennas can communicate is the square root of the product of their powers (the geometric mean). Antenna powers are divided into six classes, Class 0 through Class 5.

Class 0 antennas are the internal antennas on pod and probe cores; the other classes are standalone parts. The DSN also has three power levels, one for each Tracking Station level.

Most antennas can combine their power with each other on the same vessel. However, doing so has diminishing returns.

Effective Range Table

	Class 0	Class 1	Class 2	Class 3	Class 4	Class 5	Level1TS	Level2TS	Level3TS
Class 0	5Km	50Km	158Km	3.1Mm	8.6Mm	22.3Mm	3.1Mm	15.8Mm	35.4Mm
Class 1	50Km	500Km	1.58Mm	31.6Mm	86.6Mm	223Mm	31.6Mm	158Mm	354Mm
Class 2	158Km	1.58Mm	5Mm	100Mm	273Mm	707Mm	100Mm	500Mm	1.1Gm
Class 3	3.1Mm	31.6Mm	100Mm	2Gm	5.4Gm	14.1Gm	2Gm	10Gm	22.4Gm
Class 4	8.6Mm	86.6Mm	273Mm	5.4Gm	15Gm	38.7Gm	5.5Gm	27.4Gm	61.2Gm
Class 5	22.3Mm	223Mm	707Mm	14.1Gm	38.7Gm	100Gm	14.1Gm	70.7Gm	158Gm

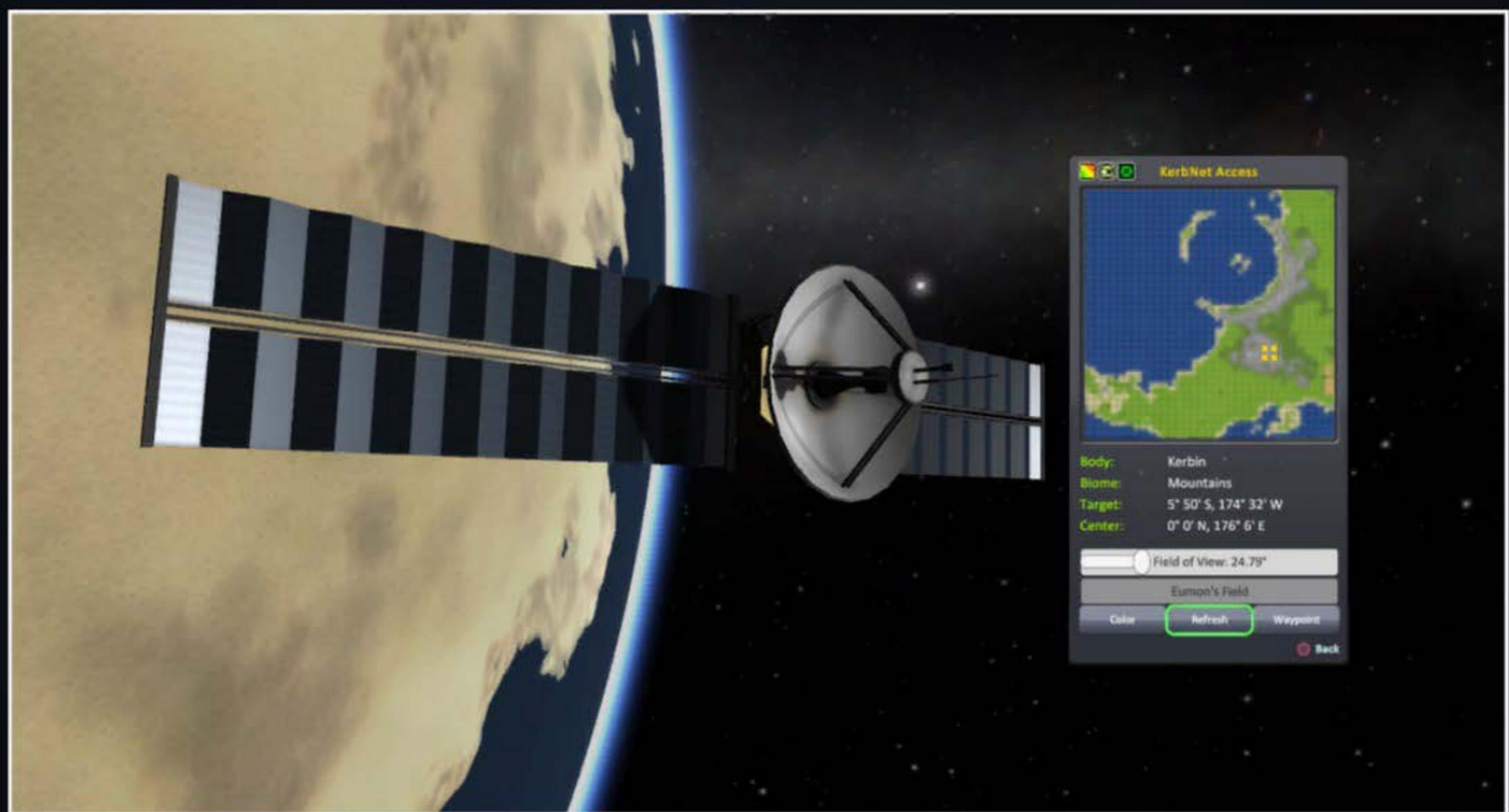


Communications Network / KerbNet

KerbNet

KerbNet is a network of information that allows your space program to link its sensors directly to Kerbin's scientific community. This in turn allows you to plan more efficient missions.

KerbNet is enabled on every probe core, as well as some more specialized parts. Each part has different capabilities which affect the detail and sort of data available. KerbNet requires a communications link with the Kerbal Space Center to access that data.

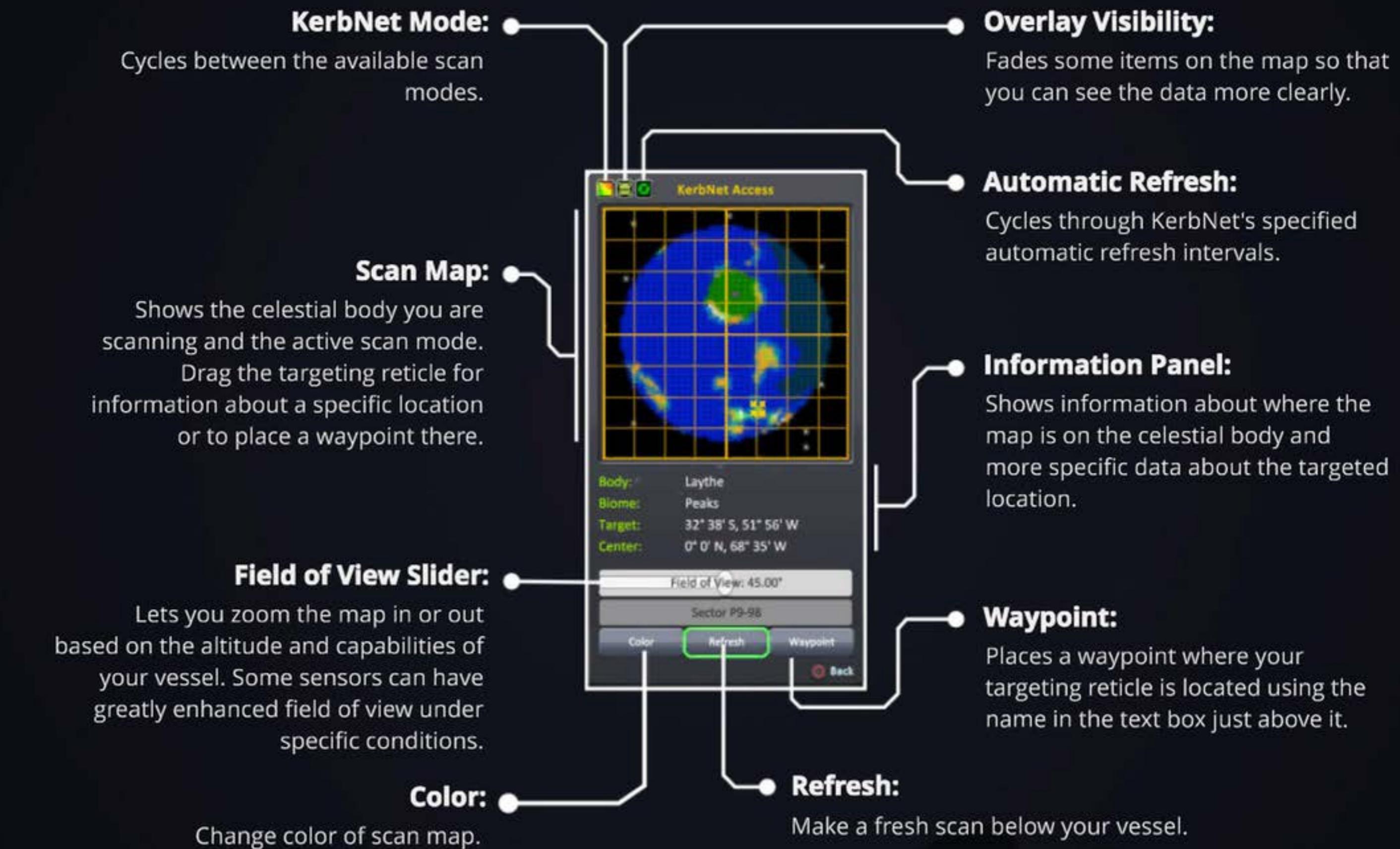


KerbNet Interface

NAV

CURSOR

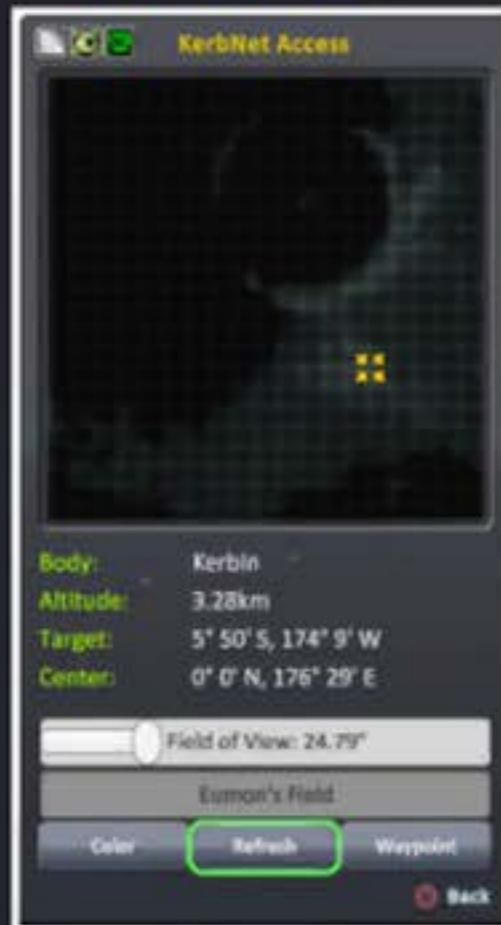
The interface to KerbNet is called up from the Action menu on KerbNet scanners.



Scanning Modes

KerbNet has three modes of operation -- depending on the scanner's capabilities.

Terrain Mode



Basic monochromatic scan of the terrain heights of the celestial body. Placing the targeting reticle will show you the height at any given location.

It is available on most KerbNet scanners and is useful for locating safe landing sites.

Biome Mode



Available on more advanced KerbNet scanners. It allows you to see a colorful biome map of the celestial body below you.

This allows you to optimize your hopping from biome to biome.

Resource Mode



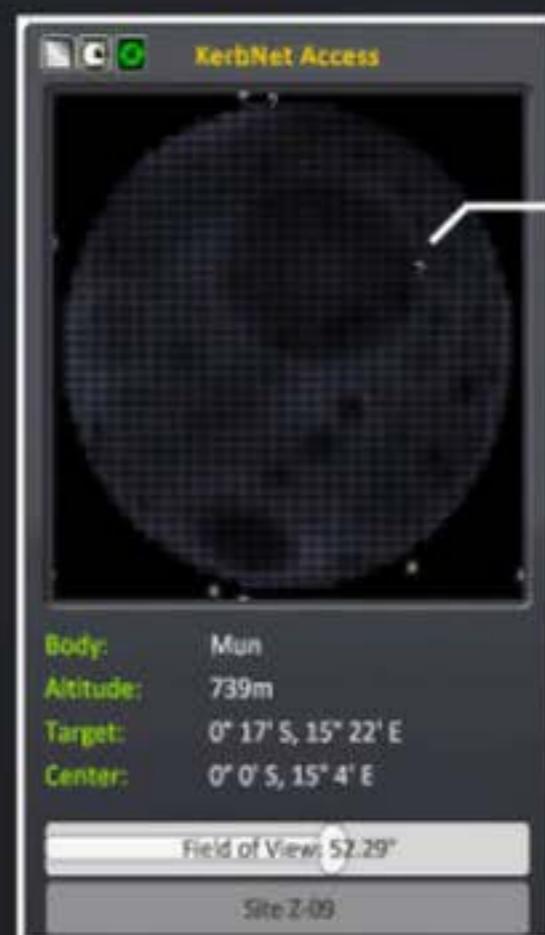
Available on highly specialized KerbNet scanners. It allows you to view detailed scans of the resource concentrations on a celestial body in contrasting color schemes.

This makes it much easier to decide where to set up your mining bases.

Waypoints

Every scan mode in KerbNet allows you to place custom named waypoints on the map by moving the targeting reticle to a location and clicking the waypoint button.

You can easily navigate to these waypoints by clicking them in map view.



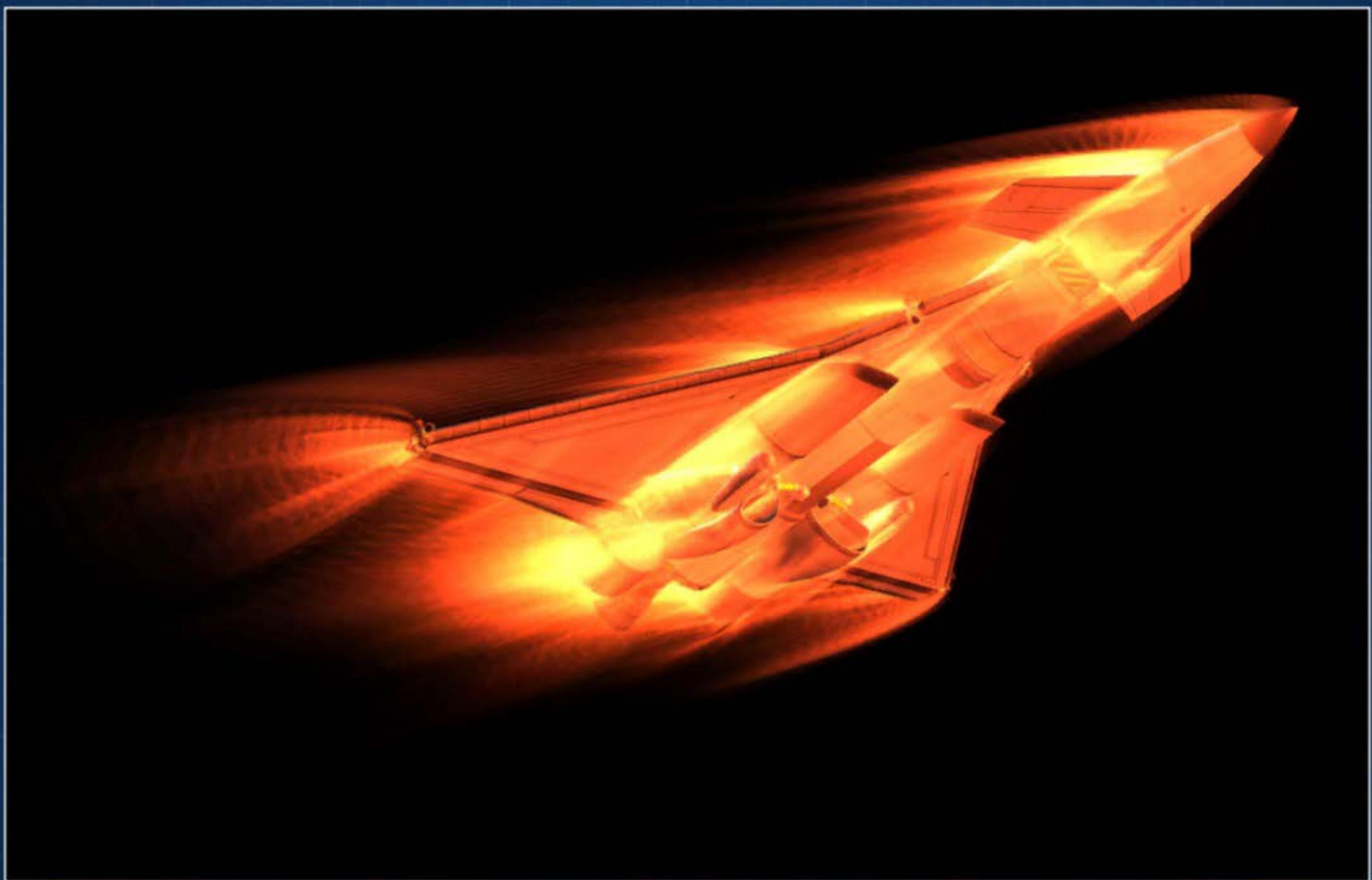
? Anomalies

Sometimes a scan will pick up something truly unexpected, and your scientists will mark this with a question mark.

These anomalous readings may disappear and reappear sporadically, so it is suggested that you tag them with a waypoint for future investigation.

It's Getting Hot in Here

It is inevitable that you will have to manage heat in your space program. Hopefully this info can help.



Parts and Heat

Heat management and thermal systems are quite complex topics, but as you are now an expert at orbital mechanics we will dive right in.

In the KSP thermal model these are the "basic" rules:

- Each part has connected internal and skin components;
- Connected parts have their individual components connected - ie. Skin<=>Skin and Internals<=>Internals
- Heat "flows" between connected components to equalize temperature over time - this is via conduction;
- Via radiation and convection heat "flows" between the skin and environment (atmosphere / space);
- The sun and planetary bodies emit radiation that heat the skin of a vessel;

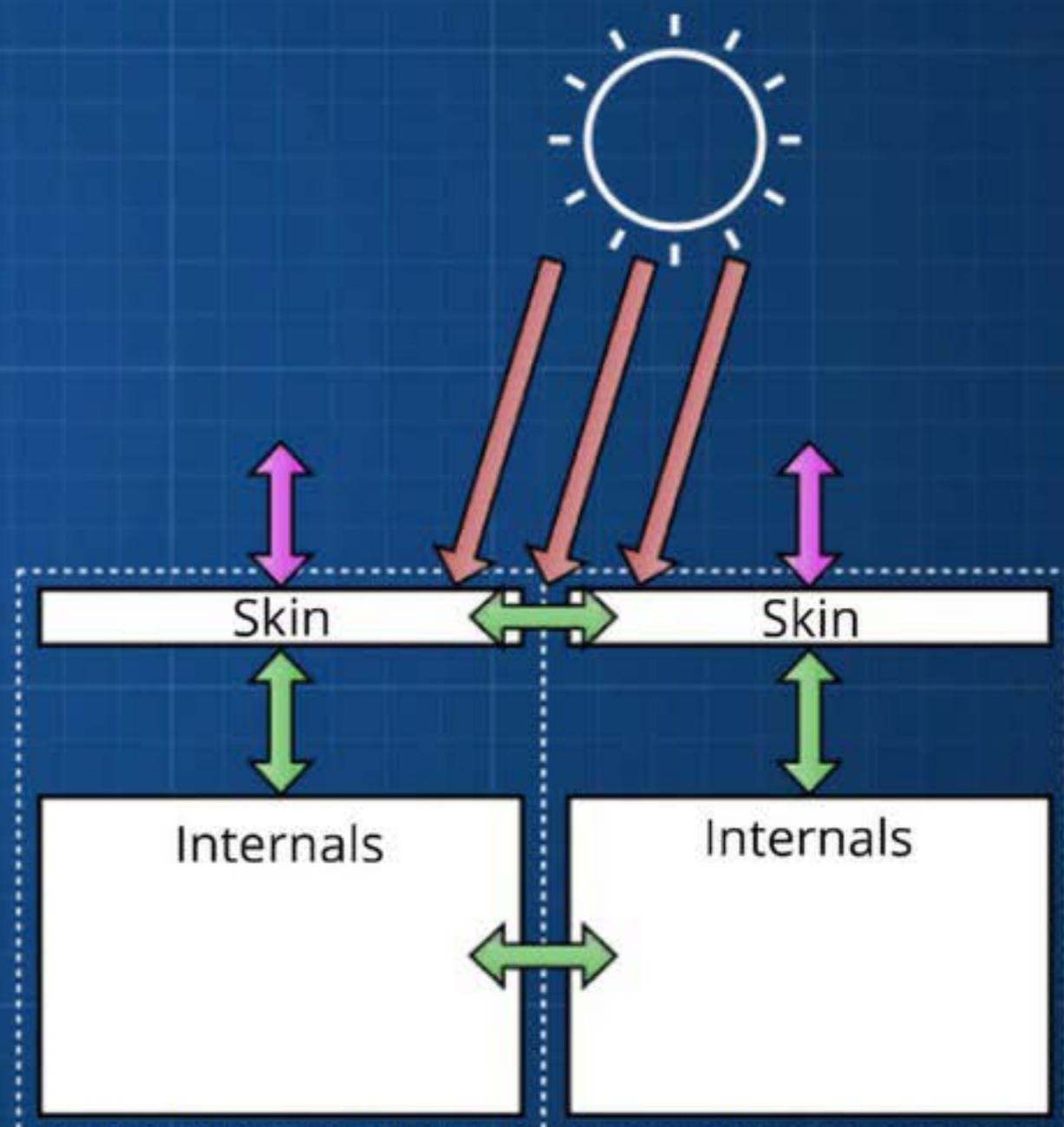
Heat Flow Diagram

This diagram shows you how these rules apply with the simplest of vessels -- two connected parts.

The following screens will cover specific part types, and finally an entire vessel to give you a chance to see it all in action.

Heat Flow Symbols

- Part to Part
- Part to Environment
- Heat Injection



Note: The flow of heat is not instantaneous. The transfer of energy happens over time.

Engines and Heat Sources

While the sun and planetary radiation will heat your vessel, parts on your craft will generally be of much greater concern.

Engines will be used for the main example here, although there are other parts that generate heat too e.g. RTGs.

Engines consume resources and convert that to thrust, with a lot of heat generated in the process. Most of that heat leaves the vessel as exhaust, so we don't have to worry about that, but some of it does "soak" into the engine part itself.

Heat Flow Symbols

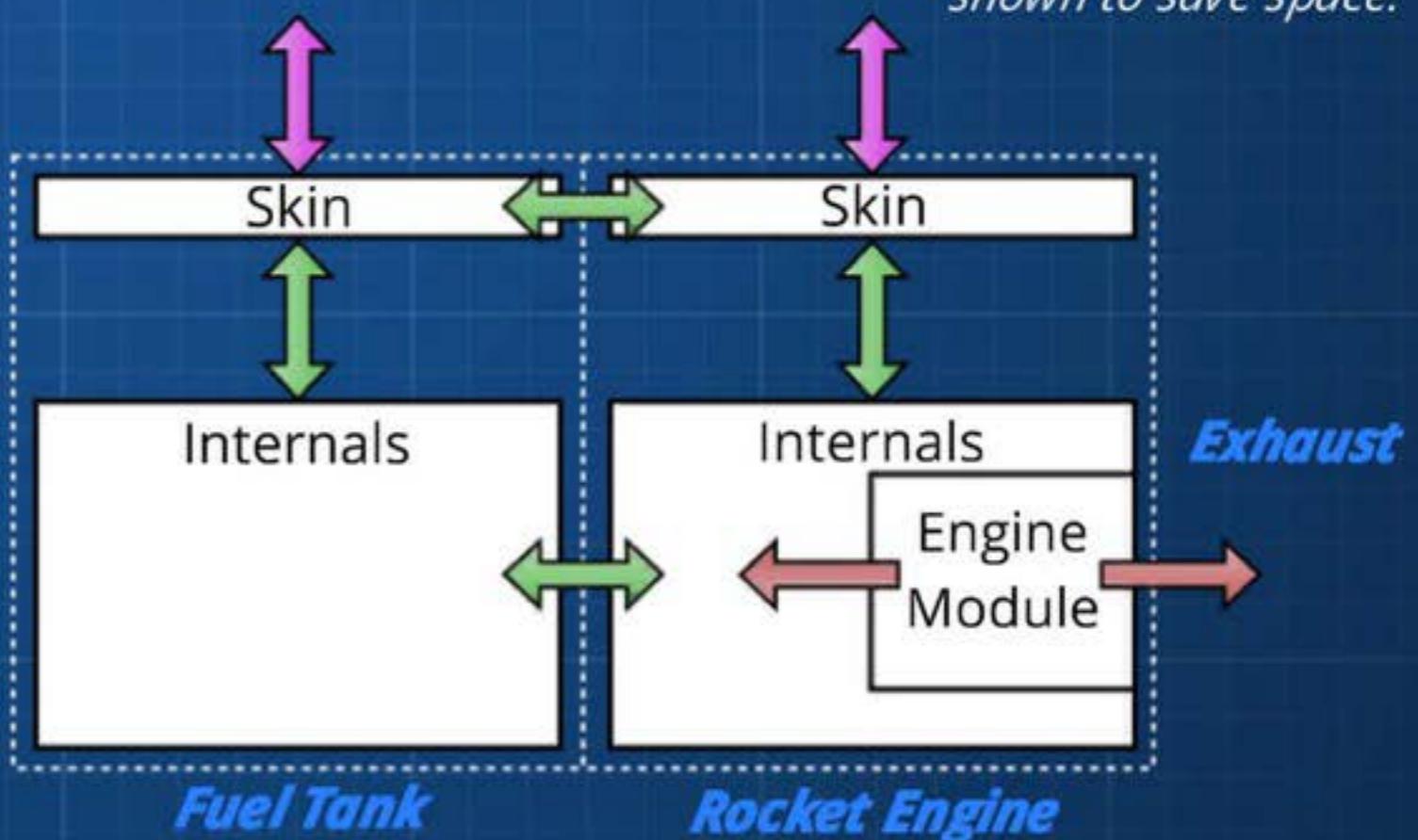
- Part to Part
- Part to Environment
- Heat Injection

The Flow From Engines

It can be helpful to think of the heat production being a module inside the internals (like the combustion chamber).

The exhaust takes a lot of heat away, but some of it soaks into the part as well.

* Body radiation not shown to save space.



Note: The flow of heat is not instantaneous. The transfer of energy happens over time.

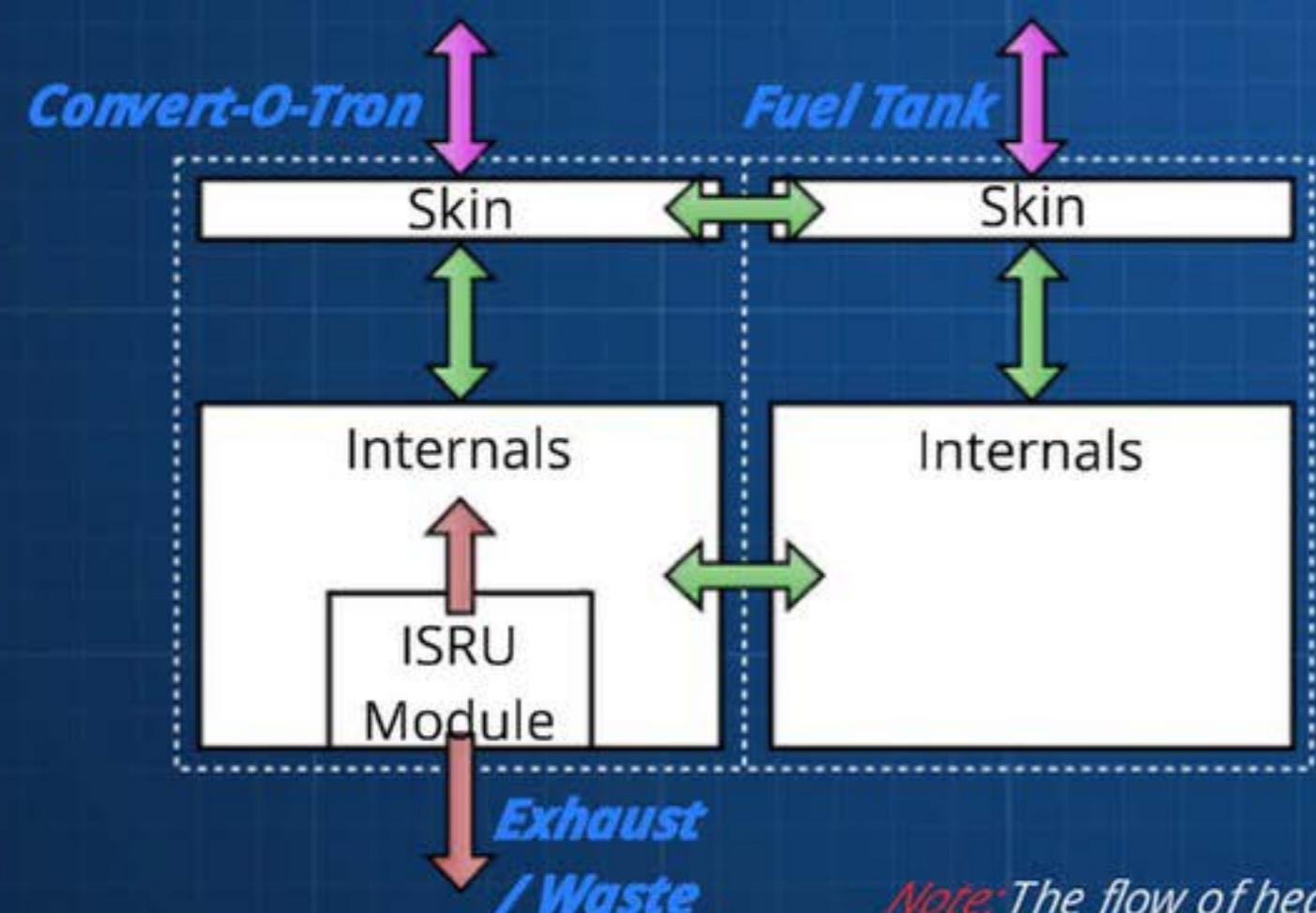
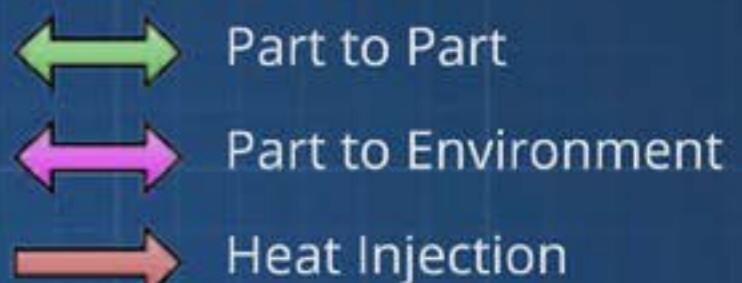
Parts With Core Heat

There is another type of heat generating part. Some parts have a core component which has another important function (for example drills and ISRU converters).

Using the ISRU as an example you can think of the core as the furnace that melts down Ore to produces resources. This process has three important thermal points:

- The core has an optimum temperature, with inadequate cooling it will overheat (and be less efficient);
- The process discards a lot of the thermal energy through exhaust directly to the environment (for drills you can think of this as the tailings of the drilling process);
- Some of the heat does "soak" into the internal component of the part;

Heat Flow Symbols



Getting to the Core of It

To keep the core from overheating you will need radiators as the part soak is simply not enough to prevent an issue.

Luckily, that's what's next.

** Body radiation not shown to save space.*

Note: The flow of heat is not instantaneous. The transfer of energy happens over time.

Getting Rid of Some Heat

There will be plenty of times when you need to cool your vessel down. That is where radiators can help.



What Are "Nearby" Parts?

Radiator panels draw heat from the part they are attached to, as well as any part attached to that one.

You can think of it as the radiator's parent part, plus one more hop (or parent + 1).

Heat Flow Symbols

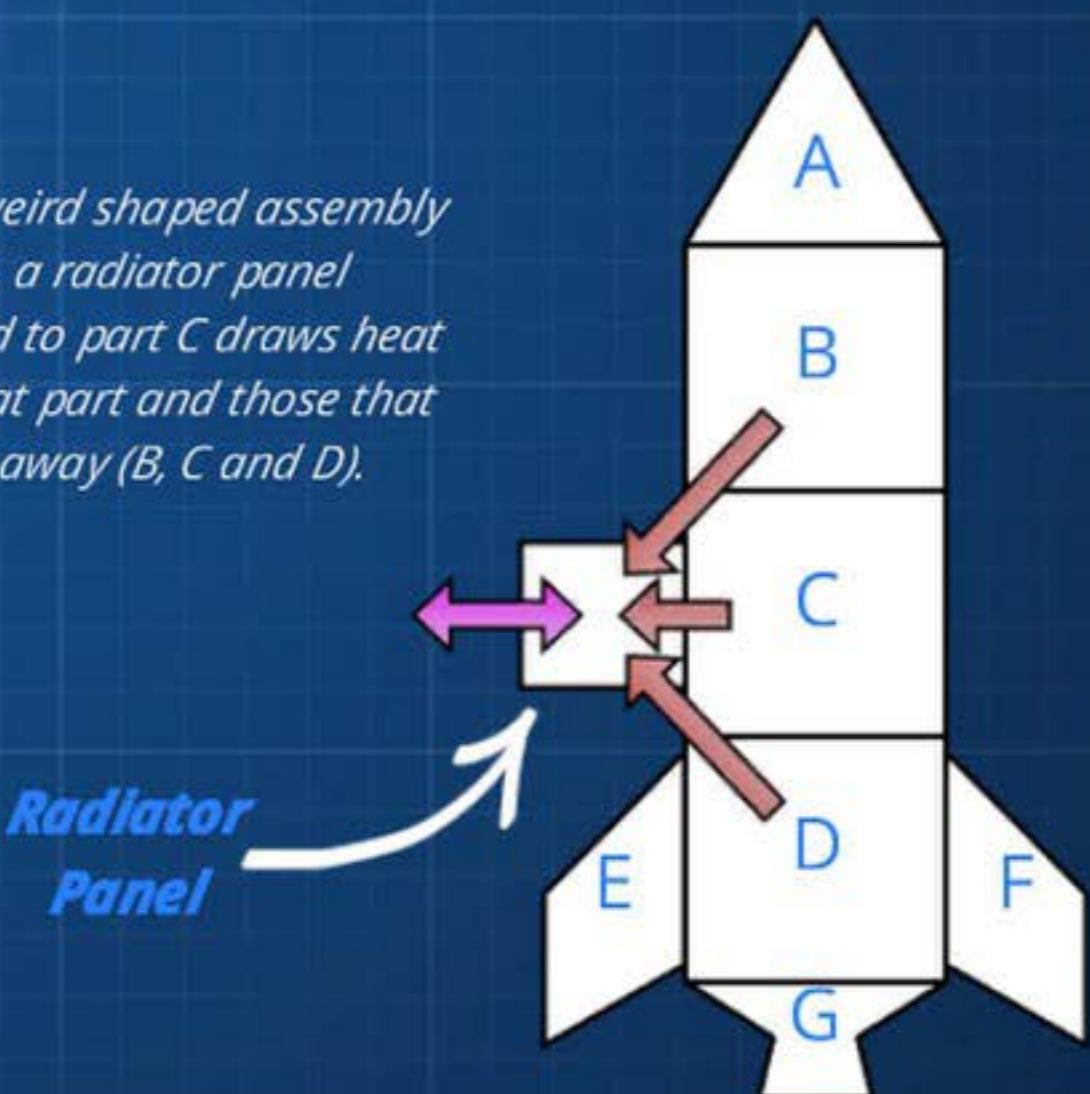
- ↔ Part to Part
- ↔ Part to Environment
- Heat Injection

Radiator Panels

Coming in surface and edge attached models, these devices pump heat away from nearby parts, as well as nearby core modules.

They do this through conduction and using their large surface area to radiate the heat into space.

In this weird shaped assembly of parts, a radiator panel attached to part C draws heat from that part and those that are one away (B, D and E).



Getting Rid of Some Heat (continued)

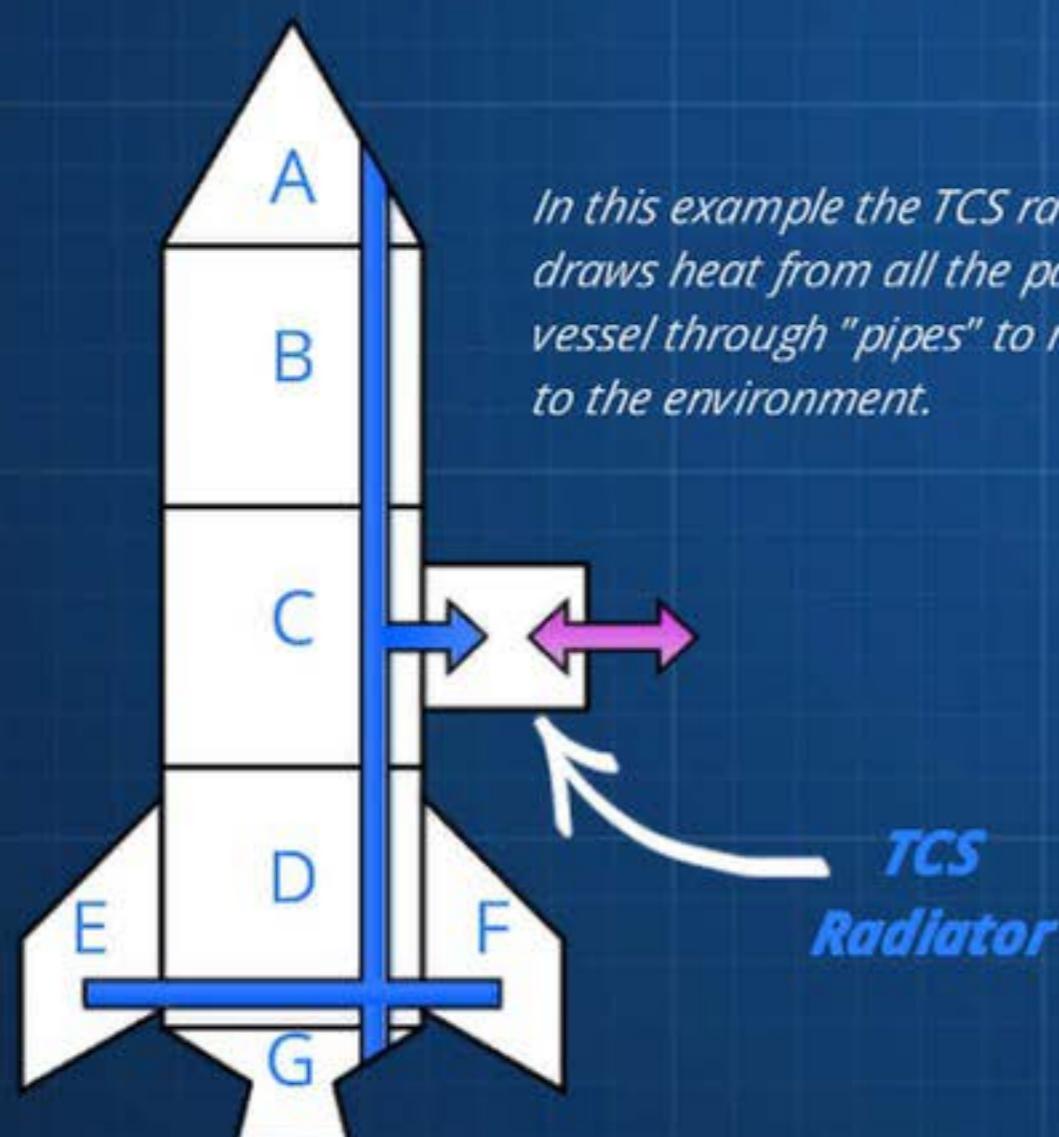
Thermal Control Systems

These parts pump liquid throughout the entire vessel to draw heat to the panels.

They, like the radiator panels, pump heat from both parts and core modules, but do not have the same "nearby" parts limitation.

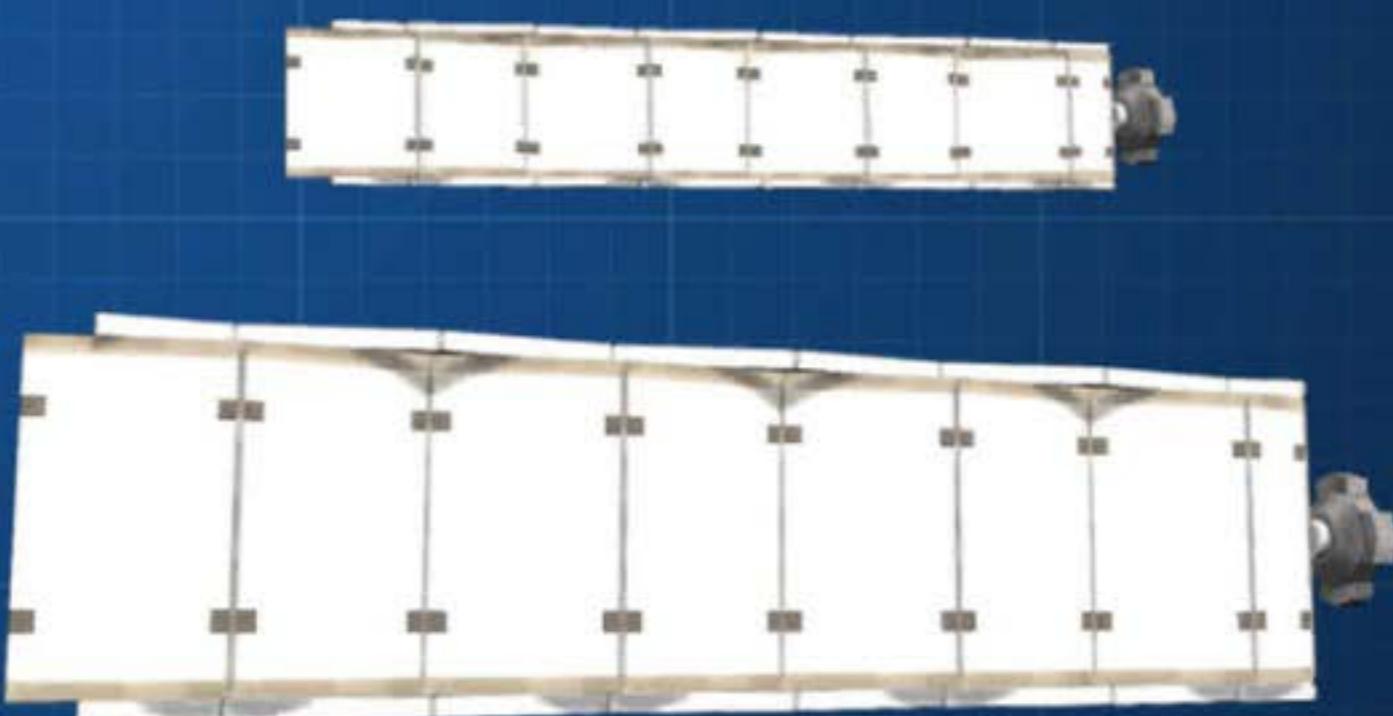
Heat Flow Symbols

- Part to Part
- Part to Environment
- Heat Injection
- Pipes



In this example the TCS radiator draws heat from all the parts in the vessel through "pipes" to radiate it to the environment.

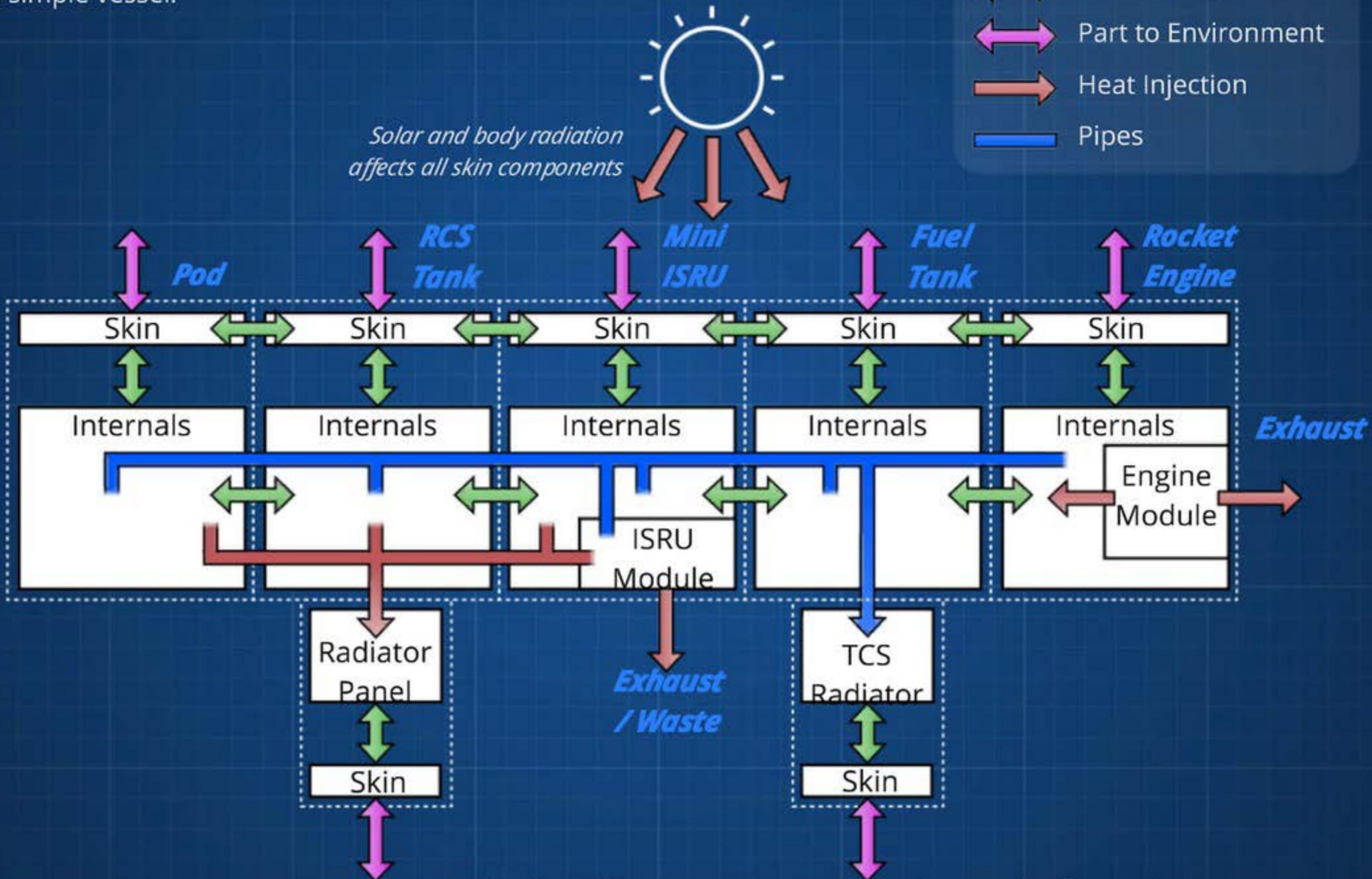
Both types of radiators require EC to run the pumps, but thermal control systems are deployable parts, so you also need some EC to extend them.



Note: Largest size TCS is simply too big to show here.

Feeling the Flow

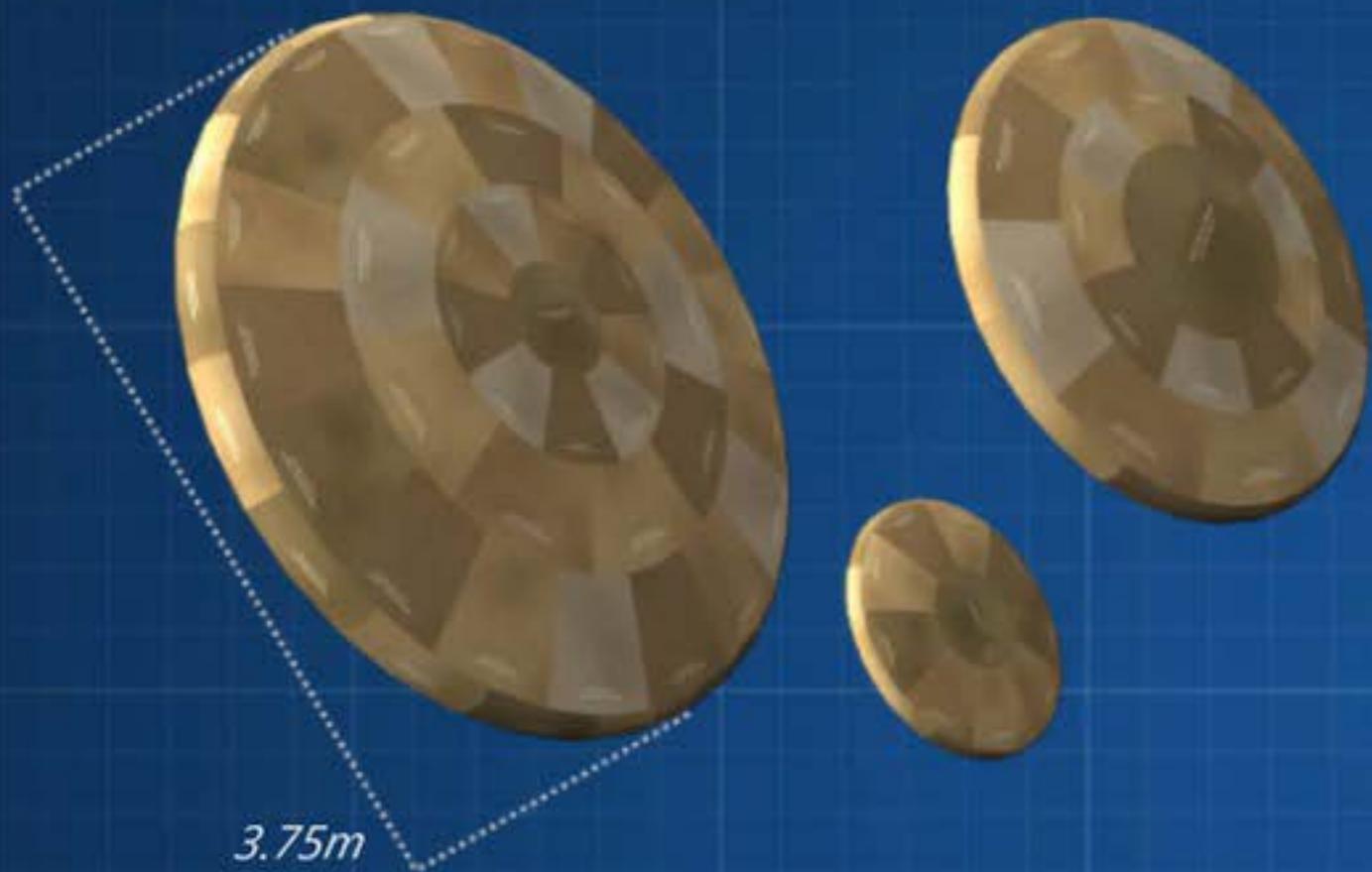
The diagram below shows how all these systems come together in a simple vessel.



Note: The flow of heat is not instantaneous. The transfer of energy happens over time.

Protection During Reentry

If a vessel is entering an atmosphere at high speed, reentry will generate a lot of heat. This heat can be "absorbed" by a heat shield that will burn off Ablator to keep the craft cool.



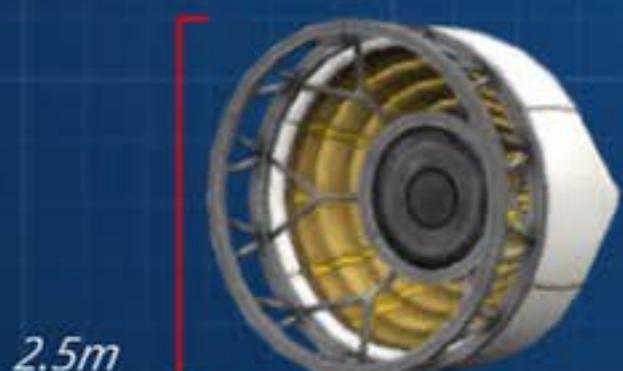
Solid Heat Shields

Available in all three sizes these heavy shields are versatile parts for protection during reentry.

Do keep in mind that their mass means you may need drogue chutes on your vessel.

Inflatable Shield

This part is deceptively small when deflated. Once deployed however, it can protect a large vessel from behind the mammoth 10m shield diameter.



Your KSP Career

The career mode of Kerbal Space Program adds some directed play to the game. It's mostly procedurally generated, so it will not be the same on each playthrough.

The goal of career mode is to build your space program from its fledgling roots to an epic undertaking that reaches the limits of the solar system. Seeing a fully advanced KSC with kerbals orbiting or walking on planets throughout the system is an amazing reward.

It adds making decisions about contracts, crew assignments, strategies and a number of other activities, to your already busy job of building and flying missions.

So let's look at some of the details.



Facilities

As your career progresses you will find that you've outgrown your original Space Center. Luckily the Kerbal Engineering department has your back, and through judicious application of Funds you can upgrade each of the facilities from basic to world class.



Basic R&D

+ =



Awesome R&D

Facility Damage

Whether by errant trajectory, decoupler issues or even nefarious circumstance you may find that you've damaged one of the facilities at the Space Center.

You can recover from these issues by repairing the facility (at a cost of course).



Result on Launchpad of misguided SRB disposal



Currencies

Throughout your career there are three currencies to keep an eye on.

Funds

Your Funds pay for vessel builds, hire astronauts, upgrade/repair facilities and on harder difficulties even buy parts as you research. Having enough to keep up with your planned missions is critical.

Recovering vessels on Kerbin will net you some handy salvage funds (the closer to the KSC you land the more return you get), but your main source of Funds are contracts.

Reputation

Reputation is earned through the successful completion of contracts. The better your reputation the better (and more rewarding) the contracts you will be offered.

Reputation can be traded for other currencies via strategies, as well as being lost if kerbals go missing, so don't ignore it.

Science

Some would say Science is the whole reason for any space program. Completing experiments and extending your kerbals' reach into space are the primary ways to generate Science.

This is used to unlock new technology and parts, to build on successes and get further afield.



Your Staff

The whole of kerbal society is knocking at the door to be involved in your Space Program. With the seemingly endless list of applicants you will find that there are three areas (or roles) that kerbals specialize in.



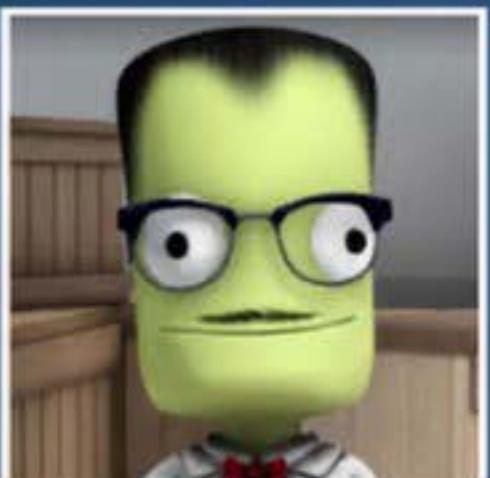
Pilots

Sometimes thought of as the rockstars of space exploration, pilots are focused on ship control and get better as they experience more situations.



Engineers

These kerbals are mechanical wunderkind. They can repair a number of broken parts, as well as increase the efficiency of drilling operations. They all strive to attain status like their hero MacGyver Kerman.



Scientists

The brainiacs of kerbal society. These guys and girls spend their time unravelling the universe (we just hope they get it put back together by dinner-time). When situated in a mobile processing lab they can increase the science earned significantly.



Kerbal Experience

As your kerbals get out and explore they will experience new and exciting situations. These translate to increases in each kerbal's experience level and can increase their skill levels.

Each kerbal gains experience from flybys, orbiting, flight, landing and planting flags on planets. The further from home they are, the more experience they will gain for each, but do note they only get XP for the first time they complete one of these around each planet.

Experience and Levels

Once a kerbal's total XP reaches the below values they will advance in levels:

Total XP	0	2	8	16	32	64
Level	0	1	2	3	4	5

Levels and Roles

Kerbals gain skills based on their role and level. The skills add up as your kerbals advance:

Level	Pilots	Engineers	Scientists
0	S.A.S. and Stability	None	EVA Interact with Experiments
1	Prograde/Retrograde	Repack Chutes	5x Lab Research
2	Normal/Anti-Normal	Repair Lander Legs	9x Lab Research
3	Target and Maneuver	Repair Wheels	13x Lab Research
4			17x Lab Research
5			21x Lab Research

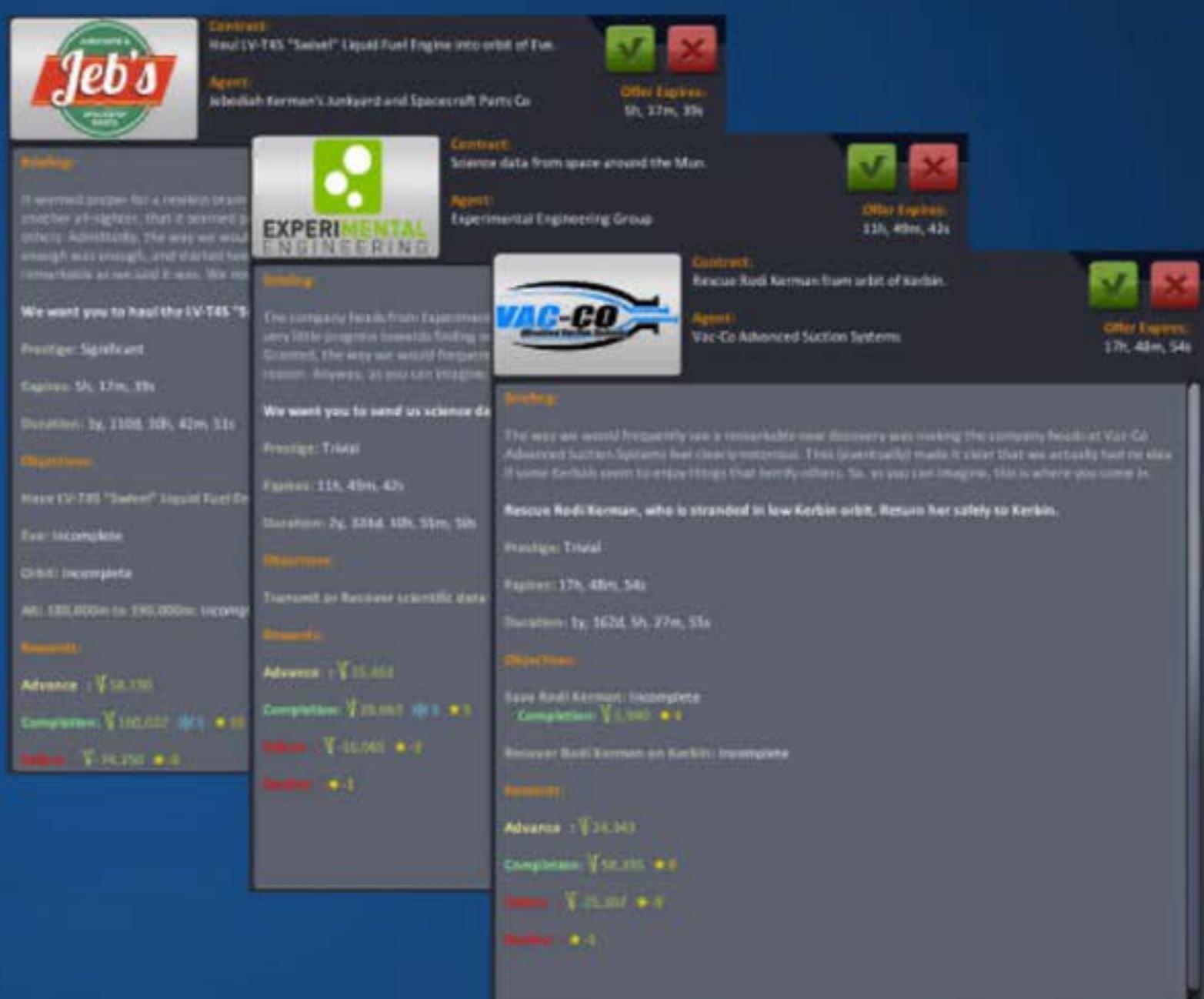
Note: Near death experience is unrelated to this topic, but a likely occurrence in a kerbal's lifetime.

Working for The Man

To advance your career you will need to take on contracts from the various companies based on Kerbin. The rewards, goals and timelines for these will vary depending on your reach into the system and your reputation.

You will sometimes be offered contracts related to vessels or kerbals you have out there too, so keep an eye out for opportunities.

Be aware that turning down (or failing) contracts will cost you in Reputation and sometimes even Funds and Science.



World-Firsts Record Keeping Society

This society of kerbal philanthropists is interested in the advancement of space exploration. They reward space programs for doing things that have never been done before.* Through this group you may find yourself getting unexpected rewards.

*Note: Must be space program related.

Advancing Technology

The core of any space program (aside from the actual space part of course) is in the research and development of technology to advance exploration. You do this through the application of Science points in the R&D facility.



The Tech Tree

This blueprint represents the master plan of the R&D department to discover everything.*

Each node represents an area for growth and completing this research will unlock the parts related to that area.

Looking Into the Future

It is important when you are looking at the tech tree, and what to research, that you look at future branches too. If you are trying to build a rover, but don't research areas that lead to wheels, it's gonna be a bumpy ride "rolling" on structural girders.

*Note: Must be space program related.

Applying Some Strategy

In the administration building you will find representatives for some KSC departments who will help you to alter how Funds, Reputation and Science are spent or earned.

Strategies come in two flavors, but all have a setup cost and allow you to adjust the commitment to tweak the return on your investment.



Conversion Strategies

These strategies trade off one currency for another over the long term, by affecting costs and reward returns.

You will pay an initial setup cost based on the commitment you are making, and will see costs and rewards adjust from then on as you play.

Immediate Strategies

These strategies are conversions of one currency to another on the spot. The setup cost is really what it will cost you to get the reward, and they take effect immediately.

Science and Space

The scientific method is an all consuming passion for many kerbals, and luckily also a key to unlocking many technological advances for spaceflight.

An important function of your space program is to see how you can advance science and technology for Kerbalkind.

Science Points

Science points (or Science) are needed to research technology areas and unlock their related parts. These points are generated primarily through experiment and observation throughout the solar system.

You will also get some for passing milestones and completing some types of contracts.



The Subject of Science

When performing science activities it is key to understand the location for the activity. These involve where you are - planet/biome - and what you're doing - flying, orbiting, landed, etc.

This combination of situation, planet and biome is the subject of an experiment - eg. landed at Minmus flats.



Wernher von Kerman

Experimenting for Profit

The most obvious way to generate Science is through activities. At its simplest this involves observations by the crew (crew or EVA reports), and works its way up through performing experiments all the way to processing data in a lab.



Crew/EVA Reports

A simple action the crew perform as required. Once you have done these you will rarely get any reward for repeating them with the same subject.

Experiment Reports

These involve the use of science parts to perform experiments. These tend to generate more data, but you do need to keep the subject in mind.

For example you won't get any seismology readings if your vessel is in space.



Turning Data into Science

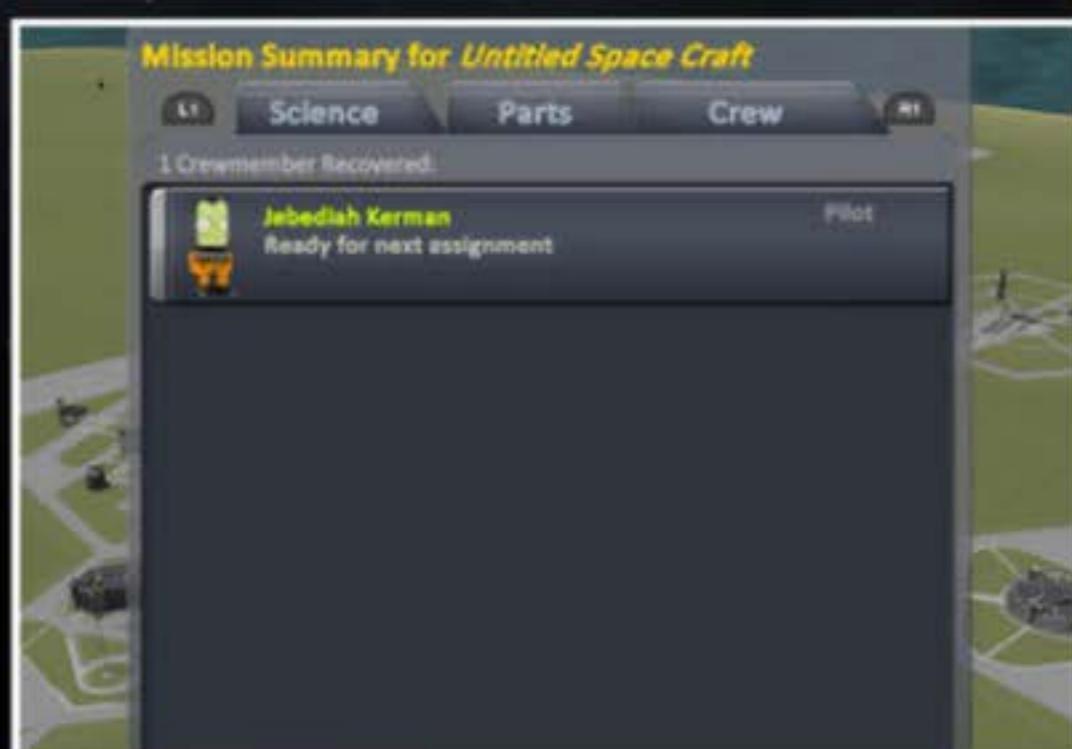
When you perform activities a report with the data is generated.

The primary method to extract the Science from that data, and advance kerbal knowledge, is to get the data back to Kerbin.

You can see all the options for the report in the result window.



Note: The recovery and transmit bars that show the amount of total Science possible, and amount this report will earn.



Bring It Back to Kerbin

By choosing "Keep Experiment" the report will be stored to be recovered with the kerbal or vessel on Kerbin's surface.

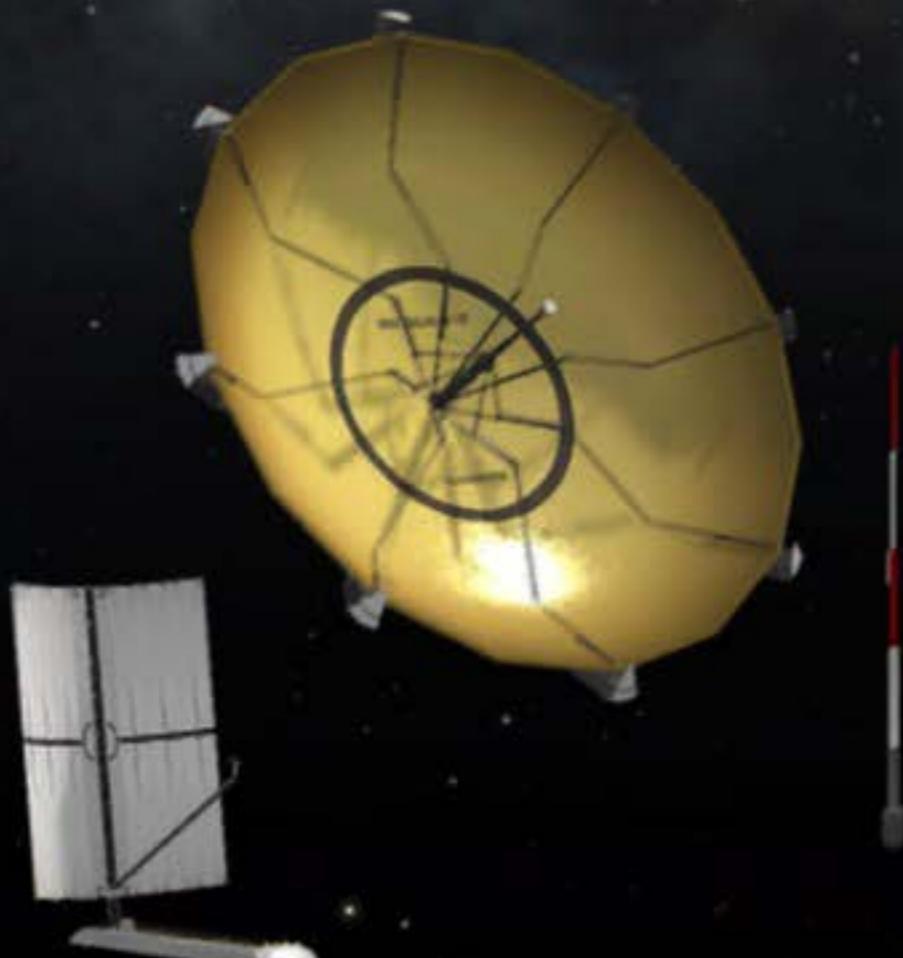
This usually nets you the best Science return, and is the only way to extract all the possible Science from any experiment and subject combination.

Phoning It In - Remote Data

Another way to get the data back to Kerbin is by transmitting it.

Transmitting the report means you will get Science without having to fly all the way home, but you will only get a percentage of the recovery value.

Another downside is that no matter how many times you transmit the same experiment/subject combo you cannot extract all the possible science.



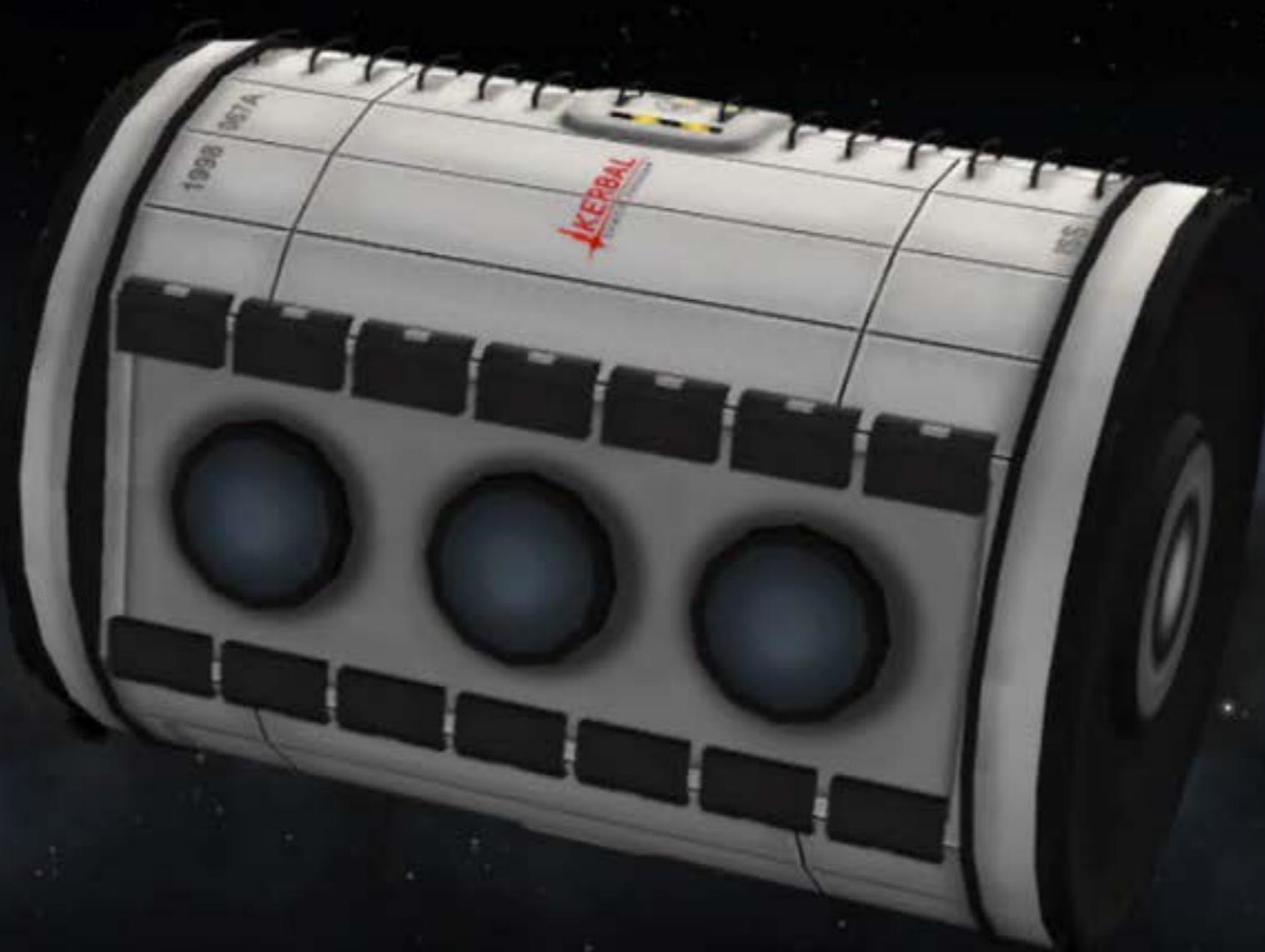
Transmission Options

To transmit the report you will need a communications antenna and enough EC to send the data. If you do not have enough EC to send the data in one go then you can choose to receive diminished returns (via the "Allow Partial" mode) or have the report returned and try again ("Require Complete" mode - this is the default).

As usual there are a range of parts, and these have varied capabilities regarding data throughput and EC required.

Processing Data in Situ

One other way to use the data you generate is with the MPL-LG-2 Mobile Processing Lab. This behemoth of a part is something you will have to work up to in career, but the benefits can be substantial.



You can process your reports in the lab if there are scientists aboard your vessel. They will slowly process the data into Science points (using lots of EC), before returning the report to you so you can deliver it to Kerbin. The number and level of the scientists aboard affects how quickly the report data is converted into Science.

Another added side-effect is that the lab can "clean" Goo and Science Jr modules so they can be reused after their data has been extracted.

Resources

The solar system is rich in many things, one of which is Ore.

This versatile resource can be mined and converted to a number of useful substances.

Whether you are setting up a refuelling station for inter-planetary travel, or just system hopping with a mini converter to top up your fuel tanks, this section should have some useful information for you.



Finding Your Ore

You will find Ore in two different environments - on planets and within asteroids - let's start with planetary mining. Finding a good place to mine is all about gathering intel. To do this there are three scanner components to help find a good spot for mining.

The Orbital Scanner

To get an overall view of a planet's Ore concentration levels, position a vessel in polar orbit and then run a scan with the M700 Survey Scanner. This will allow you to enable an overlay of the planet with Ore information.



Getting Ore Specific

Now that you have some idea of where the Ore hotspots are, what's next?

The Narrow Band Scanner

This scanner is used to get a hi-res view of the planet's surface, directly under the vessel. This can be used after an orbital scan to give more detail about Ore concentrations.



There's a mass of information and options here to help find the best place to land and drill.



The Surface Scanner

Once touched down, this scanner is used to "ground truth" the planet, and improve the results from orbital scans.



Note: You do not have to complete an orbital scan before using the surface scanner.

Ore on Asteroids

Every asteroid in the solar system has some amount of Ore in it. Generally speaking, the larger the asteroid, the more Ore there is.



Discovering the amount of Ore is a little bit more challenging though.

You can only detect the amount of Ore an asteroid contains by getting up close to it, and then checking its properties.

This means you have to rendezvous, before you know just how much Ore there might be.

The Effect of Mining

One point of note when you drill Ore from an asteroid, it does reduce the mass of the asteroid. The Ore extracted adds mass to the mining vessel, so unless you discard the Ore after drilling you will have quite a heavy vessel.

Mining for Ore

To get the Ore out of the ground you will need to drill! Drills are Electric Charge (EC) hungry devices that extract Ore while generating lots of heat. This means that drilling requires a bit of thought and management.

Kerbal engineers have developed two sizes of drill for you to use.



Major Drill

Made for long-term mining operations to extract every last bit of Ore, perhaps as part of a refuelling station.



Mini Drill

This is perfect for short hopping missions where you want to touch down, extract some Ore and move on.

Do keep in mind you have to drill in the right place, this drill has a 2.5% minimum concentration restriction.

Storage and Conversion

Ore is a chemical rich substance that has many uses. The drills extract Ore and you are going to need somewhere to put it after it's extracted.

Ore Storage

There are a range of storage options for the extracted Ore.



Ore Conversion

The kerbal version of the easy-bake oven. This converter melts down Ore and produces LF, OX, MP or a combination of these depending on the chosen recipe.



Like the drill there are two versions of the "Convert-O-Tron."

Resource Conversion Management

Due to mining and conversion being long running processes, keeping resources flowing involves some strategic thinking. It is never fun to come back and find out nothing happened in the last year. Here are some things to keep in mind:

Core Heat

Managing the core heat of these parts is key to a long running operation. If the core heat cannot be maintained then efficiency suffers. Optimal core heat is:

Drills: 500K

Converters: 1000K

Part Heat

All that heat is going to go somewhere, usually throughout your vessel. It's likely you will need to have a number of radiators on the vessel to manage heat.

Capacity

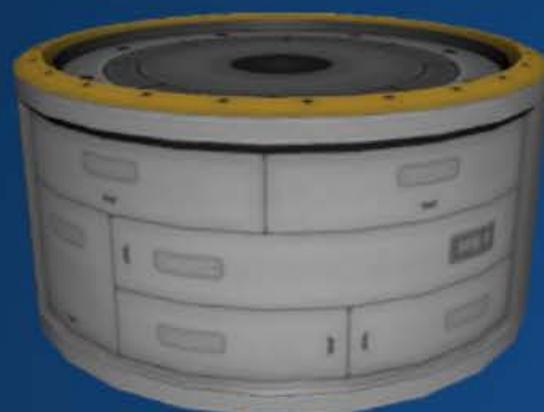
When extracting Ore, or converting it to other resources, you must have room to store the end product. If you are mining and converting then that means thinking about storing two resources.

Electric Charge

These processes are very hungry for EC, so you need some good EC sources (solar or fuel cells maybe) to back them.

Deployed Science Experiments

The amount of data an experiment generates per hour/impact is increased when deployed by a scientist, especially an experienced one



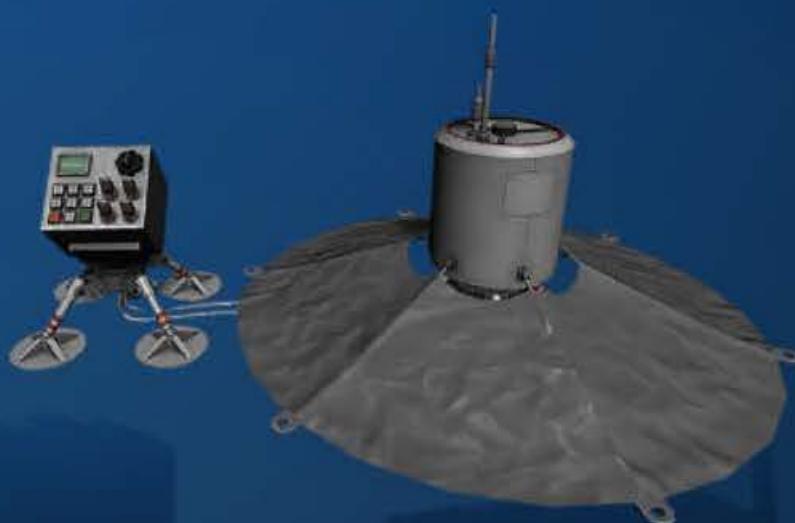
Extended Duration Experiments

Experiments like the Weather Station, Ion Detector and Mystery Goo Observation Unit collect data over time once deployed, powered and connected to a Control Station.



The Passive Seismometer

This special experiment collects data from planetary impacts. The amount of data depends on the size and speed of the object crashing into the surface and its distance from the seismometer - closer is better, up to a point.





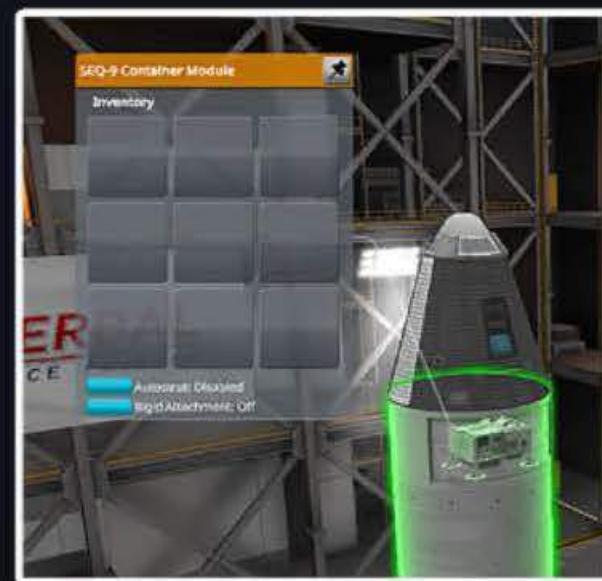
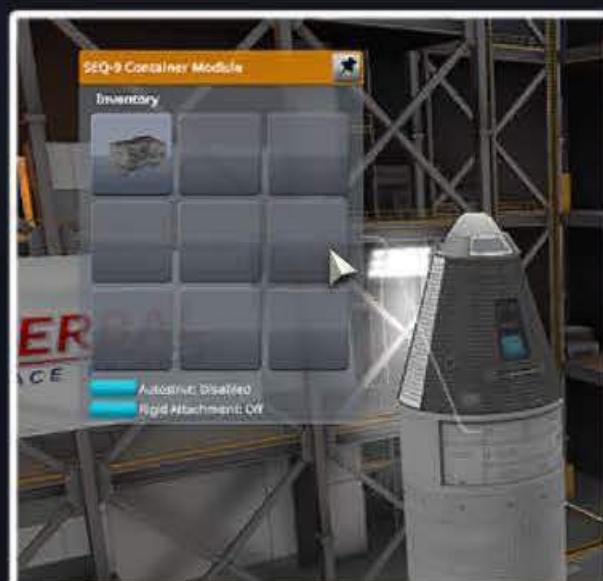
Cargo System - VAB/SPH

Spacecraft can carry cargo in special design cargo modules.



When building a craft, access the Cargo tab to see parts that can be placed into one of these cargo modules.

You can drag a cargo item from the build menu to a container/storage unit to add it to the inventory, or put it in its opened menu.



Cargo System - Placeable parts



Taking The Part

A Kerbal on EVA can get parts from a cargo container via the part menu. The kerbal has to be up close to the container part to be able to transfer the part to its own inventory.



Deploying

Once in the Kerbal's inventory, you can click the place button on the inventory panel to begin placing it. Follow the on-screen directions to rotate the part & deploy it.

Surface Features - Overview

Surface Features are objects that can be found scattered around on planets and moons and studied by a rover arm or picked up by Kerbals. Surface Features can be examined in two ways.

Small Surface Features can be picked up and returned for analysis.



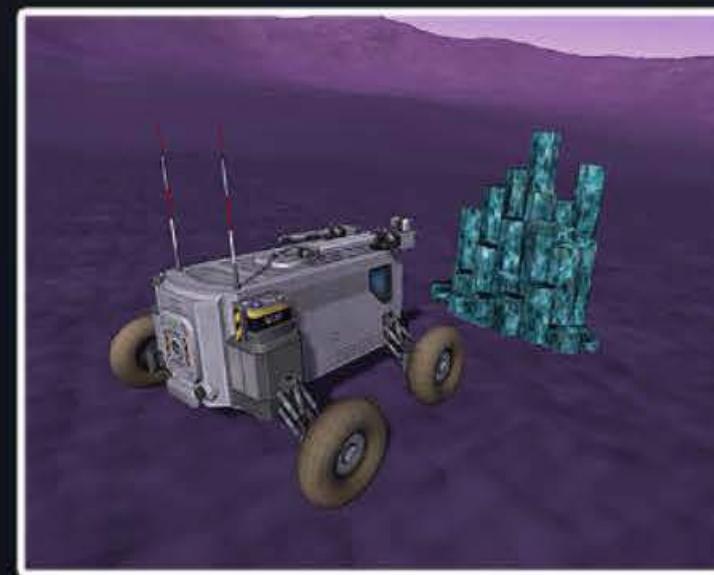
All Surface Features, especially larger ones, can be studied by a new instrument: the Rover Arm.





Surface Features - Rover Arm Details

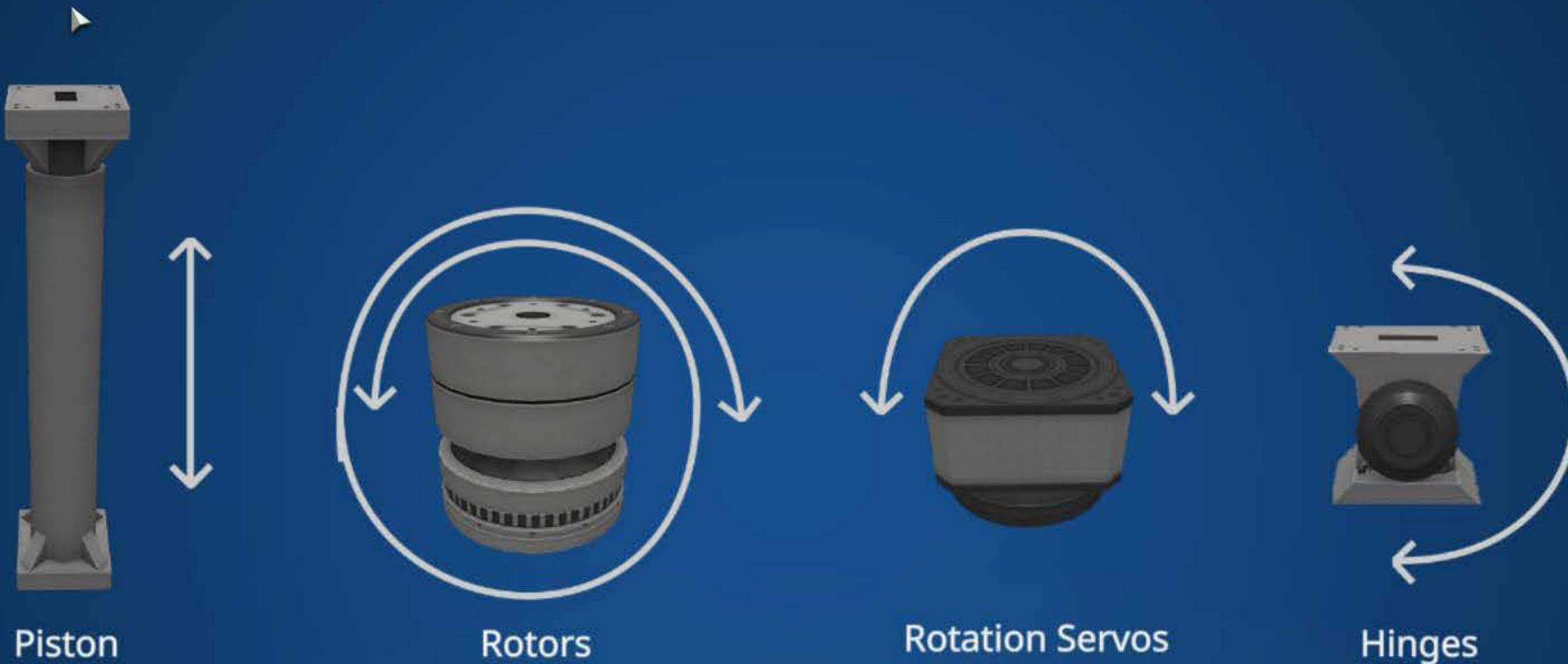
The rover arms are a new type of science equipment for studying Surface Features. They are also new to KSP - they're the first experiment with levels. Larger rover arms can collect more data than the smaller type, but they are not separate experiments. Therefore once you've scanned a Surface Feature with the best arm, you do not need to revisit it with a smaller one.



Make sure to park your rover nearby and stay still while performing a scan.

Robotic Parts

Robotics are a set of moving parts for building & controlling craft with complex moving pieces.

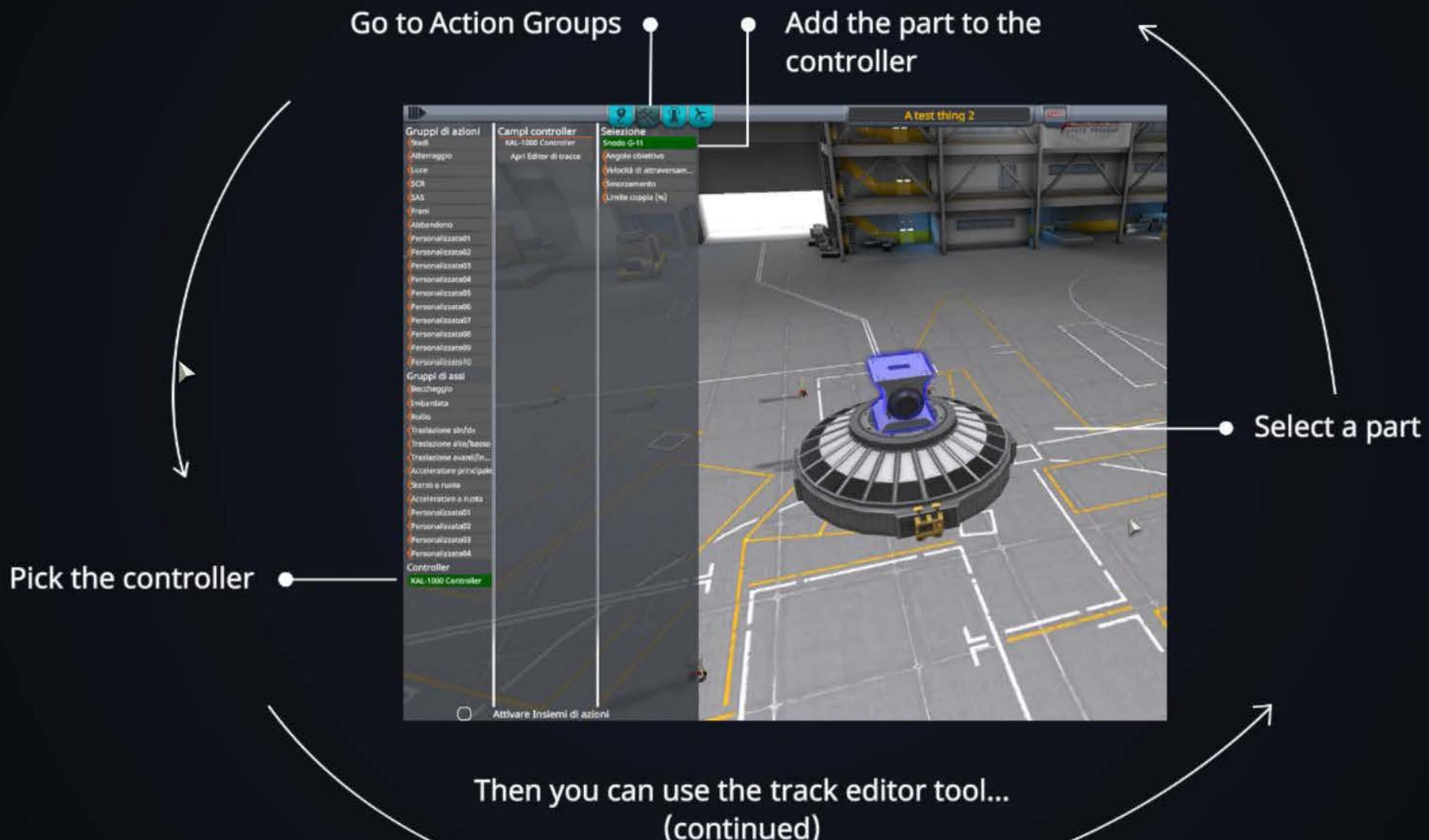


Robotic Controller:
For advanced roboticists who
want to coordinate robotic parts



Robotic Controller

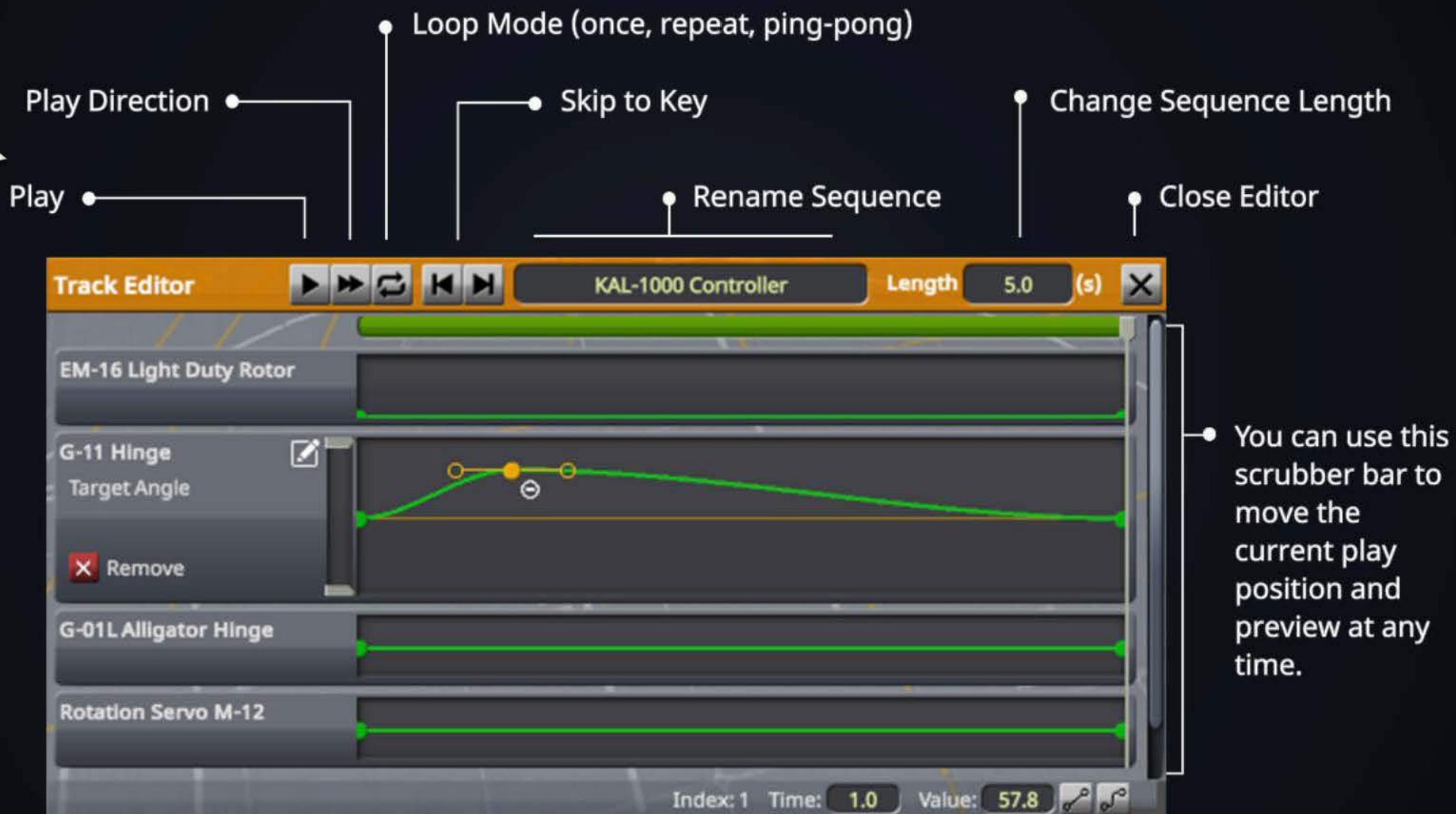
The KAL 1000 Controller coordinates multiple parts to operate in a sequence. Its primary purpose is controlling robotic parts, but is not limited to those. To build a sequence, first add the part fields that you want to control, like this:





Track Editor - Preview & Play

Once you have some curves set up, you can preview the sequence in the VAB/SPH. You can also open the Track Editor from the Controller part menu in flight to make adjustments.

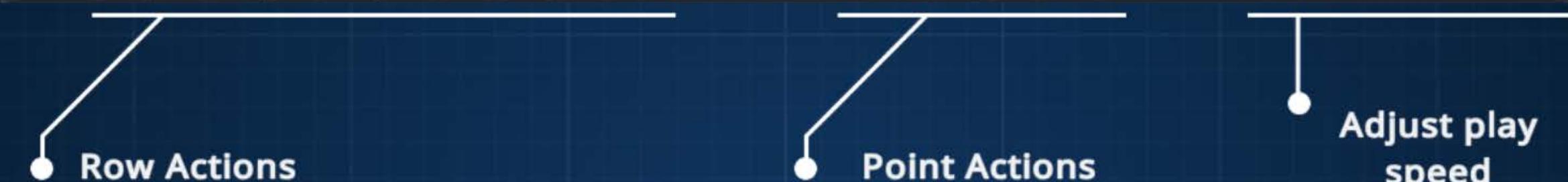


Note: For robotic parts the movement in the editor may not match in flight exactly because the controller will change the target values and your creation's physical capabilities will try to keep up.



Track Editor - Toolbar

The track editor toolbar speeds up track editting with various helpful functions.



Move row up/down the list.

Copy/Paste points from one row to another.

Apply preset curve pattern.

Mirror points in a row horizontally/vetrically.

Align tangents of the start & end points.

Clamp all points to min/max values.

Select all points.

Add point at scrub bar location.

Delete selected point.

Clamp point to min/max values.

Sharpen tangents of selected point.

Smooth tangents of selected point.

Grip Pads

Grip pads are high-strength, grip traction pads you can add to your robotic craft for a range of uses.

They come in multiple shapes and sizes.



Grip pads can be built with 3 different grip settings...



Medium Grip



High Grip



Extreme Grip

GP-004 Grip Pad

No

Same Vessel Interaction

Editor

- Destroy Part
- Show in Inspector
- Ping Part Prefab

Autostrut: Disabled

Rigid Attachment: Off

Traction: Medium Grip

Variant: Square

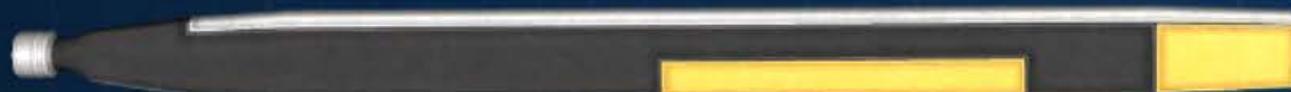
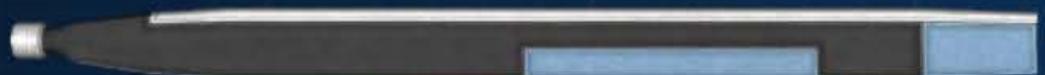
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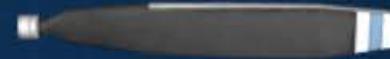
Propellers

Three kinds of propellers are provided, each kind is most suited to a different style of use. They come in a range of sizes.

Helicopter Blades



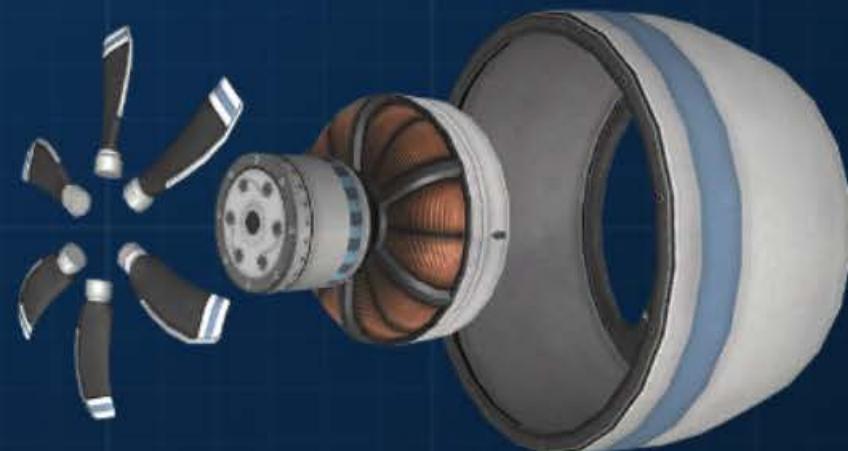
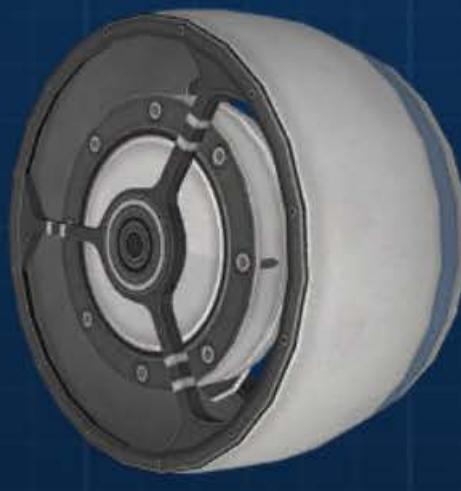
Propeller Blades



Fan Blades

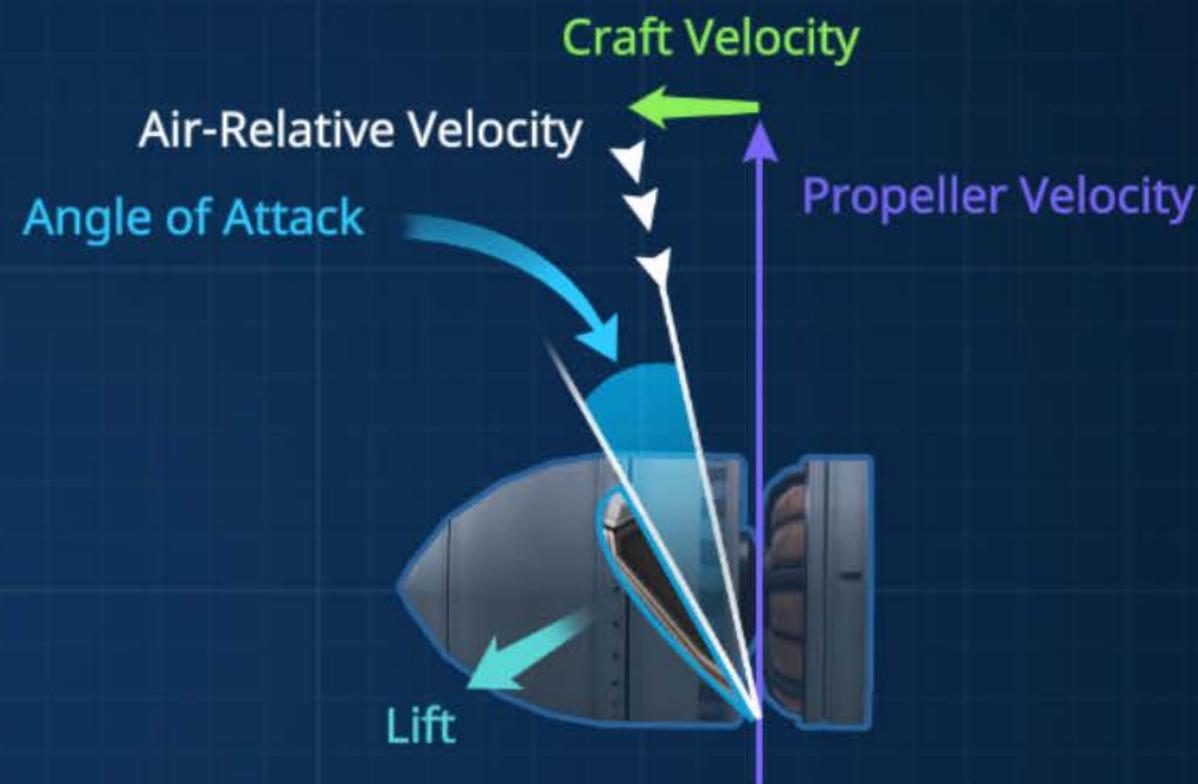
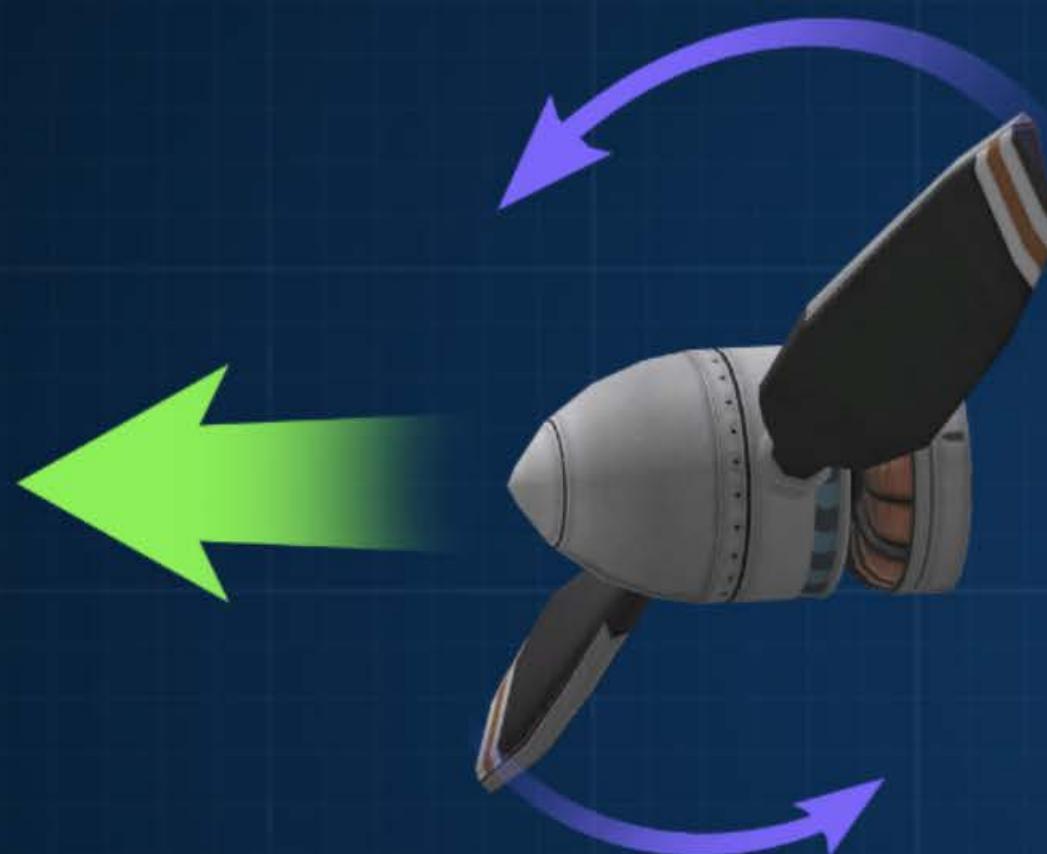


Propellers typically work best when attached to a rotor. The ducted fan blades have separate shroud parts to match.



Propellers Aerodynamics

Using propellers properly requires a good understanding of how air moves over the propeller. Below, you can see how the air flow depends on both the rotation of the propeller, and the speed of the plane.



To get lift, your propeller has to be turned to have a positive angle of attack vs the air. You can right click on a propeller blade while in flight to see what its angle of attack to the air is, and how much lift its generating.



Propeller Blade Type S	
Same Vessel Interaction	No
Pitch	Inactive
Yaw	Inactive
Roll	Inactive
Deploy	Retracted
Deploy Direction	Normal
Authority Limiter	100
Angle of Attack:	-37.9°
Forward Lift:	0.0kN
Vertical Lift:	0.0kN
Air Speed:	0.2m/s



Propeller Blade Type S	
Same Vessel Interaction	No
Pitch	Inactive
Yaw	Inactive
Roll	Inactive
Deploy	Extended
Deploy Direction	Normal
Authority Limiter	100
Angle of Attack:	-7.9°
Forward Lift:	0.0kN
Vertical Lift:	0.0kN
Air Speed:	0.2m/s