Snelflight Hoverfly

Hoverfly flight wobble

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When everything is working properly, the Hoverfly will fly smoothly. At its best it is silky, with a magically graceful quality. This level of performance frequently remains even after multiple crashes, but if your Hoverfly is more reminiscent of a concrete mixer, then this article is for you!

Wobble in flight can physically be caused only by something that's rotating. This is useful, because it narrows the search down to the rotor, and the parts thereon. There are several types of wobble.

1: Mass imbalance: This means, quite simply, that the centre of gravity of the rotor is not in the middle, so that a net centrifugal force rotates with the rotor as it spins, pulling the helicopter as it goes. It can be caused by differing component weights (particularly the wooden arms, which vary one from another). This effect is very small, however. Alternatively, if the rotor arms are not equally spaced 120 degrees apart, then the rotor will be out of balance. The wooden arms can occasionally get bent out of shape in a crash; alternatively, the arms may finish up out of position if the rotor is repaired. The carbon fibre rotor is very resistant to physical distortions.

2: Thrust imbalance: This means that the three motors are not providing equal thrust. This is the commonest cause of wobble, with several sub-causes:

The propellers need to be matched for thrust, since they differ from one another in spite of coming from the same mould, because they distort randomly during cooling. At Snelflight, we measure the thrust of each one on a special machine. They are then grouped for thrust into numbered bins, hence the grading number on the pack. The idea is that any three props from the same bin are close enough to work together without wobble. The actual differences are small, so that props of any grade will give almost identical climbout performance, but mismatched props are a leading cause of wobble, because matching has to be so precise. The props are stable, so they don't change thrust in normal use, though chips and other damage can affect them.

Propellers which are themselves out-of-balance (they vibrate in use) will generally perform less well than well-balanced ones. They also stress the rotor, especially where the motor bracket is glued to the arm. Snelflight propellers have been designed for precise balance, whereas those from other manufacturers may not have been.

Thrust imbalance can also be caused by a faulty motor (rare) and by a poor electrical connection to a motor. The latter can be caused by the vibration from running out-of-balance propellers, which can break the solder connections after a while. Check that the wires are solidly soldered to the motor tags. Check too that the motors all turn freely. It is possible to dislodge the lower motor bearing while fitting a propeller, if the armature isn't held firmly enough. This will cause stiffness. Unfortunately, the plastic housing that holds the bearing often gets cracked in the process, so that the bearing will no longer stay in place. This calls for a new motor, or a very careful cyano repair.

The motors stay well matched during their working life, but their brushes and commutators do eventually wear out. They typically last a few tens of hours, and all three tend to wear out at the same time. Black residue can often be seen inside the translucent backplate as a motor gets towards the end of its life. At about this time, a motor will sometimes begin to run poorly, producing low or inconsistent power output. This will cause a wobble. Typically, one motor will give reduced thrust compared with the others, but at a certain throttle speed (roughly the hover setting), the motor will suddenly notch up to full power. If you hold the helicopter by the rotor and slowly bring up the throttle, you can hear (and feel) this effect, and it is pretty easy to identify the particular motor this way. A hard knock will often trigger this fault if it is about ready to happen anyway, so it may appear after a crash. Unfortunately, there is no cure except a replacement motor.

3: Mis-aligned motors: If the motors are not all set at the same angle, then wobble will be created. In particular, all three motors should have roughly zero radial slant. If they seem to be sloping slightly inwards or outwards this doesn't matter provided that they are all the same, but if one is very different, this creates a net radial force which turns with the rotor, causing wobble.

4: Bearing hole not vertical: This will cause a wobble, because the rotor disc will turn on its axis, in spite of the fact that the bearing hole does not lie along it. If the hole is slanted, then it will follow a conical path, dragging the mainshaft and fuselage with it. This can only really be caused by faulty manufacture, or inaccurate crash repair. The former is unlikely, since the rotors are assembled on a jig, and if one were bad in this way, they would all have to be. Please note that if the main shaft itself is bent off the vertical then the helicopter will fly smoothly, but the fuselage will be slanted during flight. This is because the shaft is fixed, and the rotor turns around it.

5: Bad carbon brush contact: This can cause wobble, since a motor will not provide full thrust if it is not getting proper uninterrupted power. The wobble often occurs during rapid climbout, even though the aircraft is smooth at hover. The three brushes under the rotor are the issue, since the upper brush is common to all three motors and hence affects all three in unison. There is one lower brush for each motor, and they all have to make good contact all the way around the commutator. Imperfections generally disappear as the brushes 'bed-in' during the first couple of minutes of flight following a rebuild.

A Hoverfly that is out-of-balance or that has mismatched propellers will be quite flyable, the wobble being merely a cosmetic intrusion. If the wobble is so bad that it makes flying difficult, then there is almost certainly something else wrong, such as a faulty motor, or loose wiring. Cosmetic wobbles respond well to Blu-Tack balancing (see manual). Switching the propellers around can also help, especially if any of them is at all damaged since this alters the effect of any small differences in thrust, sometimes to considerable advantage. When adding Blu-Tack, bear in mind that you are correcting for a mixture of the above types of wobble. For smooth flight, the rotor may not need to be perfectly balanced in weight terms. The way in which the different wobble types interact is quite complex, and interestingly enough, can lead to a composite wobble at various multiples or fractions of the rotor’s speed. With experience, this can give you some clues about what corrections to make.