APPLICATION OF THE MULTIMEDIA DURING TEACHING OF THE HELICOPTER FLIGHT CONTROL

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In process of teaching subject of aerodynamics of helicopter understanding the explanation of working of helicopter flight control by drawing them on chalkboard often turns out to be a problem. At the Airframe and Engine Department they succeeded in solution to these problems by multimedia.. This article, through an example by using program Power Point, shows the increasing effectiveness of learning the subject.

INTRODUCTION

Helicopters are the most versatile flying machines in existence today. This versatility gives the pilot complete access to 3-dimensional space in a way that no aircraft can. If you have ever flown in a helicopter you know that its abilities are exhilarating! The amazing flexibility of helicopters means that helicopters can fly almost anywhere. However, it also means that the machines are complicated to fly. The pilot has to think in three dimensions and must use both arms and both legs constantly to keep a helicopter in the air! Piloting a helicopter requires a great deal of training and skill, as well as continuous attention to the machine.
A helicopter can do three things that an aircraft cannot:

- a helicopter can fly backwards;
- the entire aircraft can rotate in the air;
- a helicopter can hover motionless in the air.

ASYMMETRY OF LIFT

Asymmetry of lift is the difference in lift that exists between the advancing half of the rotor disk and the retreating half. It is caused by the fact that in directional

flight the aircraft relative wind is added to the rotational relative wind on the advancing blade, and subtracted on the retreating blade. The blade passing the tail and advancing around the right side of the helicopter has an increasing airspeed which reaches maximum at the 9 o'clock position. As the blade continues, the airspeed reduces to essentially rotational airspeed over the nose of the helicopter. Leaving the nose, the blade airspeed progressively decreases and reaches minimum airspeed at the 3 o'clock position. The blade airspeed then increases progressively and again reaches rotational airspeed as it passes over the tail.
Note the shaded circle in the picture labelled "REVERSE FLOW":

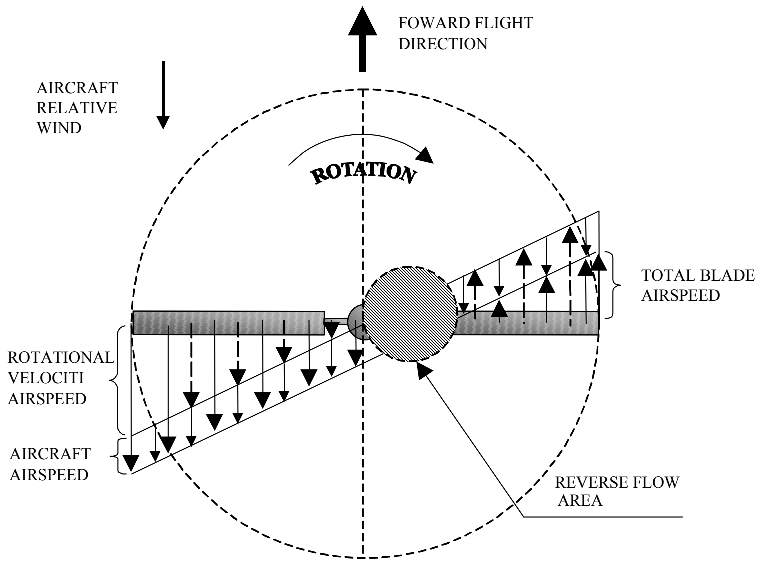

Figure 1.

Since lift increases as the square of the airspeed, a potential lift variation exists between the advancing and retreating sides of the rotor disk. This lift differential must be compensated for, or the helicopter would not be controllable.

To compare the lift of the advancing half of the disk area to the lift of the retreating half, the lift equation can be used. In forward flight, two factors in the lift formula, density ratio and blade area, are the same for both the advancing and retreating blades. The airfoil shape is fixed for a given blade. The only remaining variables are changes in blade angle of attack and blade airspeed. These two variables must compensate for each other during forward flight to overcome asymmetry of lift.

Two factors, *rotor RPM* and *aircraft airspeed*, control blade airspeed during flight. Both factors are variable to some degree, but must remain within certain operating limits. Angle of attack remains as the one variable that may be used by the pilot to compensate for asymmetry of lift. The pitch angle of the rotor blades can be varied throughout their range, from flat pitch to the stalling pitch angle, to change angle of attack and to compensate for lift differential.

In a helicopter you can move laterally in any direction or you can rotate 360 degrees. These extra degrees of freedom and the skill you must have to master them is what makes helicopters so exciting, but it also makes them complex. To control a helicopter one hand grasps a control called the **cyclic** which controls the lateral direction of the helicopter (including forward, backward, left and right). The other hand grasps a control called the **collective** which controls the up and down motion of the helicopter (and also controls engine speed). The pilot's feet rest on pedals that control the tail rotor, which allows the helicopter to rotate in either direction on its axis. It takes both hands and both feet to fly a helicopter!

HOW HELICOPTERS FLY

A rotary motion is the easiest way to keep a wing in continuous motion. So you can mount two or more wings on a central shaft and spin the shaft, much like the blades on a ceiling fan. The rotating wings of a helicopter are shaped just like the airfoils of an aircraft wing, but generally the wings on a helicopter's rotor are narrow and thin because they are spinning so fast. The helicopter's rotating wing assembly is normally called the **main rotor**. If you give the main rotor wings a slight angle of attack on the shaft and spin the shaft, the wings will start to develop lift.

In order to spin the shaft with enough force to lift a human being and the vehicle, you need an engine of some sort. Reciprocating gasoline engines and gas turbine engines are the most common types. The engine's drive shaft can connect through a transmission to the main rotor shaft. This arrangement works great until the moment the vehicle leaves the ground. At that moment there is nothing to keep the engine (and therefore the body of the vehicle) from spinning just like the main rotor does. So, in the absence of anything to stop it, the body will spin in an opposite direction to the main rotor. To keep the body from spinning you need to apply a force to it.

The normal way to provide a force to the body of the vehicle is to attach another set of rotating wings to a long boom. These wings are known as the **tail rotor**. The tail rotor produces thrust, just like an aircraft's propeller does. By producing thrust in a sideways direction, counteracting the engine's desire to spin the body, the tail rotor keeps the body of the helicopter from spinning. Normally the tail rotor is driven by a

long drive shaft that runs from the main rotor's transmission back through the tail boom to a small transmission at the tail rotor.
What you end up with is a vehicle that looks something like this:

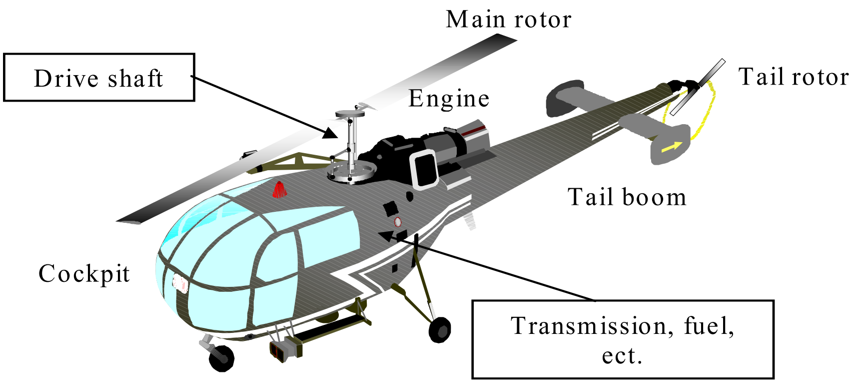

Figure 2.

In order to actually control the machine, both the main rotor and the tail rotor need to be adjustable. The following two sections explain how the adjustment works.

THE TAIL ROTOR

The adjustment of the tail rotor is straightforward — what you want is the ability to change the angle of attack on the tail rotor wings so that you can use the tail rotor to rotate the helicopter on the drive shaft's axis. The pilot has two foot pedals that control the angle of attack.

Figure 3.

THE MAIN ROTOR

A helicopter's main rotor is the most important part of the vehicle. It provides the lift that allows the helicopter to fly and it also provides the control that allows the helicopter to move laterally, make turns and change altitude. To handle all of these tasks, the rotor must first be incredibly strong. It must also be able to adjust the angle of the rotor blades with each revolution of the hub. The adjustment provided by a device called **swash plate assembly,** shown in this photograph:

Figure 4.

The swash plate assembly has two primary roles:

— Under the direction of the **collective** control, the swash plate assembly can change the angle of both blades simultaneously. Doing this increases or decreases the lift that the main rotor supplies to the vehicle, allowing the helicopter to gain or lose altitude.

— Under the direction of the **cyclic** control, the swash plate assembly can change the angle of the blades individually as they revolve. This allows the helicopter to move in any direction around a 360 degree circle, including forward, backward, left and right.

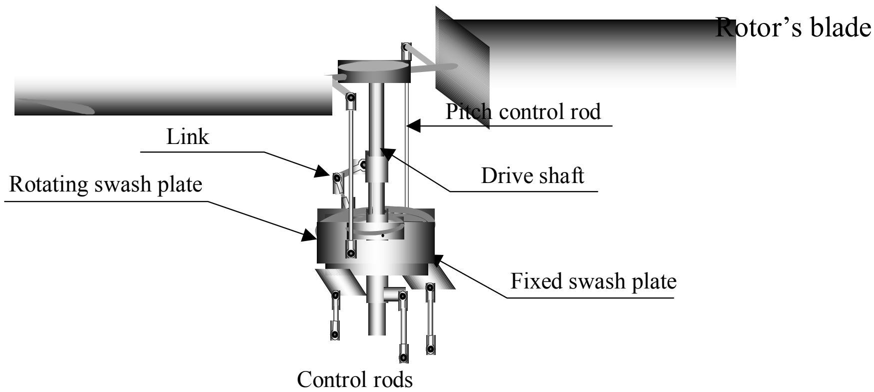

Figure 5.

The swash plate assembly consists of two plates: the fixed and the rotating swash plates. The rotating swash plate rotates with the drive shaft and the rotor's blades because of the links that connect the rotating plate to the drive shaft. The pitch control rods allow the rotating swash plate to change the pitch of the rotor blades. The angle of the fixed swash plate changed by the control rods attached to the fixed swash plate. The fixed plate's control rods are affected by the pilot's input to the cyclic and collective controls. The fixed and rotating swash plates are connected with a set of bearings between the two plates. These bearings allow the rotating swash plate to spin on top of the fixed swash plate.
The collective control changes the angle of attack on both blades simultaneously:

Figure 6.

The cyclic control tilts the swash plate assembly so that the angle of attack on one side of the helicopter is greater than it is on the other, like this:

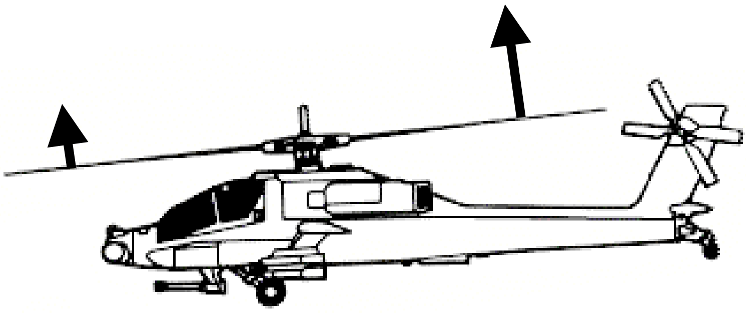

Figure 7.

The following slides created by me help you understand the relationship between the cyclic and collective controls and the swash plate assembly.

In general:

— The collective control raises the entire swash plate assembly as a unit. This has the effect of changing the pitch of both blades simultaneously.

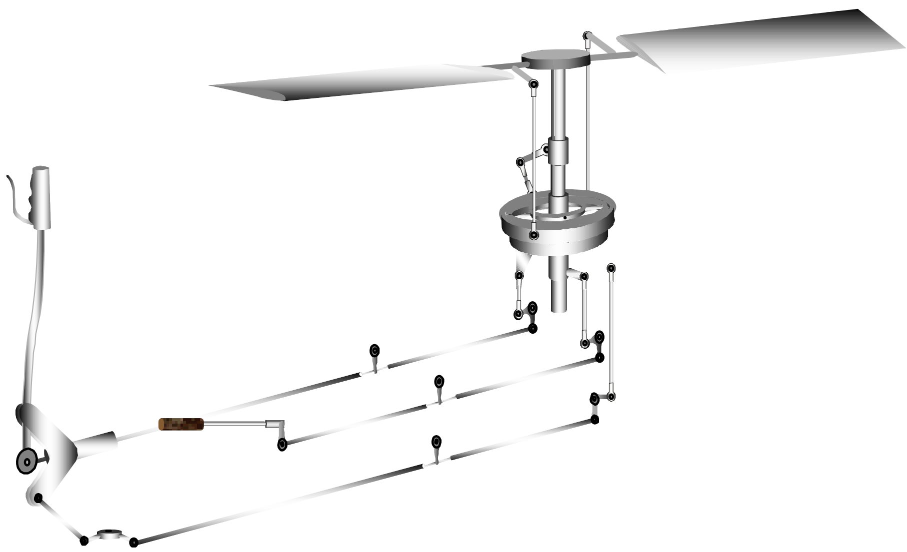

Figure 8.

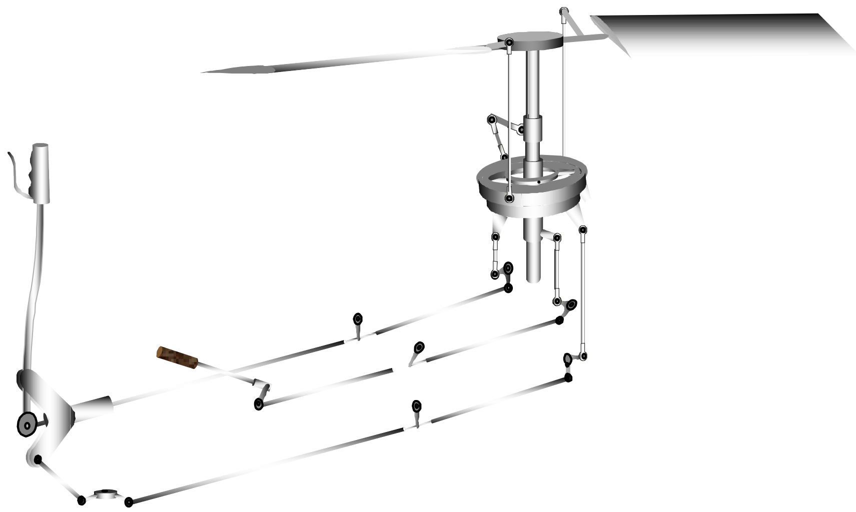

Figure 9.

— The cyclic control pushes one side of the swash plate assembly up or down. This has the effect of changing the pitch of the blades unevenly depending on where they are in the rotation. The result of the cyclic control is that the rotor's wings have a greater angle of attack (and therefore more lift) on one side of the helicopter and a lesser angle of attack (and less lift) on the opposite side. The unbalanced lift causes the helicopter to tip and move laterally.

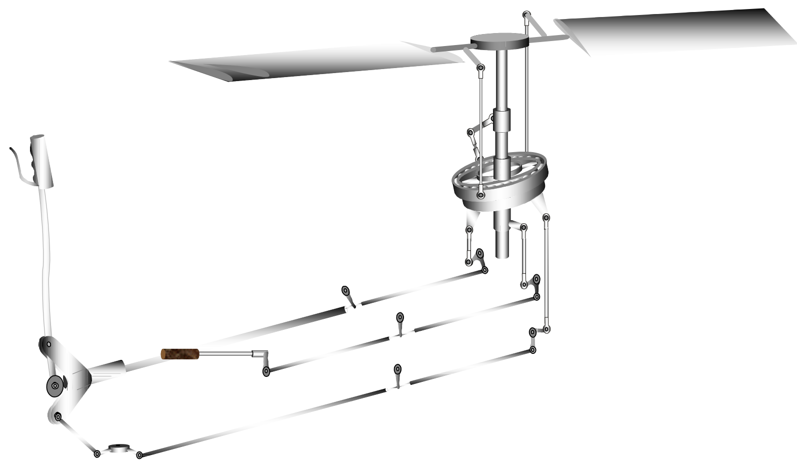

Figure 10.

CONCLUSIONS

The pilot has three major control systems with which to fly the helicopter; the cyclic stick, the collective pitch lever and the rudder pedals. The cyclic stick controls the angle of the main rotor by angling the rotor head to which all the blades are attached. This in turn controls the course that the helicopter follows; effectively pointing the rotors in the desired direction of travel. The collective pitch lever controls the common angle of attack of the main rotor blades, which, in conjunction with the throttle, is used to control the amount of lift generated by the rotor disk. The rudder pedals increase and decrease the amount of power to the tail rotor, which is varied according to the amount of collective lift being applied and manoeuvre of the aircraft being undertaken.

The aim of my lecture read during this conference is to prove the fact with demonstration of slides made by Power Point software that using multimedia the effectiveness of education can be increased.

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