Rotary-Wing Aerospace Vehicles

Familiarisation with rotary-wing aircraft assemblies and geometry.
Classification of rotary-wing aircraft

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WITH ONLY TWO EQUATIONS

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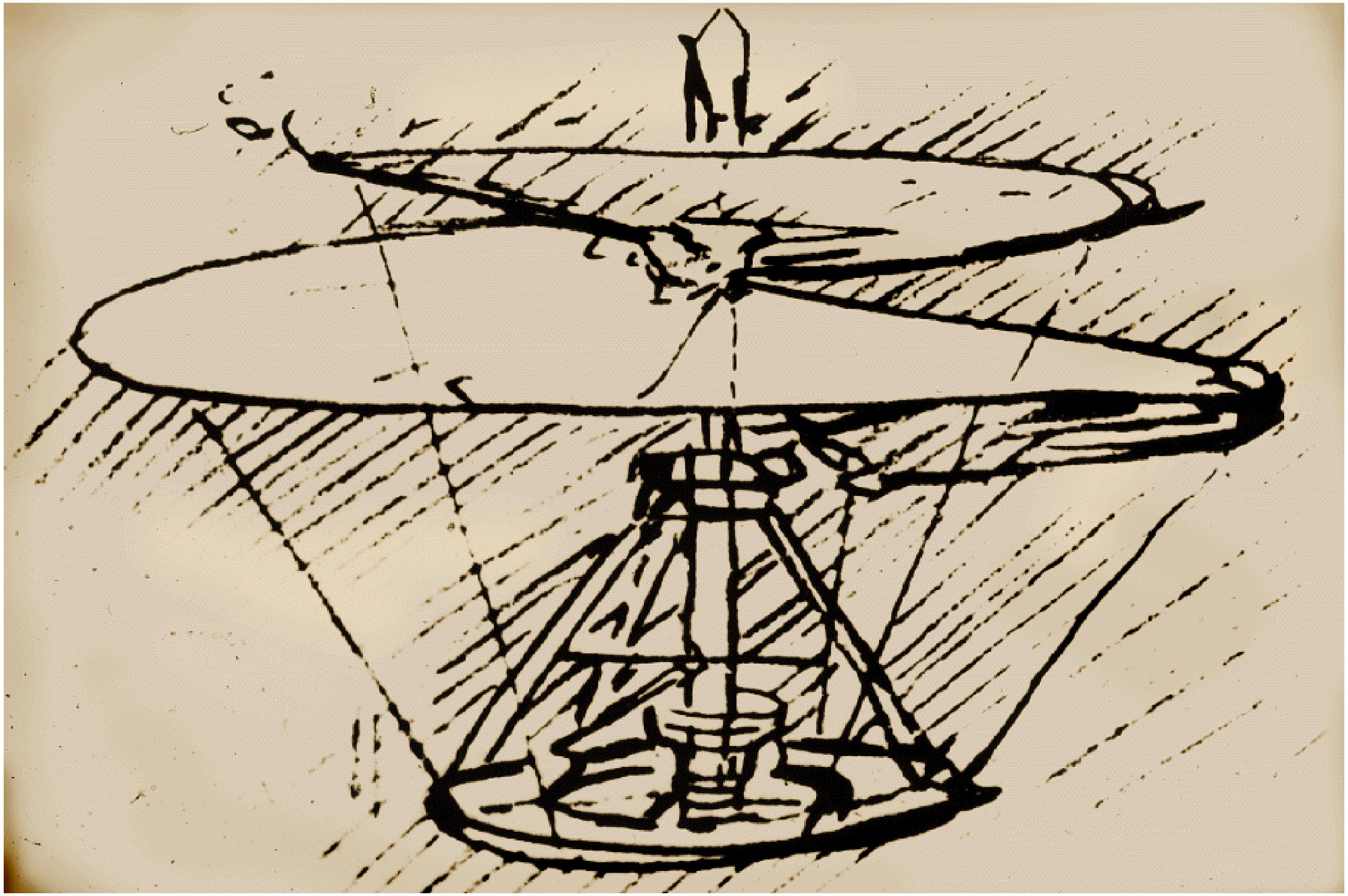
AVDASI 1 – Introduction to Rotary-Wing Aerospace Vehicles

The normally accepted interpretation of "rotary-wing" aerospace vehicles are those that sustain flight by virtue of a wing that rotates about a shaft affixed to the vehicle. This form of flight is unique to man-made devices as no such mechanism exists in nature.



AVDASI 1 – Introduction to Rotary-Wing Aerospace Vehicles

The purpose of this lecture is to:

- Differentiate between rotary-wing sustained flight and vertical take-off and landing (VTOL) capability. (true helicopters, autogyros, tilt rotors, tilt wings, prop-hangers).
- Give a brief history of rotary-wing flight. (early steam powered models, manned-"hoppers", autogyros, helicopters).
- Follow through the path of development to the modern helicopter. (power-to-weight ratio, blade design, control issues).
- Consider the attributes of the different configurations within this class of aircraft. (conventional, coaxial, tandem, side-by-side, tip-jet, syncropter, notar).
- Provide a basic understanding of the physical performance limitations. (weight, speed, altitude, range).
- Investigate the existing and future roles for such aircraft. (MedEvac, **S**earch **A**nd **R**escue, utility work, transport, attack, heavy lift, Mars missions).
- Consider possible future configurations. (lift and thrust compounding, **A**dvancing **B**lade **C**oncept, Stopped Rotor).

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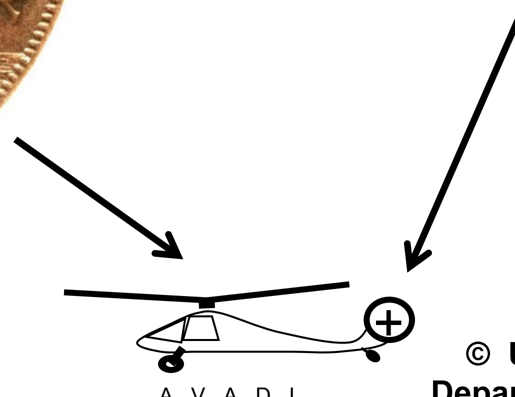
Just to go back to the term “**Conventional configuration**” again.

This is the most popular helicopter configuration and is generally referred to as the *“Penny Farthing”* helicopter. This is because it has a single main rotor and a single, smaller, tail rotor. It got it’s name from two British coins that existed before decimalisation of the British currency in 1971.

Many of you may not have know this.



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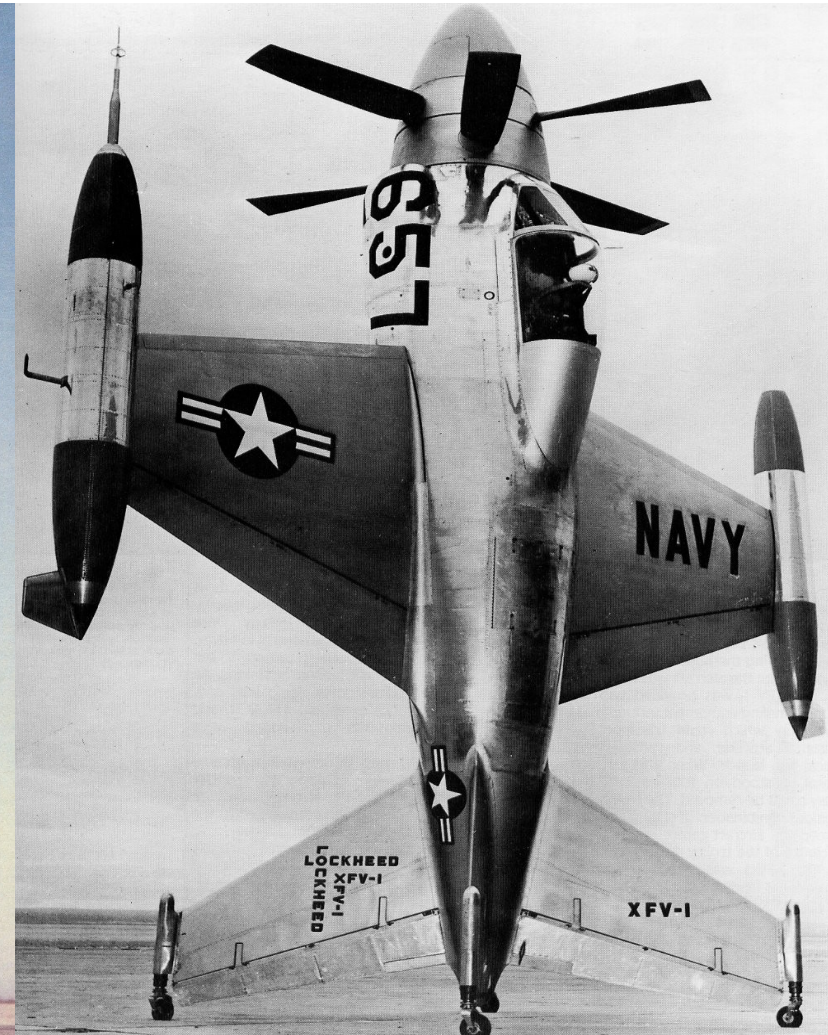

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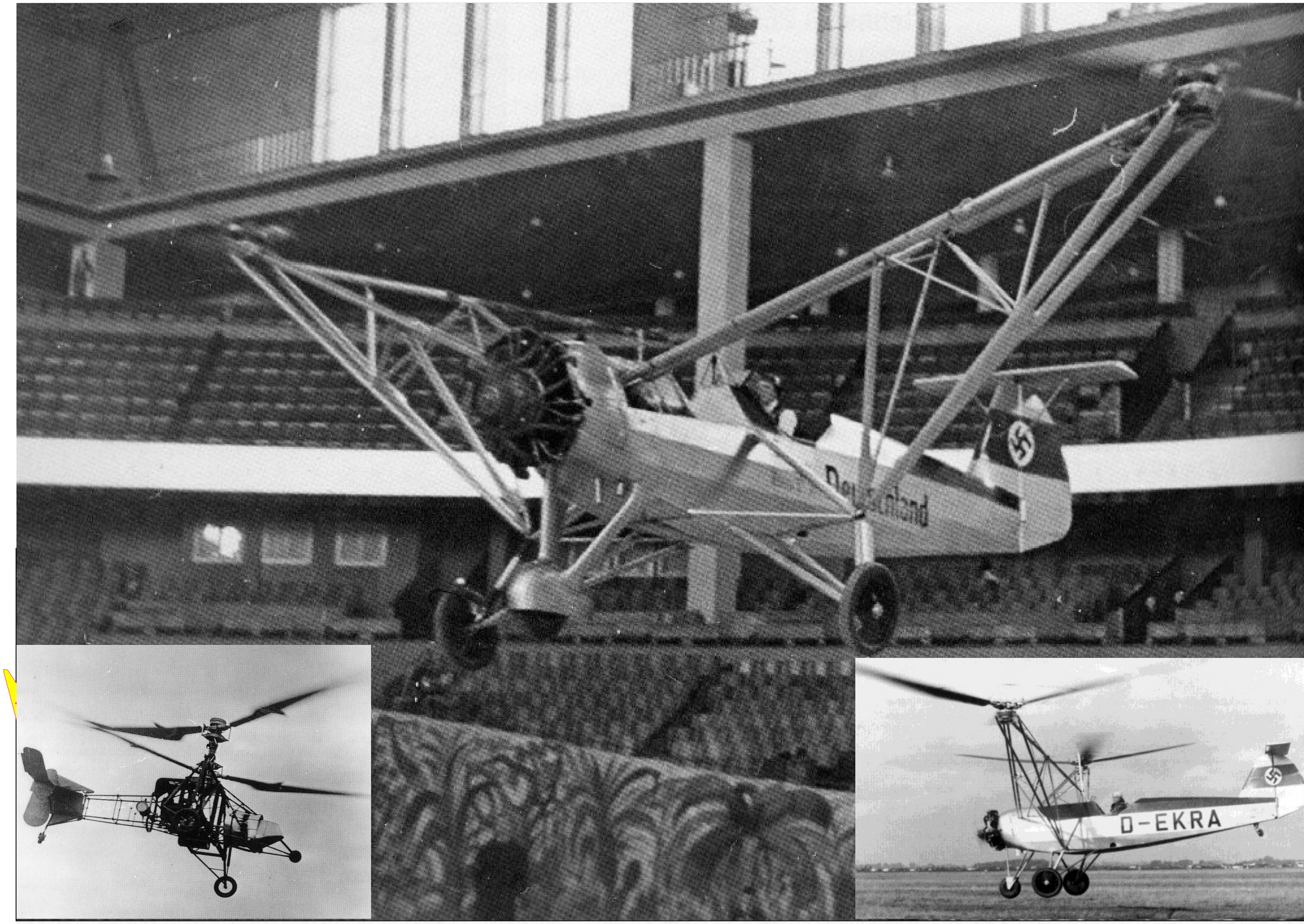

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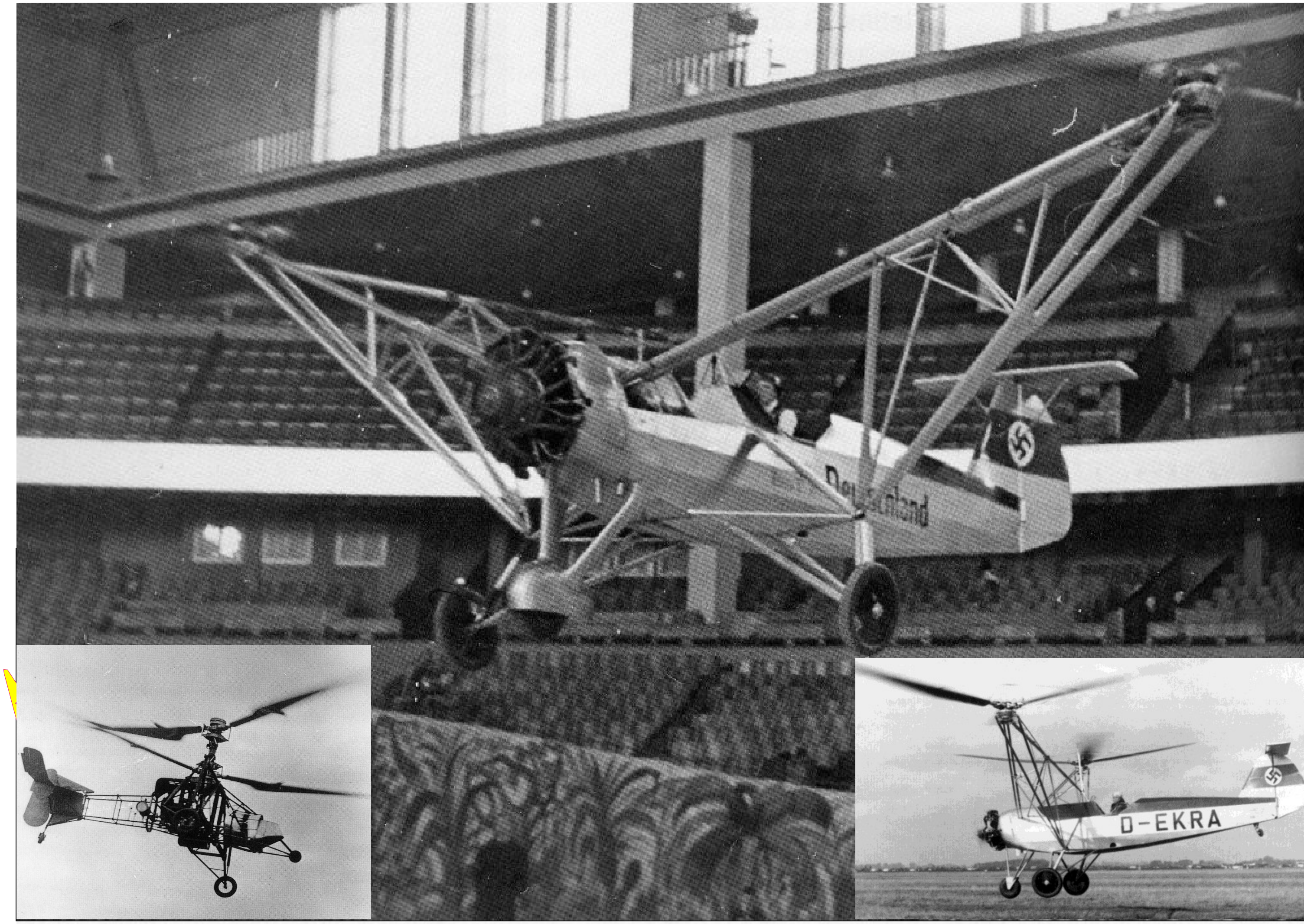

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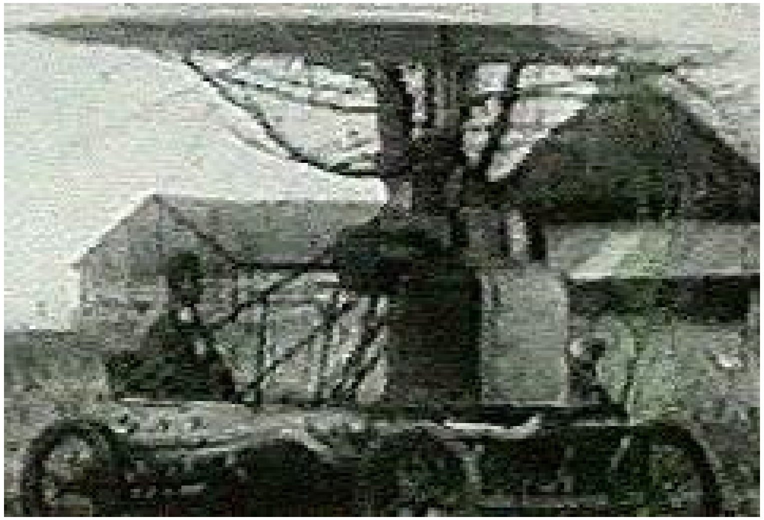
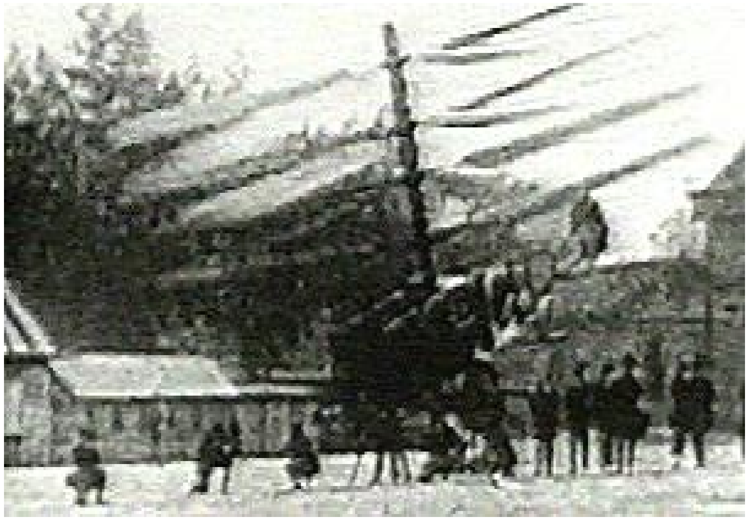
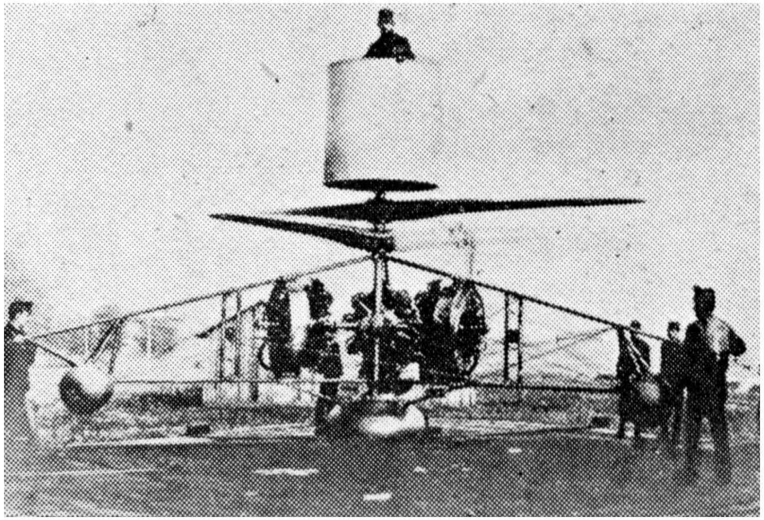
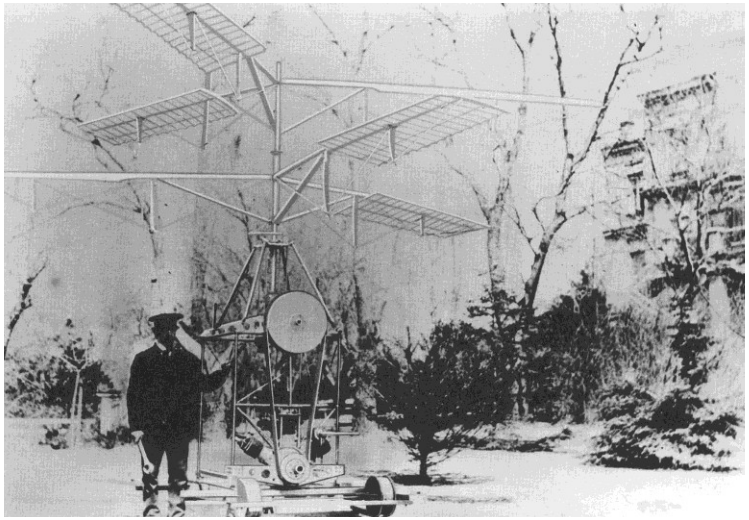

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Provide a basic understanding of the physical performance limitations. (weight, speed, altitude, range).

Now we do need to consider some basic mechanics.....

Force = Mass x Acceleration

for every action (force) there is an equal and opposite reaction (force)

Rotor lift (force) is the reaction to accelerating a mass of air downwards

large mass x small acceleration = force = small mass x large acceleration

22,000 lbs

measured in hours ← hovering endurance → measured in minutes

Provide a basic understanding of the physical performance limitations.
(weight, speed, altitude, range).

Helicopters have very large diameter rotors

just like fix wing aircraft, for efficiency it helps to work with a large mass of air

BUT… for performance and noise reasons, blade tip speed is limited and for conventional helicopters therefore so is weight, speed, altitude and range.

more weight = more lift = more power = larger rotor = slower rotation = more torque

more torque = heavier gearbox = more weight = more lift…….

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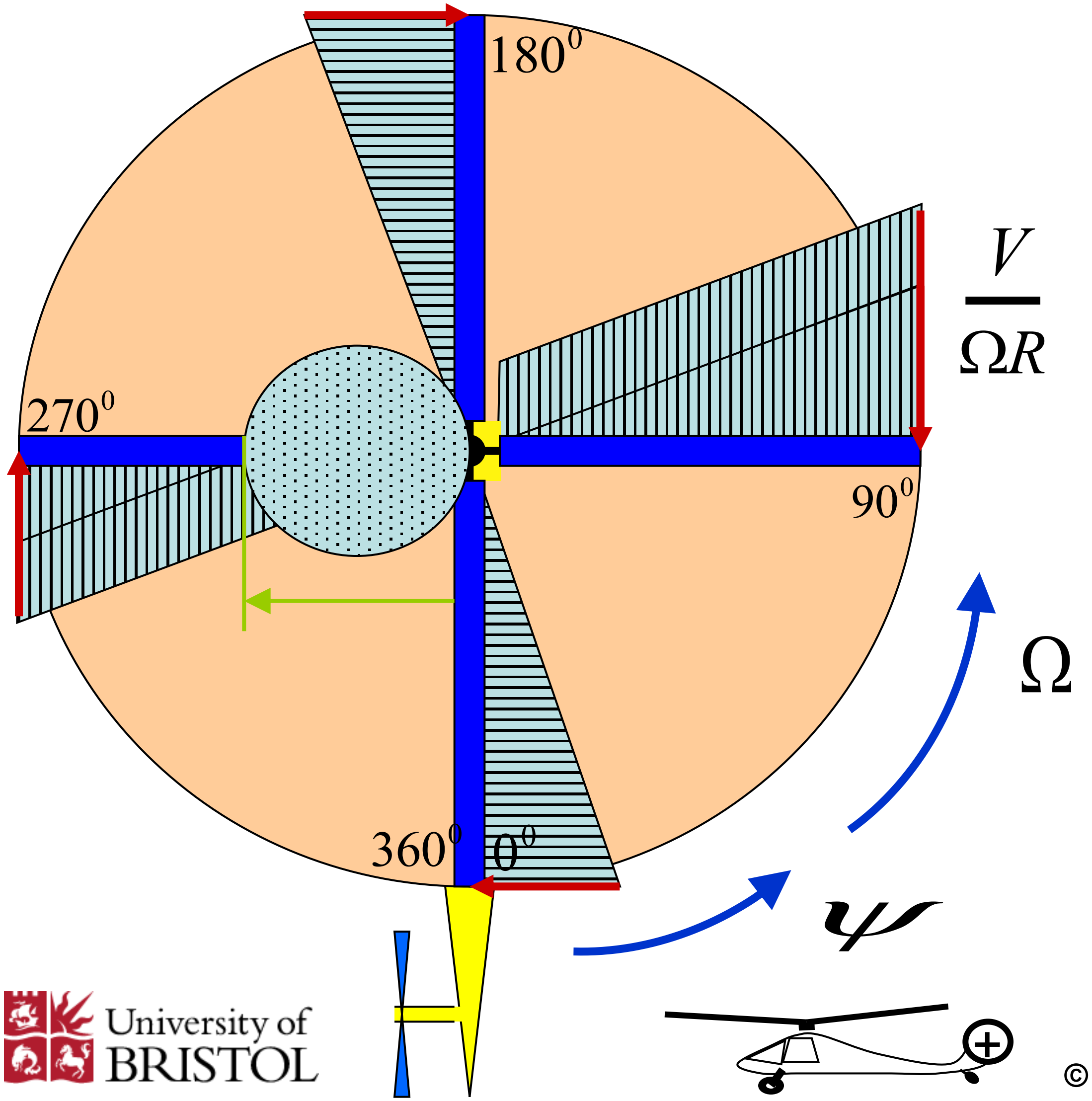

$$\frac{V}{\Omega R} = \mu$$

In addition to the blade velocity due to rotation

there is a common velocity acting on all elements due to edge-wise flight.

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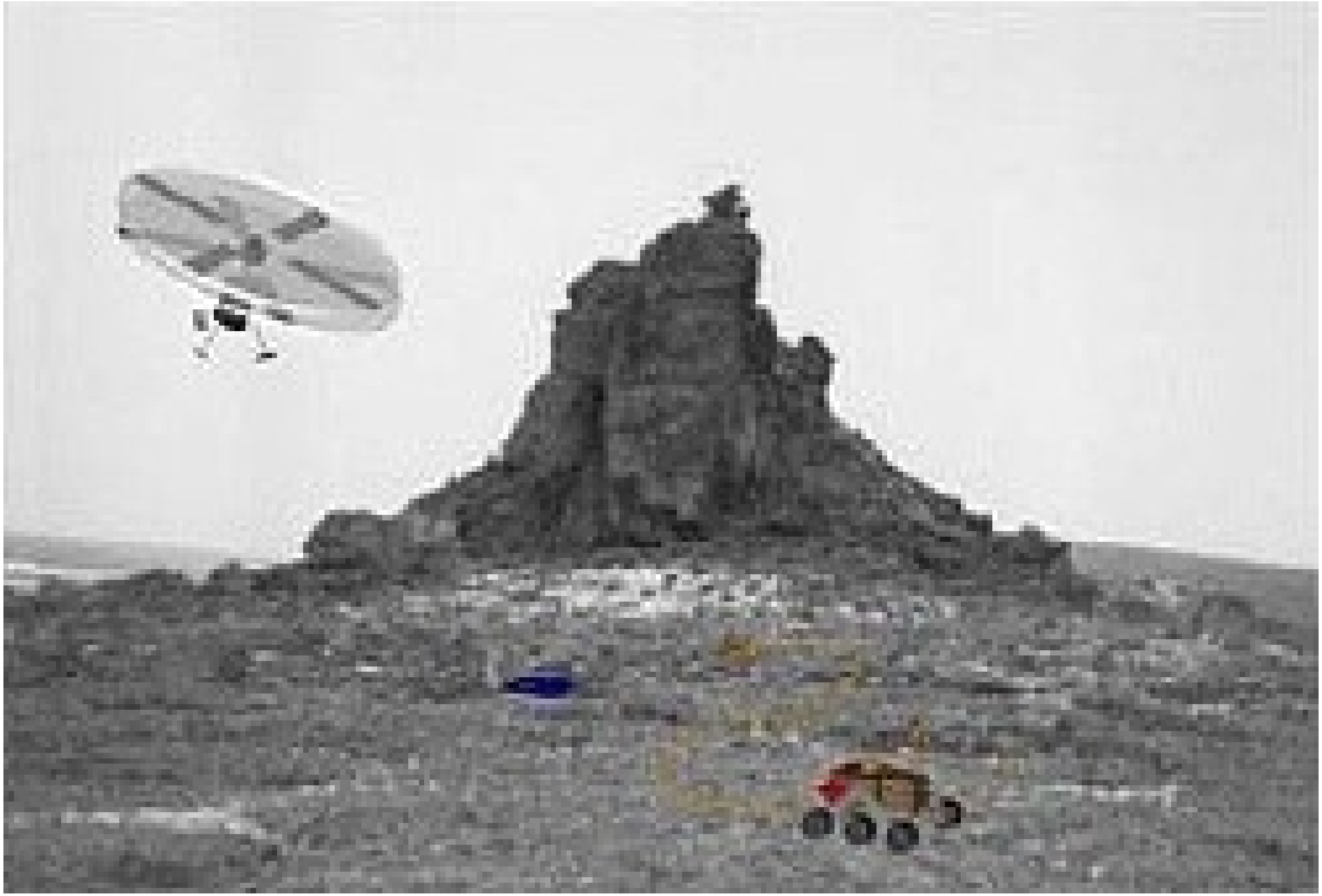

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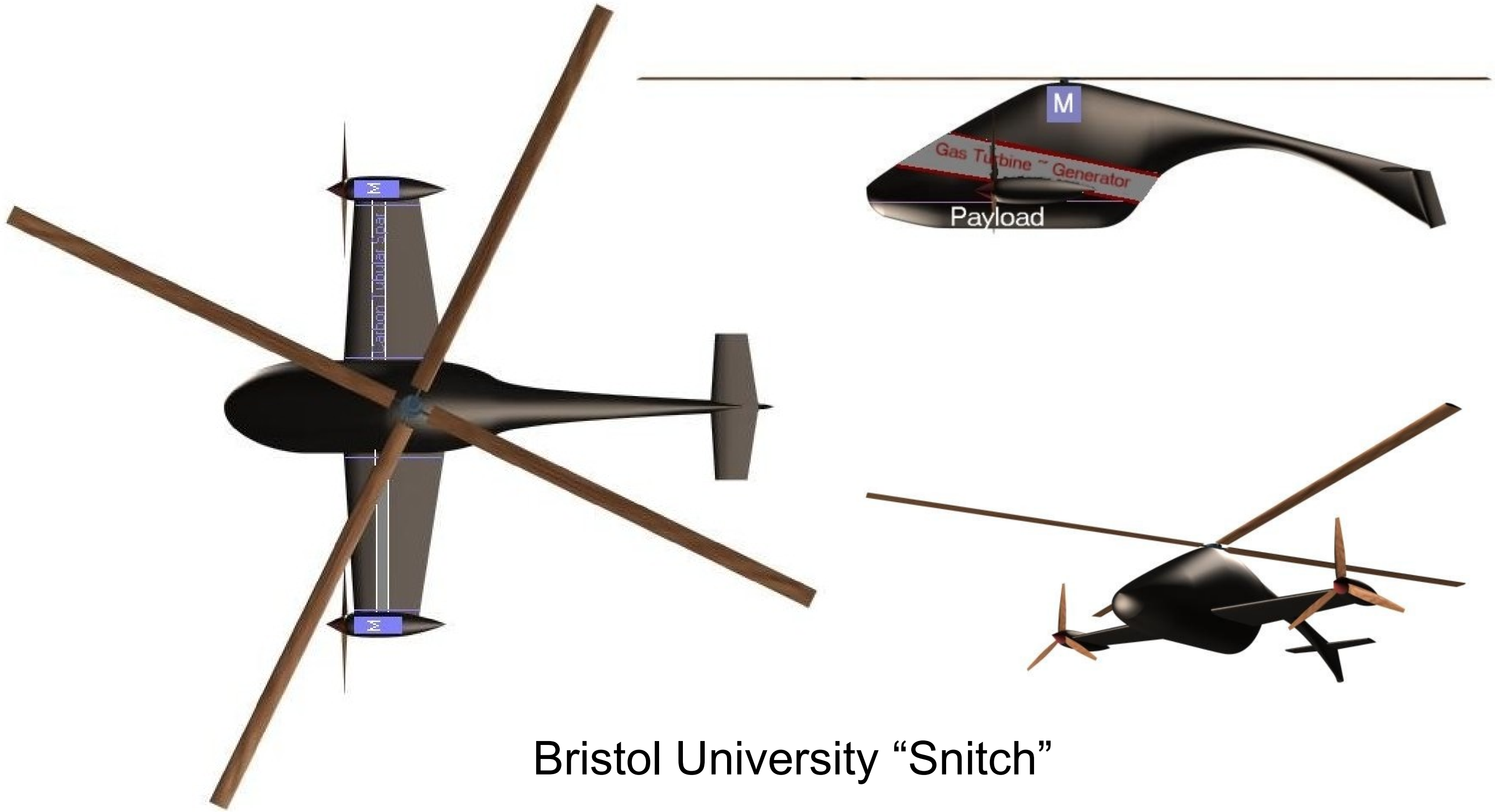

Bristol University "Snitch"

The modern helicopter is a very capable machine, uniquely able to fly in all directions and more importantly hover for useful periods of time.

Whilst the helicopter can be a machine of war, it is a pleasing fact that it is far more often performing the role of saving lives than it is taking lives.

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The Search and Rescue (SAR) helicopter is often <u>the only form of transport</u> that can access survivors in the aftermath of floods, hurricanes, earthquake and many more natural disasters that we believe to be due to climate change.

Rotorcraft lectures & research opportunities for the next 3 years!

- Year 2 – Six formal lectures as part of Aerodynamics 2
- Year 3/4 – Helicopter Aerodynamics & Dynamics optional course
- Year 4 – Design task in conjunction with AgustaWestland (optional)
- Year 4 – Rotorcraft related research for final year project