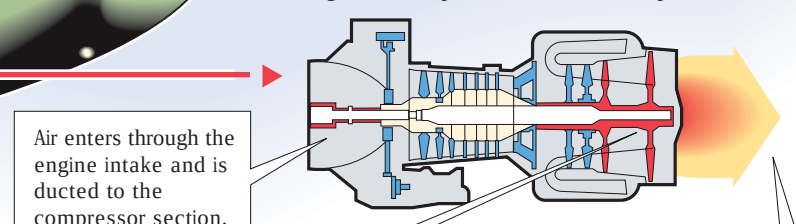
High, **heavy** and hot

Operations that U.S armed forces are conducting in the war on terrorism in Afghanistan demand that helicopters fly at the limits of their capabilities.

But high altitudes and heavy loads eat into an aircraft's performance, sometimes leaving them unable to land normally – or, sometimes, even safely.

GETTING ALOFT

The Chinook uses the Lycoming T55 turboshaft engine, which produces 3,750 horsepower.



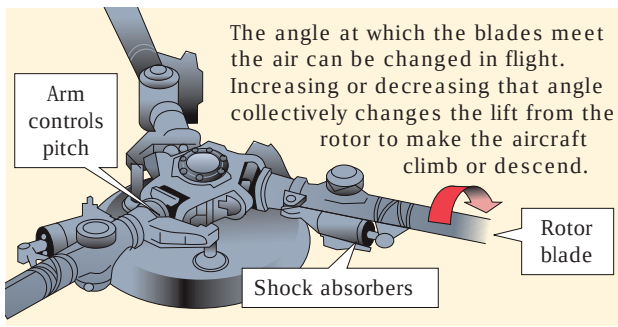
Air enters through the engine intake and is ducted to the compressor section.

Then the compressed air flows into the combustion section, is mixed with jet fuel and ignited.

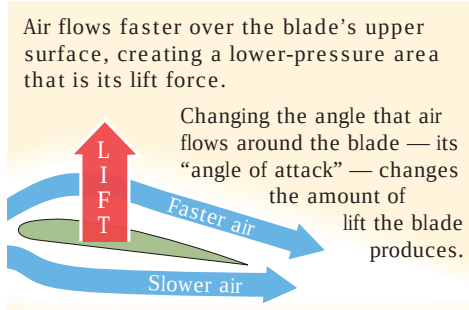
The power turbine extracts energy from the hot gases and then expels them through the exhaust. The rotational energy from the turboshaft engine is captured through a system of gears, transmissions and driveshafts.

ROTORHEAD AND ROTOR BLADES

The rotorhead, where the rotor driveshaft connects to the rotorblades, carries the huge centrifugal forces created by the turning blades, as well as transmitting control forces to the blades so the helicopter can hover, move in any direction, turn, climb and descend.



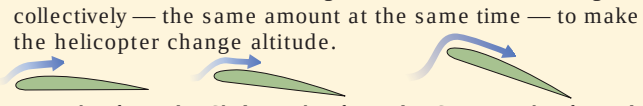
The angle at which the blades meet the air can be changed in flight. Increasing or decreasing that angle collectively changes the lift from the rotor to make the aircraft climb or descend.

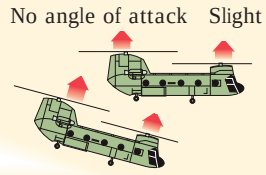


Air flows faster over the blade's upper surface, creating a lower-pressure area that is its lift force.

Changing the angle that air flows around the blade — its "angle of attack" — changes the amount of lift the blade produces.

As the blades rotate, their angle of attack can be changed collectively — the same amount at the same time — to make the helicopter change altitude.



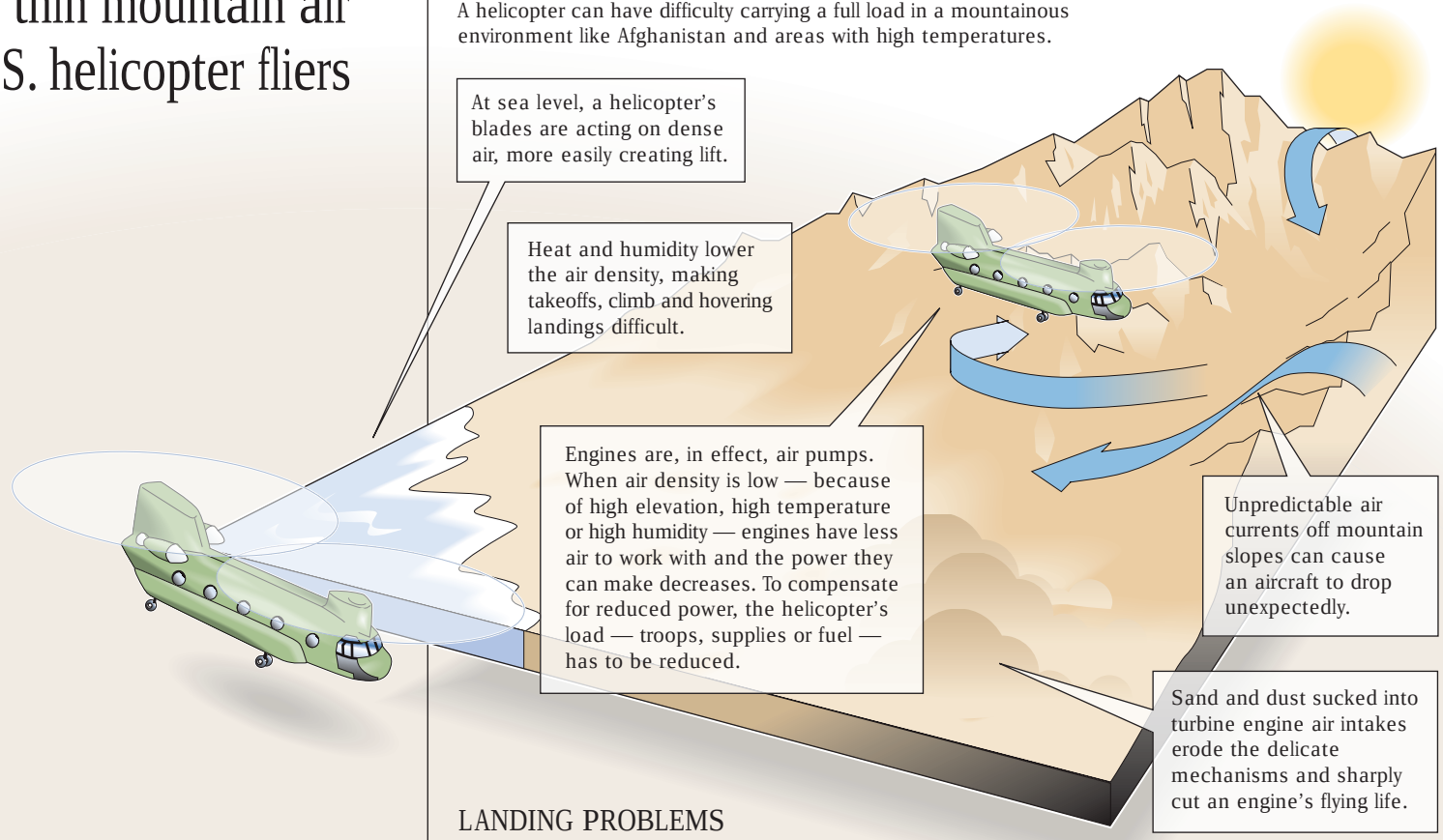


Their angle of attack can also be changed cyclically — differing amounts at differing points in the circle of rotation — to turn the aircraft.

Afghanistan's thin mountain air challenges U.S. helicopter fliers

POWER ISSUES

A helicopter can have difficulty carrying a full load in a mountainous environment like Afghanistan and areas with high temperatures.



At sea level, a helicopter's blades are acting on dense air, more easily creating lift.

Heat and humidity lower the air density, making takeoffs, climb and hovering landings difficult.

Engines are, in effect, air pumps. When air density is low — because of high elevation, high temperature or high humidity — engines have less air to work with and the power they can make decreases. To compensate for reduced power, the helicopter's load — troops, supplies or fuel — has to be reduced.

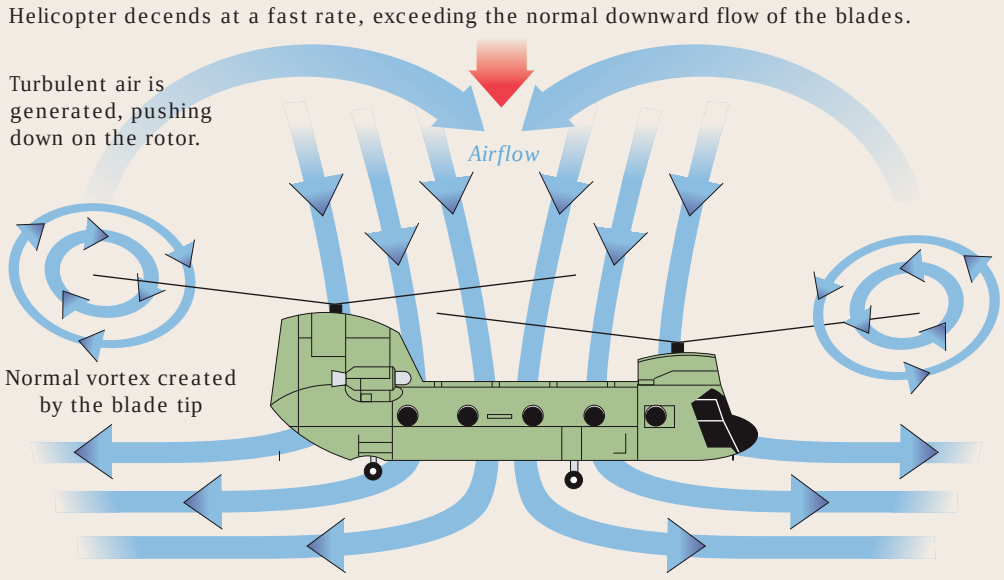
Unpredictable air currents off mountain slopes can cause an aircraft to drop unexpectedly.

Sand and dust sucked into turbine engine air intakes erode the delicate mechanisms and sharply cut an engine's flying life.

LANDING PROBLEMS

Helicopters can get into trouble by descending too fast with too little forward speed. Called "settling with power," the aircraft gets caught in its own rotor's powerful downwash of air. Trying to arrest the descent with more power only pushes the helo toward the ground faster. Helicopters can also enter this turbulent "vortex-ring state" when landing with a tailwind.

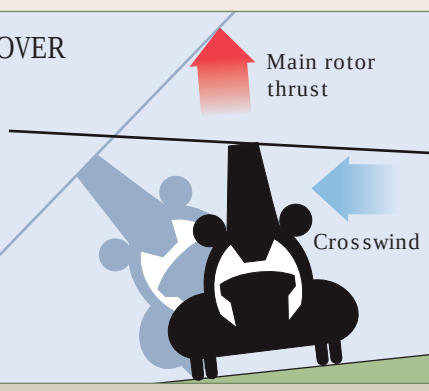
Helicopter decends at a fast rate, exceeding the normal downward flow of the blades.



The full power of the engines is not enough to overcome the sink rate, resulting in a crash.

DYNAMIC ROLLOVER

Mountain slopes and rough terrain can start a chain of events that sends a helicopter toppling over on its side, a situation called "dynamic rollover."



As the helicopter starts to roll sideways as it touches down on a steep slope or by catching its landing gear on an obstruction, the pilot attempts to use the rotor's lift to stop the roll. But the rotor can only tilt so much. Should the helicopter exceed this "critical rollover angle," the aircraft will continue to roll, dangerously out of control.

SOURCES: U.S. Army, U.S. Coast Guard, FAA, NASA, Federation of American Scientists

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