The Open University

The physical world: helicopters

Traditional rotor blades

V/O: The key to making lift is getting air to flow over an aerofoil. In a helicopter you do it by spinning the rotor blades.

ANGELA: Once the rotors get going they whiz round at constant speed, but to generate lift you don't change the speed, you change the angle of the blades as they rotate. Angling a blade upwards into the onrushing air increases the lift, and the effect is dramatic enough to cause take off.

TUTOR: We make more lift; we change the angle of our wing by pulling up this lever. If I pull it up it increases the angle of them, throws more air down, makes thrust straight up, and it supports our weight, we get lighter, we pull it up some more, we take off and we're flying. Of course when you pull it up the the rotors are harder to push through the air, so we need to push them harder as well. And you don't really have to worry about that because the lever does that automatically. When you pull the lever up, it also tells the engine to push harder too.

(CONVERSATION IN HELICOPTER)

MAN: It's a fundamental law in physics that if you push an object or a gas or a liquid in one direction, the object doing the pushing will go in the other, and this is how helicopters work. The pilot has a lever on the left called the collective pitch; when that lever is pulled, the aerofoils tip up at the front and increase the lift, and this drives air downwards, and as a result the helicopter goes the other way.

TUTOR: This cubic metre of air weighs about a kilo and a quarter, it's quite heavy really, if you think about that, a litre of water weighs one kilo, so that's quite a big mass to chuck around. So we throw, with our wing, we throw cubic metres of air, kilo and a quarter chunks of air, down. And that lets us, gives us lift and supports us.

V/O: Looking at a rotor in slow motion the smoke pattern shows air being downwards. The pressure difference above and below the blade that produces lift also causes this downdraft. As air rushes down, an equal and opposite forces push the rotors up so a helicopter flies.

(CONVERSATION IN HELICOPTER)

MAN: It is wrong to associate floppiness with lack of strength; you've got both. The rotor needs to be able to flex up and down, backwards and forwards, and in twist, and it is allowed to do so. But the structure and the materials are designed such that that can happen, but the rotor is still very, very strong indeed.

ANGELA: Just became something looks flimsy it doesn't mean it's weak. If you want to suspend a heavy weight you need something that's strong in tension. During a flight rotor blades are under a huge amount of tension, a force many times the weight of the helicopter, so you need lengthwise strength in the blades. And the body of the helicopter is kept suspended in the air by the tension in the rotors.

(CONVERSATION IN HELICOPTER)