



The physical world: helicopters

Modern rotor blades

V/O: For everyday flying machines you want to keep the technology as simple as possible: basic rotor blades will do the job. But if you really want to explore the limits of aerodynamics the big military helicopters are at the cutting edge of blade technology.

ANGELA: There aren't many companies that can make really big helicopters, but this is one of them. Around the world thousands of lives hang in the air thanks to the rotor blades made here at Westland Helicopters in Yeovil.

**CAPTION: COLIN HAGUE
CHIEF TEST PILOT
GKN WESTLAND HELICOPTERS LTD:**

Most of the aircraft that we make and are involved in are military ones like the H101 that you see behind me here, which is the RAF version, the troop-carrying version. And these are a new design of rotor as you can see from the very unusual shape of them with the great big paddle tip at the end of it, and in fact they are a revolution in rotor design.

V/O: This complex shape has evolved to push back the limits of aerodynamic design. The amount of lift an aerofoil makes depends on the angle of attack and the air speed. Air flows more slowly at the hub of a rotor than at the faster-moving tip, so to produce an even amount of lift along the blade you want a higher angle of attack at the hub than at the tip. That's achieved by making the rotor with a twist along its length. Aerodynamics determines the optimum design, as the angle of attack increases, the flow above an aerofoil becomes turbulent; this increases drag and reduces lift. So there is a limit on the angle of attack that can be used. But that's not the designer's only problem.

**CAPTION: MARTIN MIDDLETON
OPERATIONS MANAGER
GKN WESTLAND HELICOPTERS LTD:**

Because the tip is moving through the air at high speed we have to try and avoid some of the aerodynamic effects that occur as we reach the speed of sound. This is achieved by a sweep in the blade here, which is not dissimilar to the sweep you see on fixed wing aircraft, or even the sweep that you see start to deploy on supersonic aircraft as they come up towards the speed of sound they just swing their wings back.

Prototypes of this aerodynamic technology flew in the mid-1980's. The Lynx aircraft actually took the world speed record at just under 250 miles an hour; really you're not going to change that unless you rewrite the laws of aerodynamics and Newtonian mechanics.