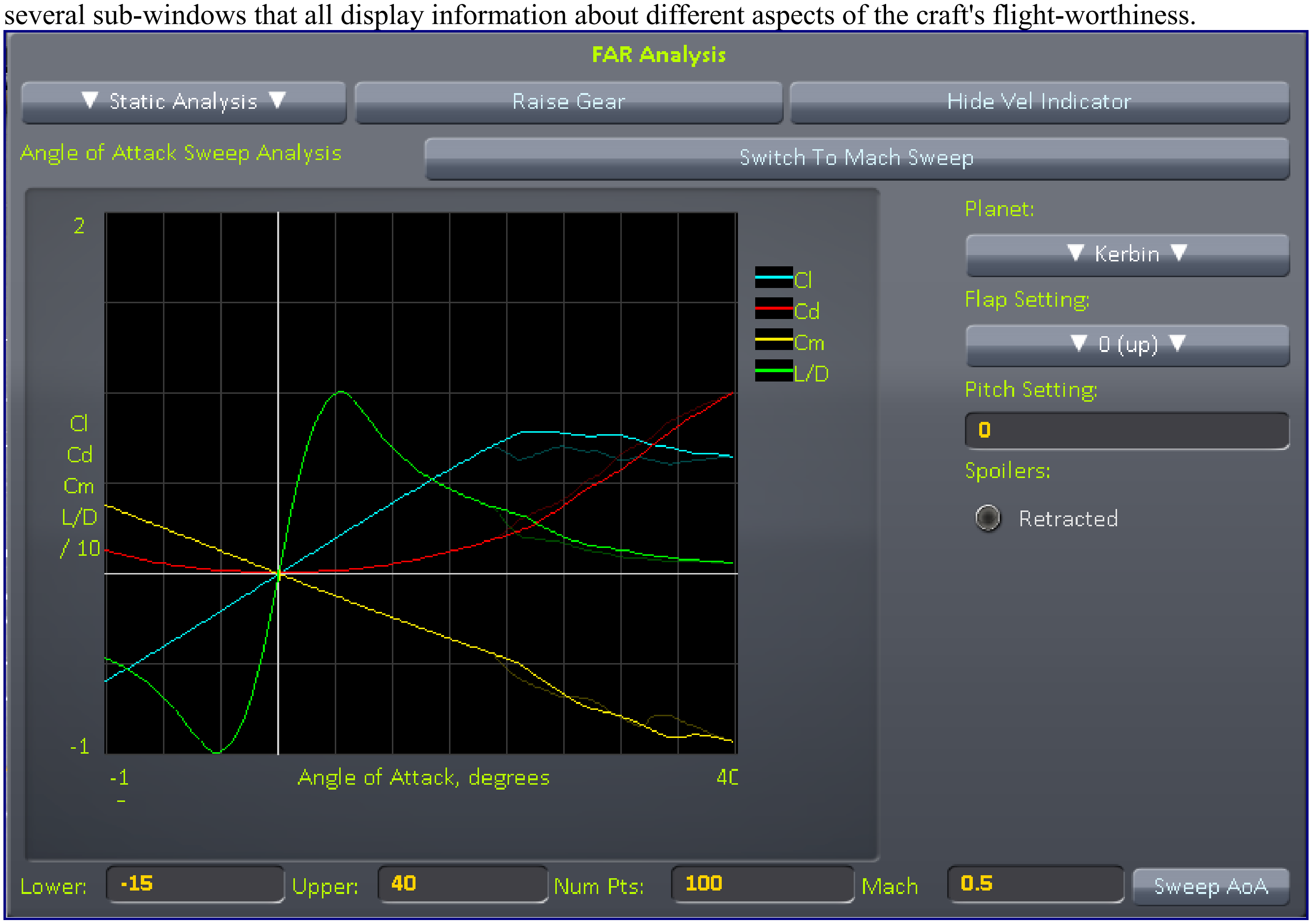
Building a plane in FAR is no different than in stock - CoL behind the CoM, wheels just behind the CoM, try to have fuel tanks placed so that CoM moves forward as fuel drains, remember to have proper control surface inputs for the control surfaces, etc. Where FAR differs from stock is the level of granularity of the aerodynamic model being used, the level of control the user has in tweaking and tuning a design the method of calculating lift, and the data the user gets from the editor about how their craft will perform. In the stock game, adding wing parts and an engine is all you need (usually) to make something that will fly. FAR is a bit more complicated; FAR looks not at the number of wings you have bolted onto a craft, but where the wing areas are, and how large they are. Wings that are clipped into a fuselage will be ignored, and wings clipped into each other will be viewed as one wing, not multiple. Additionally, wings with insufficient vertical separation (wing stacking) will impart a malus to lift, similar to real-life. FAR, when looking at total lift and drag of a craft, uses a Voxel-based system to calculate the aerodynamics of the craft as a whole, rather than simply adding up all the lift produced by wing parts on the craft and seeing if the lift value is enough to counter gravity. Blended body designs will exhibit the body lift you'd expect them to, craft with all sorts of lumps or protrusions will generally have higher drag, etc, and FAR takes area-ruling into account when calculating trans-sonic and supersonic drag. Finally, the settings on control surfaces matter much more – in Stock you can get away with all control surfaces left on default Pitch/Yaw/Roll settings, but in FAR you'll want to specify what axis each control surface responds to. That said, if a craft built with FAR looks like a plane, it will likely fly like one. But how well?

FAR includes a number of tools to get a detailed technical look at how your craft will perform; use of these tools isn't required or necessary. They provide diagnostic feedback on flight performance, before it's even left the SPH. They are completely optional, but they can help enormously, either for fine tuning, or helping someone new to FAR better understand why their plane is or isn't performing.
Clicking on the FAR icon on the toolbar in the Editor brings up the FAR Analysis window. This window has several sub-windows that all display information about different aspects of the craft's flight-worthiness.



Here is the default window that is opened, the Sweep Analysis window. There are several data fields that values

can be entered, and a Graph readout.
The **Lower**, **Upper**, and **Mach** data fields allow specifying the range of Angles of Attack for FAR to calculate on a craft. **Num Pts** can be ignored, for the most part, it simply controls how many datapoints are calculated for the graph. More points, the finer resolution the graph ranges are. By adjusting these values, you can see how the plane is predicted to behave at the specified airspeed in mach. Clicking the **Switch to Mach Sweep** button will change the data inputs, and allow you to see how the craft will behave at a set AoA over a range of airspeeds instead.
Flap Settings allow calculating flap deployment if the craft has any, and what level of deployment, from none (0), to fully deployed (3).
Pitch setting is what level of deflection any control surfaces with Pitch enabled are deflected, ranging from 0 (no deflection) to 1 (full deflection).

In the example above, a sweep graph has already been plotted, testing craft performance from -15 degrees AoA to 40 degrees AoA, at Mach 0.5 (~168m/s). This yields 4 colored lines.
-Yellow (Cm): The Yellow line is a measure of Pitch movement, and can be read as an indication of craft stability. Ideally, this value decreases as AoA increases, such a craft will want to return to a neutral AoA in the absence of Pitch inputs; an increasing value as AoA increases means the craft has pitch instability – it will want to lawn dart or stall in the absence of control surface Pitch inputs; this is generally undesirable.
Here, the example craft is fairly stable, at least up to 40 degrees AoA.
-Red (Cd): The Red line indicates the coefficient of drag. Generally linear at low AoA, becomes non-linear at high AoA.
Here, craft drag is fairly low up to ~20 degrees AoA, and begins to rapidly increase past that.
-Cyan (Cl): The Cyan line is the coefficient of lift. This stays more or less linear up to critical AoA, at which point maximum lift is achieved and past this point the craft will go into a stall and begin losing lift.
Here, the craft will begin to stall at around ~22 degrees AoA.
-Green (L/D): The Green line is simply a measure of the Cyan line divided by the Red line, and acts as a general measure of how efficient the craft is at producing lift.
Here, best lift vs drag is achieved at ~5 degrees AoA.

What does this tell us? At ~170m/s, the craft is stable and will return to prograde in the absence of control inputs, it will begin to bleed energy past ~5 degrees AoA, and past 20 degrees AoA the craft is in danger of stalling.
But what about Yaw or Roll stability, or general information about the craft? Clicking the Static Analysis button in the top left allows transition to the Data+Stability Derivatives sub-window:

Lots of scary numbers.

The Stability Derivatives window is likely where the most time will be spent tweaking a craft in FAR. The Flight Conditions allows the user to select the planet, altitude and speed in mach you want FAR to simulate the craft in flight at, which will affect all the data values below the Calculate Stability Derivatives button once it has been clicked.
The top data field is raw data about elements of the craft. Of immediate usefulness are the Level Flight data. Here, Altitude and Airspeed have been set to 1.5km altitude and 0.5, and from here, the analysis states what that airspeed is in m/s, the coefficient of lift (Cl) and drag (Cd) the craft will have, and the necessary AoA required to maintain level flight. Checking various speed and altitude combos is a good idea, as needed AoA will almost certainly change, perhaps drastically. Setting altitude to 0 and airspeed to 0.2 mach (~68m/s, simulating takeoff) would show needed AoA has jumped to 8.4 degrees for the example craft here, for example. Wing incidence (rotation of the wing along the Pitch axis to provide intrinsic AoA while flying prograde) can reduce this.
The Inertia fields state what sort of torque is generated during roll/yaw/pitch movements, with X = Axis of Roll, Y = Axis of Pitch, and Z = Axis of yaw.
Finally, **Aircraft Properties** simply measures wing dimensions and wing area.

The Longitudinal and Lateral Derivative numbers come in 3 flavors: Green, White, and Red. White numbers are

neutral, and their values are simply data values. Green numbers indicate that that particular aspect of craft performance is within expected tolerances for stable flight, and Red numbers indicate instability in that particular aspect of craft performance.
Of the values listed, some of the main important ones:
Mw: Is your CoM in the right place? If this value is red, the craft will try to nosedive or back flip. Try shifting either the CoM or the main wing around to bring the CoM closer to what in stock would be the CoL indicator.
Yß and **Nß**: Yaw sideslip stability, does the plane want to fly straight?. Unless the tailplane is huge (i.e. large enough to be generating substantial amounts of lift), likely to be green. Dihedral (Wing is angled, with wing tips higher than the wing root) improves this.
Lß: When the lift vector and gravity don't line up (when the craft has rolled and is not parallel with the horizon), sideslip occurs. Does this induce the craft to roll? Generally going to be green unless tiny tailplanes and/or excessive Anhedral(Wing is angled, with wing tips lower than the wing root) are present.
Mq, **Lp**, and **Nr**: Pitch, Roll, and Yaw rotation stability. If the craft undergoes rotation, will said rotation damp out? Generally not going to be red unless other things are also red.
Lr: Does the plane have a vertical stabilizer? If red, the craft lacks sufficient Yaw stability, and will want to flatspin. Fix with either a larger tail or a longer empennage.

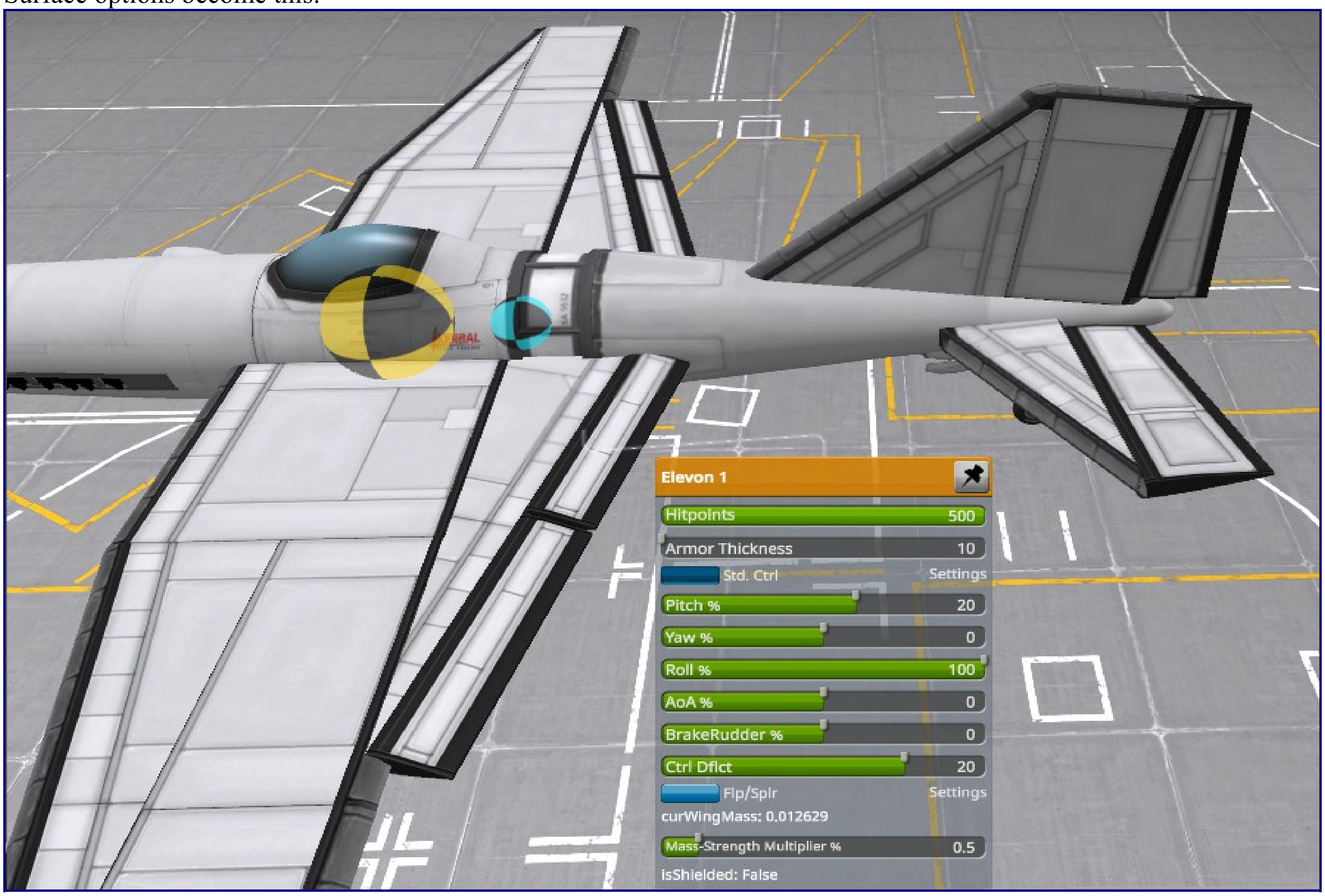
The third tab is the **Stability Derivative Simulation**. This just takes the data from the latest Stability Derivatives calculation in the Data+Stability Derivatives window. The Stability Deriv Sim isn't something I've ever really used, and is *entirely optional,* it is entirely possible to design excellent FAR craft without even opening this window.
That said, here is a brief rundown of the tab.
Once you've run a Data+Stability Derivatives calculation, you get the aircraft's flight stats - properties, longitudinal derivatives, and lateral derivatives.
Switching to the Stability sim tab ports the D+SD numbers into the sim, and presents you with a subset of those numbers, a graph, and some data inputs.
For the longitude sim, these are: **init w** - downward velocity, in m/s; **init u** - forward velocity, in m/s; **init q** - pitch rate, in rad/s; and **init theta** - pitch attitude, in radians.
For the lateral sim, these are: **init beta** - sideslip angle, in radians; **init p** - roll rate, in rad/s; **init r** - yaw rate, in rad/s; and **init phi** - roll angle, in radians
EndTime is how long the sim will run for - i would suggest changing this to ~30 or so to get a better idea of overall stability.
dt I don't know, but it appears to change Y-axis graph scale.

What the sim panel is used for is determining flight stability in response to deviations from the initial static stability values calculated earlier - the stability deriv panel gives a snapshot of how the aircraft will perform in any one specific state of altitude, speed, and orientation; the sim panel shows how stable the craft is when subject to changing states.
When you enter a number into one or more of the init*X* fields and click the 'Run Simulation' button, you get a graph output with four colored lines , each corresponding to one of the 4 derivatives, that show the change in flight state that the specified deviation. This output will likely be an oscillating waveform. A craft that is stable should have a waveform that damps out and decreases toward a neutral rest state as time increases.. An unstable craft will have a waveform with increasing magnitude and frequency as time increases. So if you wanted to, say, see if a plane is stable pitching up 5 degrees from a 1km ASL level cruise at mach 1, you would go to the stability deriv tab, enter in the appropriate flight conditions, then go to the Sim tab and run a simulation with init theta set to 0.0872 (1 radian = ~57.3 deg; 5 deg = pi/36). If you wanted to see how it performs at 2km, you'd have to go back to the stability tab, run another stability calculation, and return to the sim tab to run another sim, etc.

For the most part, the vast majority of seeing if an aircraft is stable will be done in via Data+Stability calculations; the Sim tab is mainly there to give an idea if an aircraft's oscillations damp down in flight. It's a tool that's there for those who know how to use it, but is by no means essential for successfully building something in FAR.

The last tab is the **Transonic Design** tab. This has two main components. On the left is the **Transonic Area Ruling Analysis.** This updates whenever a change is made to the craft being built in the editor, and tells you the vessel's **Max Cross-Section Area**, **Mach 1 Wave Drag Area**, and **Critical Mach Number.** The max Cross-Section is self-explanatory, it tells you how large your craft is as a cross-section. Generally want this to be lower for lower drag. The Mach 1 wave drag is a measure of the area that will generate wave drag at mach 1, and Critical Mach number is the airspeed at which the airflow over some point of the aircraft reaches, but does not exceed, the speed of sound. Exceeding this speed will result in those areas of the plane creating shock waves , and a corresponding increase in drag coefficient.
Clicking the **Raise Gear** Button at the top will raise landing gear, and allow you to see what the craft performance will look like when gear is retracted.
The Right side of the Transonic Design Tab allows you to toggle on various curves (displayed as a 2D plane along the longitudinal axis) of either the craft's cross section, curvature, or pressure coefficient. Smoother is better.

Now, interpreting FAR analysis data has been covered, but what about tuning? In stock, Control surfaces have togglable pitch, Yaw, and Roll inputs, and deflection amount can be changed. In FAR, instead the Control Surface options become this:



Pitch, Yaw, and Roll inputs can be customized. In this case, the inner aileron here has full Roll input, and will provide a 20% Pitch input as well. Control Dflect is the number of degrees the control surface will rotate when deflecting from input..
AoA% allows the control surface to respond to craft AoA. Setting this to 100, for example, would mean that if, say, the craft pitches up and increases AoA by 5 degrees, the control surface would deflect down an equal amount, the practical effect of which would be damping sudden increases in AoA. Setting it to -100%, likewise, would cause the control surface to deflect up 5 degrees, remaining parallel with the prograde vector and

providing Pitch input after Pitch control Surfaces have ceased input.
BrakeRudder allows the control surface to be used similarly to A.I.R.B.R.A.K.E.s with Yaw inputs enabled, and permits Yaw inputs without needing vertical stabilizers/rudders.
Lastly, Mass-Strength Multiplier % allows tweaking the mass of the wing or control surface. This in important, for FAR models aero stresses and aero failures – in other words, pull a hard turn with wings that aren't sufficiently sturdy, and the aero forces exerted on the plane during the turn will rip the wing off. Heavier wings are stronger, and can higher Gee turns. That said, default Mass-Strength is somewhat heavy – the example craft has a mass of ~4200 kg with all wing parts at 1.0; reducing M-S Mult to 0.5 dropped the craft weight to ~3500kg. The lower the strength, the less aerostress the wing can tolerate before failing, but the lower the mass, the less the overall mass of the craft, and the less wing loading. Finding the ideal setting may take some trial and error, but main wings and control surfaces with more than 10 degrees of deflection should probably remain above 0.5.

Tuning control settings can take some time. Setting inputs too low results in a reduction of maneuverability. Conversely, setting them too high runs the risk of the control surface stalling at full deflection, resulting in a loss of control, which may translate to overall degraded aircraft performance or sudden oscillations as the craft reacts to the sudden reduction in control authority on that axis. Also of note is the effect of speed on control surface performance. At higher speeds, aeropressures increase on deployed surfaces. A control surface that could fully deploy without incident at low speed may undergo more aerostress than it can handle and break, or result in the craft undergoing too great a vector change, resulting in increased drag and unwanted energy loss.

So you've built a plane, tweaked it, and have now launched it. As mentioned earlier, if a craft looks like a plane, chances are it will fly like one. But what if it doesn’t? Some things to check, then. What is the Lift Coefficient of the aircraft, and what AoA is required to generate lift at takeoff conditions? If the Lift coefficient is small, consider increasing the wing area of the craft by adding more wing, or reducing the mass of the craft. The other option is increasing craft thrust - higher thrust can get away with smaller wings, and vice -versa. If the AoA required is high, consider adding some Angle of Incidence to the main wing – AoI is the measure of the angle of the main wing compared to the fuselage, with the leading edge of the wing higher than the trailing edge (usually). Be careful when adding AoI, as more than a few degrees of tilt to the wing may result in needing negative AoA at higher speeds to maintain level flight, as well as adding unnecessary drag. If both cL and AoA are acceptable, check CoM and Landing gear placement. If going for a modern tricycle arrangement, are the rear wheels just behind the CoM to permit the aircraft to pivot the nose up during takeoff? If going for a inverse tricycle arrangement, are the main wheels providing enough elevation relative to the rear wheel to add some extrinsic Angle of Incidence when the craft is a rest or taking off?
If the craft is yawing left or right on the runway during liftoff, are your landing gears on straight? non-perpendicular wheels can behave oddly. If your gears are fine, is the craft Yaw stable at low speed? If not, try a wider wheel base or larger tail/greater yaw authority.

Once the craft is airborne, do the control surface deflection settings permit a level of response appropriate to the craft? Most turns are accomplished by rolling, then pitching, rather than via yaw; Does the craft have a good roll rate, and sufficient pitch authority? If not, consider increasing either control surface deflection or more/larger control surfaces. Is the CoM more or less centered on the main wing to permit the craft to easily rotate around it for pitch maneuvers? If using a multi-fueslage design, is the CoM centered with the Center of Thrust, and/or is there sufficient dihedral or tailplane area to prevent sideslip and yaw?