

## How to Tweak the flight dynamics of FS2004 aircraft.

**The information in this file has been gained over time, so if it doesn't seem to match some of my earlier updates; I was still learning and did not know, at the time, some of the things that are in this file.**

DO NOT MAKE CHANGES IN AIR OR AIRCRAFT.CFG FILES YOU HAVE NOT BACKED UP.

First of all, some, maybe most, model makers do not complete the job they started before they upload it to a site for others to download and enjoy.

Where some of them fall down is in putting the information in the aircraft geometry section that they have, or at least could have, by writing things down as they make the model. I refer to the wing apex and height, horizontal tail position and height, wing sweep (if any), etc. that they at least knew when making the model.

This also applies to the engine section(s) and propeller section of the aircraft.cfg file that they have at least some of the information for, and don't always enter it accurately, if at all.

This info is used every second by the flight engine of the flight sim to tell the sim how the aircraft is flying. So not having this information as correct as possible is a mistake that at least some model makers have been making. That is, if they want the aircraft to fly the best it can in the sim.

Because of the above, the first thing you need to do is find the specifications for the aircraft in question and see if the model maker at least tried to make the aircraft.cfg file match the aircraft it belongs to.

The bad thing is that, if you look at three or four places on the Internet that has specifications for the aircraft, they won't all necessarily agree on every point, such as empty weight, or max gross weight, or on almost any other point. They usually do agree for the most part, but rarely on everything, even for the same model of the same aircraft.

Therefore the best source for the info is a book by someone known for attempting to be accurate with such information, like Jane's various books on aircraft. Your library may have a copy of one or more editions of Jane's all the World's Aircraft. Something like this is the best source that I am presently aware of.

You can use the info from the web, most of it is reasonably accurate, just that like anything on the web, it is only as accurate as the person who entered the information.

The next thing to do is put a new nav light into the lights section of the aircraft.cfg file. You do this so you can use it to find out the positions of the wing apex and height; wing root chord, ( the distance from the front of the wing to the trailing edge, measured

next to the fuselage) horizontal tail position, height, and span; vertical tail position, height, and span; (rarely is the span for the horizontal tail or vertical tail correct on an aircraft that is flying poorly). If you think the engine and, or wheel positions are not correct you can use the light to check on them as well.

For each position on the aircraft that you check with the light this way you may have to move the light 6 or more times to accurately find the position you are attempting to establish, such as wing apex and height.

**Note:** When you change something in the aircraft.cfg file, you must change planes and then go back to the one you are working on for the changes to show up. Because of this, I usually start the sim with the aircraft above or below the one I am working on in the choose the aircraft screen, then once inside the sim, switch to the aircraft I am working on, see what the changes did, if anything, then, when I leave the sim to make further changes, the sim automatically shifts to a different plane, so when I go back into the sim with the new changes made I don't have to shift aircraft again until I am back inside the sim again.

A few things to know about using a nav light to find positions: There are only 19 lights possible at present in the lights section; from 0 to 18. Any other numbers will be ignored.

You can skip numbers, but you cannot put them out of order, such as light 5 before light 3.

The first number after the = sign is the type of light it is.

The second number is the longitudinal (forward or back) position of the light, measured from the datum point.

The third number after the = sign is the position left or right of center.

The fourth number is the height above or below the datum point.

After the fourth number is the type of light, or effect, it is: eg. fx\_navred.

Each of these values is separated by a comma; and sometimes, in addition, by one or more spaces.

If, as sometimes happens, all the lights are used, go to a light the color you want to use, remark it out with either ; or // in front of the line for the light. Then go to the beginning of the next line and hit enter two or three times. This will make a space for you to write a line for the light you will use. Write in a new light with the same number as the one you remarked out, or copy the line you remarked out, (not including the //) paste it in the space, and change the position numbers to match where you wish to start. **Note:** If you have all the position numbers for the light at 0, the light will almost certainly be inside the aircraft fuselage. So you should start with it far enough left or right, and, or high enough so this won't happen. Sometimes just left or right leaves it inside the wing. Also if you have the sim start without the nav lights on by default, you might need to turn them on.

The thing to remember once you have found, and written down, all the

information you need, is to delete the new light you made, and possibly, remove the // or ; from in front of the light position you used.

Something to know about engine locations: The position of the engine(s) is the point from which the thrust of the prop(s) or thrust of the jet emanates from. So if you have some idea where the datum point is you can have some idea whether the engine(s) seem to be positioned correctly. If you think they are not accurately positioned, you can check their position(s) with the light.

After you have all this data, you can enter it into the aircraft.cfg file in the proper places. Then open the air file and check that the data in the air file matches the data in the aircraft.cfg file, changing what needs to be changed.

The places in the air file where the matching data are, do not usually follow in the same order as the data in the aircraft.cfg file. In other words you will have to skip around in the aircraft.cfg file to enter the new data into the air file as you scroll through the air file records.

To edit the air file you need an air editor like the one that comes with Airman, an air editor written for FS2002. It works just as well with FS2004. I am not sure why there are unknowns in the opened air file. I suspect the powers that be want it that way.

The main thing about unknown records in the air file is; that unless you know that the file was generated for the aircraft it is with, you should not leave any unknowns in the 1500's section. This section deals mainly with jet engines, but some of it is for piston engines also.

Just so you know, each record has a number beside it and some form of description to the right of it, even if it is just the word 'unknown'.

After you have Airman installed on your computer, click on an air file and when the open with box opens, browse to where the air editor is inside Airman. Eg.

**F:\Airman\support\aired\aired.exe.**

Make sure that the always open with box is checked, and click OK. Once the air file is open, you can size the window so it takes up about a third to a half of the width of your screen so the records are easier to see and edit.

Some of the records are easy to edit since you only have to click on them to change their value, those that say bool in the little box, others, clicking on them opens a window or box, which, when open, the info in the box can be edited.

Others are graphs or tables that may or may not be correct for the aircraft. If you know it is wrong, say record 451's graph says there is dihedral, when you know there is none. What you need to do is find an air file for an aircraft like the F-22 that has no dihedral, and, after removing the bad record 451 by right clicking on it and clicking on the 'remove record' choice that is in the box that opens when you right click the record; then right click on the 451 record in the F-22 air file and copy it to clipboard, then right click in the other air file again, almost anywhere will do, and click copy from clipboard. You then have corrected the wrong information to the correct information. If there is dihedral, the graph will resemble a W. No dihedral means the graph will be a straight

line.

If the maker of the model knows these things, I expect that at least the info in the aircraft.cfg file would all be there, and be correct.

**Don't remove records or change records unless you are positive that the record is wrong for the aircraft it is with.** This does not change what I wrote before about the 1500's section. If it only has the word unknown after it and it is in the 1500's it should be deleted from any file not specifically generated for the aircraft it is with.

On one update I did for an aircraft with piston engines I deleted all the unknowns in the 1500's. Then after running the aircraft, went back to find one of those unknowns back. If this happens to you, leave the new unknown there. It had to have been generated by the information in the air and, or aircraft.cfg file so it was specifically generated for the aircraft.

Two things I often find **wrong** with jet aircraft: one is that the record for variable intake reads true instead of false. The other is, that quite often, aircraft with afterburners have the record 1521, 'engine reheat available'; reading, false.

Once you have completed going through the air file and changing everything that you know is not correct, fly the aircraft, first to see if it still does fly, and also to see if it flies better than before. It may or may not fly noticeably better. If it does not fly, you changed something that you shouldn't have, or made an entry error. Or left something not changed that should have been changed, like the engine type in general engine data in the aircraft.cfg file when changing from jet or turboprop engine(s) to piston engines, like you have to do with some of Kazunori Ito's planes.

Just before taking off you should go to the aircraft section of the menu and click on fuel and payload. If there is a warning about overweight and you know you have the proper empty and full weights entered in the aircraft.cfg file, you need to reduce payload and, or fuel load so you are at least 100 pounds under the maximum weight. Any aircraft without a load, only fuel on board, and has a gross weight over 20,000 pounds, I usually try to stay at least 1,000 pounds under full weight. If you don't bring the aircraft down to the maximum weight or less, some of the following changes I will be covering will have to be redone, when you **do** notice that the aircraft is overweight.

If you have ever taken off with an new airliner, then almost immediately turned around and tried to land it; but had it crash due to overstress, even though you touched down gently, being overweight was probably the problem. This is one reason to check this out for all new aircraft, even if they otherwise fly correctly.

It seem some aircraft makers overload their aircraft, with fuel and or payload, even though most real world aircraft rarely take off as fully loaded as possible.

Obviously the fuel section of the aircraft.cfg file contains the fuel load information, the weight\_and\_balance section is where to permanently change any payload information. Some, or all, station values can be reduced, or brought to 0, your choice. Just so you end up at, or below, maximum gross weight.

After correcting, if necessary, the fuel and payload, here is where I usually set

the autopilot for 37,000 ft, and a climb rate of 2,000 to 4,000 ft. per minute (depending on the aircraft).; take off, and engage the autopilot, leaving full throttle on. Depending on how the aircraft is flying and how I feel, I usually go to 4x or 8x time compression till nearing 37,000 ft. For aircraft that won't go that high, change 37,000 ft. to whatever altitude it is supposed to fly fastest at.

Once at altitude I check to see how close the aircraft comes to reaching the fastest it is supposed to go in level flight. Sometimes it over-speeds, other times it is too slow.

If it is a jet, go into the aircraft.cfg file and change the value for the air intake in the turbine engine data. If it is slow make the air intake smaller. If too fast make the air intake (inlet\_area) larger. Then go fly the aircraft again and see if it reaches proper speed at altitude without going too much faster than it is supposed to. **Note:** this value is also in the air file inside record 1501, if the air file has a record 1501, but might as well be left whatever it is until you have decided what the inlet area should be; so you are not constantly changing it for nothing. Record 1501 also has the thrust, in pounds, for the engine. This should be changed to the correct value if you know it, because you should not have to change it to have the aircraft fly fast enough.

Some air files have both a record 600 as well as a 1501 for jet engines, I have found it best to delete the 600 record and possibly any other records numbered from 600 to 700 if there is a record 1501 along with the proper control records 1502–1507.

If it is a turboprop aircraft you can go into the propeller section of the aircraft.cfg file and change the gear ratio, closer to 1to1 for aircraft that are too slow, and higher like 17 to 1 for aircraft that are too fast. To some extent you can also vary the intake area and pounds of thrust, to change the speed.

For piston engine aircraft, go to the [piston engine] section and try changing the cylinder displacement and, or the compression ratio of the engine. Another thing to check is the max\_design\_mp= line to see if it is correct for the aircraft. Correct or not, increasing the value after the = sign will increase the max speed of the aircraft.

You have to choose which you think will best serve the purpose of attaining the correct max level speed of the aircraft, while leaving everything possible match the correct information for the aircraft. This is where having an aptitude for doing flight dynamics comes in, and helps you decide what to change for best results. Practice making changes also helps.

Something to remember, when setting a value for never exceed speed, either as a mach number or in knots: The never exceed speed, (over speed) should be at least a little above the max level speed of the aircraft (20 to 100 knots). So going slightly above the maximum level speed won't cause the aircraft to crash from over stressing it.

The numbers for never exceed speed are normally in both the air and aircraft.cfg files.

Once you have the aircraft reaching the speed it should at altitude, without going too far over it, it is time to check the moments of inertia values (MOI). They are in the weight and balance section of the aircraft.cfg file. If they are in the millions and the

aircraft is normal jet fighter size or smaller, they are probably larger than necessary. If they are very large for the aircraft they are with they can effect, at least in a small way, how the aircraft rolls, turns, etc.

There is a section in the air file called primary aerodynamics, once opened there are 8 sub-sections. In the roll, pitch, and yaw sections there are records, such as pitch stability in the pitch section, that work in co-ordination with the MOI section of the aircraft.cfg file.

I am going to give you some values for these records, this does not mean you must stay with these values, particularly in pitch stability, to have the aircraft fly properly. If the aircraft seems unstable with these values, experiment by raising or lowering them to find what works best.

Roll dampening: somewhere near 4000.

Pitch stability: 35000 to 95000.

Yaw dampening: 2000 to 5000.

All these values have a minus sign in front of them, make sure it is still there when you edit the values.

These values have a direct impact on how much, pitch moment due to elevator, etc. you will need for the aircraft to have enough elevator force, aileron force (roll moment due to ailerons), and rudder force ( yaw moment - rudder) for proper control of the aircraft. Large changes in pitch stability, and or roll and yaw dampening means you will have to increase or decrease these other values to keep the flight envelope what you wish it to be.

Besides the above Roll, Pitch, and Yaw values in primary aerodynamics, I try to keep the corresponding MOI values in the aircraft.cfg file somewhere below the 1,000,000 units mark. This is not always possible for larger aircraft. Larger aircraft being, something larger and heavier than the average jet fighter. Something else to remember, most entries in the air and aircraft.cfg file don't use commas or other separators as I just did, no matter what units are used.

The MOI values in the aircraft.cfg file, and the corresponding values in primary aerodynamics, together control whether the model shakes in any of the three planes of rotation. If the aircraft shakes while sitting on the runway or while in the air, one, or more, of these values is too low. If the value(s) in primary aerodynamics are within the above ranges, you should normally just add more moi to the moi value(s) in question, until you have the aircraft flying without shaking.

This is where you must decide whether to just increase the MOI values or to also change the corresponding values in primary aerodynamics. If the MOI values are below the 1000000 unit mark, it is usually best to just add more moi units to roll, pitch, or yaw as needed.

It is normally a waste of time to try to adjust the forces for roll, pitch, and yaw in the primary aerodynamics section, until you have dealt with the MOI values and their corresponding 'primary aerodynamics' values, because those in primary aerodynamics

directly affect how much force the elevator, ailerons, and rudder need to work properly.

To be sure the aircraft doesn't have a stability problem, [ MOI values], I set the autopilot for 5,000 ft. and leave the throttle on full until the aircraft is at 5,000 ft. and reaches full speed or over speeds. If the aircraft remained stable, the values are at least high enough, whether they are so high as to be over kill, you must decide and act accordingly. 10 to 20 thousand units more than absolutely necessary is definitely not over kill.

Once you have taken care of all the above, it is time to check if there is too much or too little force acting on the elevator, ailerons, and rudder. I usually do this by taking off, usually in tower view, and trimming the aircraft so it is climbing slightly at 300 knots. Obviously you will have to use a different airspeed value for aircraft that won't reach this speed, or that barely reach this speed.

Then I make sharp turns, rolls, and other manoeuvres to see if anything needs adjusting. It usually does. This is where you go to the primary aerodynamics section and change, as necessary, elevator force (pitch moment due to elevator), aileron force (roll moment due to ailerons), and rudder force ( yaw moment - rudder). This is in part an art, since it is done by eye, and also by taking note of how much gee forces are exerted when each axis is pushed to the limit. If you hit, shit + Z three times you will have the gee forces, and other info, at the top of your screen for easy reference.

When adjusting the rudder, as well as making sure the rudder forces are not too strong or too weak, there is another section in primary aerodynamics called side forces which has an entry called: side force - rudder. This value may or may not be correct. If correct, when flying with one wing down and nearly level, applying full rudder so the nose points more towards the ground will not have the aircraft gain much, if any, altitude. If the aircraft, while basically flying on its side, gains a good amount of altitude when the rudder is applied, the '**side force - rudder**' value is too high.

This, in particular, along with corrections to the rudder, elevators, and ailerons, is something at least partly subjective and therefore easier for some to see and correct than for other people.

Once you have everything the way you think it should be, it is time to try a few landings to see that the aircraft can be trimmed properly for landing, and that it is not otherwise difficult to land the aircraft.

If the panel the aircraft came with has poor forward visibility, here is where you may wish to change panels until you have checked out how easy or hard it still is to land the aircraft. If I am going to change panels I usually rename the original panel, panel.old, then copy the panel I am going to use into the aircraft folder.

By now the aircraft usually is flying fairly well, and the most common problem is there may be too little trim for the aircraft to be trimmed correctly with the gear and full flaps down.

In primary aerodynamics under pitch there is a record: 'pitch moment - trim range'. This should never be less than 1.00, unless you are sure that 1.00 is too high. I have yet to find an aircraft where 1.00 is too high. By the way, this, like some other

correct values, is a negative value and the minus sign should always be there.

If there is not enough trim, increase the value, to 1.50 or 2.00 or higher, until you do have enough to trim for a proper landing with the flaps and gear down, with at least some trim to spare. I find these things are much easier to figure out when the panel has a digital trim gauge as part of it.

Another two things to check in the pitch section are: pitch moment - flaps and pitch moment - gear. When negative these values tell the sim how much to pitch the nose down when the gear and, or the flaps are down. When positive, lowering the gear and, or the flaps will raise the nose, this is not normal for any aircraft with the horizontal tail behind the wings.

For correct, or near correct values of these records see what they are in a similar aircraft that is flying correctly.

There are other records in all eight sections of primary aerodynamics that may or may not need changing, you will have to decide whether they need changing by seeing how the aircraft is flying. If in doubt about something, look at the values for these same records in a similar aircraft that is flying the way it should.

There is something in the lift section that is almost always not correct: 'lift due to elevator' and 'lift due to horizontal stabilizer'. First lift due to elevator should nearly always be positive, the value will depend on the aircraft.

Second the record, 'lift due to horizontal stabilizer', should always be zero for aircraft with the horizontal stabilizer behind the wings.

Unless the elevator and horizontal stabilizer are one and the same, as on some aircraft, the horizontal stabilizer never supplies any lift. It just supplies stability if it is located behind the wings, nothing else. Even if the elevator and the horizontal stabilizer are one and the same, the value for, 'lift due to horizontal stabilizer', should be zero.

Any of the records that I did not cover in this document, can be compared to an air file for a similar aircraft for bringing the figures into the ballpark for further tweaking, if desired or for what the graphs should look like. The easiest way to change graphs to what they should be is to delete the wrong graph and replace it with one copied from an air file with the correct graph.

I think I should mention something about dihedral. First what dihedral does, for those who don't know. When you bank an aircraft that has dihedral, and then you bring the controls back to neutral, the wings will tend to go back to level flight on their own because of the dihedral. This works for positive or negative dihedral.

The first record under the roll section of primary dynamics is dihedral effect. If the wings don't have dihedral this should be zero, if the wings have dihedral, this should not have a value of zero.

The value will depend on the size of the aircraft and the number of degrees of dihedral the wings have. One way to check what it should be is to again find a similar aircraft that is flying correctly with the same, or nearly the same, number of degrees of dihedral and try that value.



Most of the tweaking is easier to do when you have watched various aircraft in flight for hours at a time and have a good knowledge of the forces keeping an aircraft in the air.

This document has been written to give you a **starting point** for learning how to edit flight dynamics. It is not everything you can know about editing flight dynamics. I will change, and, or add to this document anything that someone proves to me is wrong, or that I believe will make it easier for someone to edit an aircraft's flight dynamics.

I am human, I don't claim that everything here is complete or accurate in every way; but it is as accurate as my present knowledge allows it to be.

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