Chinese Al-chemist KO HUNG 320 AD described a flying top that used spinning feather blades to become airborne.

1170 years later in 1490, Leonard Da Vinci designed a ‘lifting screw’ that he thought would some day lift a man. No real progress for the next 300 years.

Between 1784 and 1900 people from Europe and America experimented with steam engines and working models.

Germany’s Nikolaus Otto’s four-stroke cycle IC engine’s power-to-weight rates made the helicopter possible.

First human fixed wing flight-1903
Paul Cornu of France made the first successful helicopter flight in 1907.

Production
In 1939 Igor Sikorsky a Russian Immigrant to America built a helicopter that was dependable and predictable enough to be mass produced.

In 1942 his company began production of a two passenger helicopter which marked the beginnings of the helicopter industry.

Important Performance Milestones

- max speed of 250mp/hr
- altitudes over 7 miles
- capability to take off and lift vertically 60 tons. This one is the most important

Making the helicopter fly has involved wrestling with a long catalogue of problems.

- It was necessary to invent the use of a tail rotor to stop the helicopter spinning around on the main rotor axis.

- It took the genius of Juan de la Cierra to devise a system of articulated blades to prevent the aircraft rolling over continuously. Blade articulation leads to sluggish control.

Remedy:

- Hingeless rotor → aircraft stability is compromised.

- The helicopter can never fly fast judged by the fixed wing aircraft standards.

- Climbing is straight forward

- Descending involves turbulent, vortex laden wake.

- With any practical combination of stability and control characteristics the helicopter remains a difficult and taxing aircraft to fly and generally requires auto-stabilization to restrict the pilot work load to a safe and comfortable level.
### Types of Rotorcraft

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>Single-rotor helicopter</td>
<td>like fixed wings</td>
</tr>
<tr>
<td>Tandem rotor</td>
<td>tilt-rotors</td>
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<tr>
<td>Side-by-side rotors</td>
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<td>Co-axial rotors</td>
<td></td>
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<tr>
<td>Tip-driven rotors</td>
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</tbody>
</table>

#### Principle

A rotor produces an upward thrust by driving a column of air downwards through the rotor plane.

#### Induced Power

The work done on the air, represented by its change in kinetic energy per unit time is

\[
P_i = T v_i = T^{3/2} \sqrt{\frac{2}{\rho A}}; \quad C_{P_i} = C_{T}^{3/2} / \sqrt{2}
\]

Induced power \( P_i \) is the major part of the total power absorbed by a rotor in hover.

#### Profile Power

Power required to overcome the drag of the blades is the profile power \( P_o \).

#### Figure of Merit (M)

The ratio of induced power \( P_i \) to total power \( P_i + P_o \) is a measure of rotor efficiency in hover.

\[
M = \frac{P_i}{P_i + P_o} = (1 + P_o/P_i)^{-1} = (1 + C_{P_i} \sqrt{2}/C_{T}^{3/2})^{-1}
\]

A good Figure of Merit is around 0.75 considering other power required.

#### Directional Control

Through a swash plate mechanism, via the control stick, pitch of individual blades passing specific points can be changed creating differential lift on the blades and a resulting tilted resultant force.

Cyclic pitch is also used to compensate for the differential forces produced on the advancing and retreating sides.
Anti-torque device The fuselage has a tendency to rotate in a direction opposite to the rotor. The tail rotor generates a force that generates a torque opposing the main rotor torque. By varying the tail rotor thrust, the pilot can turn the helicopter to either side.

Auto-rotation:
When power fails the blades of the rotor are driven by the action of the relative wind, much like a windmill, as the helicopter heads down in a controlled descent. Collective pitch is used efficiently to control the speed.