

The CIX VFR Club	Flight Training Notes	Exercise 4c
For Simulation Purposes only. Not to be used for real World flight	TRIMMING	Issue 1.4 04/08/12

1 INTRODUCTION

This series of tutorials for the CIX VFR Club are based on real world flight training. Each document focuses on a small part only of the necessary skills required to fly a light aircraft, and by echoing real world training, you will be a better Flight Simulator pilot and get more enjoyment out of the hobby as a result.

These tutorials are written specifically for the Flight Simulator Default Cessna 172. Some details will be different for other aircraft.

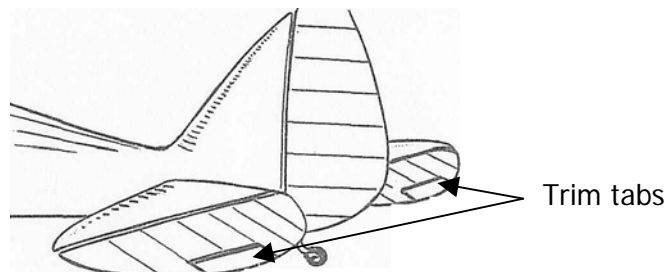
You should read Exercise 4b before continuing with this tutorial.

2 RELIEVING THE PRESSURE

2.1 The Trim Controls

The purpose of these secondary controls is to take the load off the primary ones during the various conditions of flight. For example, it would be tiring in the extreme were the pilot to be called upon to hold back the stick during a prolonged climb or have to constantly hold it forward to obtain a desired airspeed in level flight.

The simplest form of elevator trim control consists of a small lever which is connected to the control linkage via a pair of springs, and this type is used in the De Havilland 80a – the Tiger Moth. Other types, e.g. the Piper PA38 Tomahawk uses bungee rubber cords, but the most sophisticated is the trim tab which is mounted on the elevator, and which is used in the Cessna 172 and most larger aircraft. The airflow over the trim tab holds the elevator in the desired position without any effort from the pilot. The trim tab is actuated by the elevator trim control.



Over the years, analysis of accidents has led to a significant degree of standardization of controls. Imagine the consequences of a pilot

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concentrating on the outside view, say during landing, and reaching for a control, but it turns out to be the wrong one! In most aircraft today: -

- Throttle levers are black and have smooth handles
- Mixture levers are red and have finely knurled handles
- Propeller pitch levers are blue and have coarsely knurled handles
- Trim controls (if not electric) are large black wheels set in the same plane in which they act, with raised projections (“nobbles” if you like) widely spaced on the rim.

The trim wheel is normally set into the coaming or cabin fitments in such a way that only the top surface is visible, perhaps one quarter of the diameter, for a reason which will become apparent. They are normally mounted near the throttle and mixture levers or between the seats. The elevator trim affects the aircraft in pitch, so is mounted vertically (i.e. on a horizontal spindle).

2.2 Balanced Flight

In normal conditions of flight the aircraft is in balance. This can be upset by changes in weight distribution such as amount of fuel, number of passenger seats occupied, luggage, etc., carried. Changes of throttle setting will also upset this balance, both in direction (yaw), due to the twisting motion of the slipstream, (don't worry about the technicalities!) and pitch, due to changes in thrust. Alterations in airspeed also upset the balance of the aeroplane because the resulting small changes in angle of attack affect the position of the centre of pressure (See exercise 3, paragraph 1.4). All of these out-of-balance forces must be compensated for by the controls.

The airspeed and power setting in which the yoke will remain in its neutral position, and the aircraft fly in a stable manner will differ according to load, so is never predictable. Nor will it be necessarily a configuration which the pilot wants. In practical flight conditions, the yoke would have to be held constantly slightly forward or slightly back to maintain balanced flight were it not for the trimmer which relieves the pilot who would otherwise soon get very tired.

Whilst most light aircraft are fitted with an elevator trimmer only, larger types have a rudder and in some cases aileron trimmer also. In the Cessna 172, the only trim control is the elevator trim.

2.3 The Art of Trimming

Provided smooth conditions exist an aircraft will fly "hands off" in a climb, glide or level flight when correctly trimmed. Trimming is simple in theory, a little more tricky in practice. Firstly, decide the desired airspeed for the flight condition (climbing, straight and level etc.), and set an appropriate

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power setting. Then make small movements of the yoke until the aircraft is maintaining the desired condition and airspeed. Finally, the trim wheel is turned to relieve the pressure which the pilot can sense through his hands. To relieve forward pressure on the yoke, the trim wheel is turned by moving the hand forward on the exposed surface, and vice versa. (It is to avoid turning the wheel in the wrong direction that only part of it is exposed and can be grasped).

In Flight Simulator, the trim controls are either to click the mouse on the trim wheel – at the top for nose down trim and the bottom for nose up trim – or to press the numeric keypad ‘7’ for nose down trim, and numeric keypad ‘1’ for nose up trim. Trimming is such an important aspect of control, that for those with a yoke or joystick, it is virtually essential to assign two of the buttons for trimming, preferably two which are one above the other. The upper one should be set to activate nose down trim and the lower one to activate nose up trim.

To trim accurately in Flight Simulator, the technique is similar to that of the real world where electric trim controls are fitted. Whilst holding the yoke or stick to maintain the desired flight condition, press the appropriate button, and at the same time relieve some of the pressure. Repeat this action until the stick is in the neutral position. You then observe the instruments to check that the desired airspeed is being maintained, and the aircraft is flying level or climbing or descending at the appropriate rate.

When the aircraft is flying exactly level (neither climbing nor descending), note carefully the power setting and the pitch attitude of the aircraft. This is extremely important, because, with experience, rather than guessing the power setting and pitch attitude to achieve your desired airspeed, then constantly adjusting trim to achieve it, you should try to remember the pitch attitude required for that airspeed. Then you will be able to set the correct rpm and pitch attitude to the correct position quickly, with only small adjustments required to trim.

Learning the correct pitch attitude will take a bit of practice, but once learned, the numbers don’t change. In the 2D cockpit, for example, at 90 knots, the horizon is typically about 1½ inches (40mm for the youngsters) above the top of the panel. This distance is different for different airspeeds, and also depends on whether you fly using the 2D cockpit or the 3D (Virtual) cockpit. There is no other way to learn these correct attitude “pictures” than practice, practice, practice.

For accurate flying, and to avoid pilot fatigue (including in Flight Simulator), trimming is vital. An experienced pilot will adjust the trim control to correct any out-of-trim changes, perhaps caused by turbulence or changing winds (notorious in FSX), as soon as they become apparent.

One of the beauties of trimming is that if you trim accurately for a cruise speed of 105 knots, but need to add a little power say to stop a slight

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descent, then once back at the correct altitude, you can reduce the power back to your previous setting, and the aircraft will re-establish at 105 knots.

In Flight Simulator this doesn't work as well as in real life unfortunately, due to the exaggerated "phugoid" movement in FS, which is normally designed out in real aircraft, but if you are patient, it will re-establish at 105 knots

2.4 Power, Attitude, Trim

The PAT rule is one of the second vitally important rule of successful accurate flying. (See Exercise 4a, paragraph 3 for the first important rule). First set the **power** you want for the flight condition you want. For the Cessna 172, set 2250 r.p.m. for level flight at normal cruise speed. Then move the yoke to set the pitch **attitude** which will achieve the cruise speed of 105 knots. Then **trim** out the out of balance pressure on the yoke or stick. This method of setting up flight conditions is always used, (with one exception outlined below).

So, in Flight Simulator, on the Cessna 172, to establish level flight at, say, 90 knots: -

1. Set **power** to 2100 r.p.m.
2. Set pitch **attitude**
3. **Trim**

2.5 The Only Exception

When leveling out after a normal (full power in the C172) climb, if you apply the PAT rule as you reach your desired height, the moment you reduce power, you will start to descend whilst still establishing the cruise attitude. You would then have to add power to recommence the climb.

So, in this situation, you set the cruise **attitude** as you reach your desired height, then allow the airspeed to build up to cruise speed, then reduce **power** to 2250 r.p.m. Then **trim** out the out-of-balance stick force.

So – leveling out after the climb, it is APT – Attitude, Power, Trim.

In this paragraph I used the word 'height' instead of 'altitude' to avoid any confusion with 'attitude'!

2.6 Trim for Airspeed

Summarised into one sentence, use trim to maintain accurate airspeed, use power to control climb or descent.

3 TRY IT IN THE AIR

Here are some exercises in trimming to try in flight.

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1. Set 2250 rpm and establish cruise speed of 105 knots. Adjust with very small movements of the yoke until 105 knots is achieved. Don't "hunt the airspeed", but wait a few seconds (10 – 20) after each adjustment for the airspeed to stabilise before making another change. Add or remove power in 25 r.p.m. increments if there is a tendency to climb or descend.
2. Set full power and lower the nose to maintain level flight. Trim. Check what airspeed you achieve. It will be around 120 knots.
3. Set 1800 r.p.m. and raise the nose to maintain level flight. Your airspeed will be about 71 knots.
4. Climb to 3000 feet. Close the throttle completely, and raise the nose to establish 70 knots. You will find that you need to keep holding the yoke further and further back at first. When established at around 70 knots, Trim to maintain exactly 70 knots. Adjust trim in small increments if necessary to maintain exactly 70 knots. This might take several minutes. The nose will be fairly high – possibly as high as in normal cruise flight. The aircraft will descend at around 600 feet per minute. Maintain this accurate airspeed as the aircraft descends right down to 500 feet, then apply full power and set the climb attitude to establish a climb at exactly 70 knots. Trim to maintain this airspeed.

4 ADJUSTING FS SETTINGS

In FS the trim on the default 172 is rather coarse. You press the trim button or key once, and the change to pitch is greater than you need to establish trimmed out flight. This can result in you having to constantly chase the attitude with an "up" adjustment, followed quickly by a "down" adjustment.

Fortunately this can be adjusted in the aircraft.cfg file which may be found in the main folder for the aircraft you are flying, e.g. for FSX;

Flight Simulator X\SimObjects\Airplanes\C172

First, make a safe copy of the file, e.g. aircraft.cfg.saf

Then open the file in Notepad and look down the file for a line as follows

```
[flight_tuning]
```

Then look down the subsequent lines (about 10 lines) until you see the line
elevator_trim_effectiveness = 1.0

Save this line as a comment by typing // in front of it, then add a comment at the end "FS default value"

Now add new a line beneath:

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```
elevator_trim_effectiveness = 0.5
```

You should now have the following two lines:

```
//elevator_trim_effectiveness = 1.0 //FS default value
elevator_trim_effectiveness = 0.5
```

Now save the file, and try it out. Start FS, load that aircraft and fly around testing the trim sensitivity.

You can adjust the value to whatever you find best for you without exiting FS. Pause FS and minimize it. Change the setting in aircraft.cfg. Maximise FS again and reload the aircraft from the aircraft menu. This will also load your new setting. Repeat until you are satisfied with the value.