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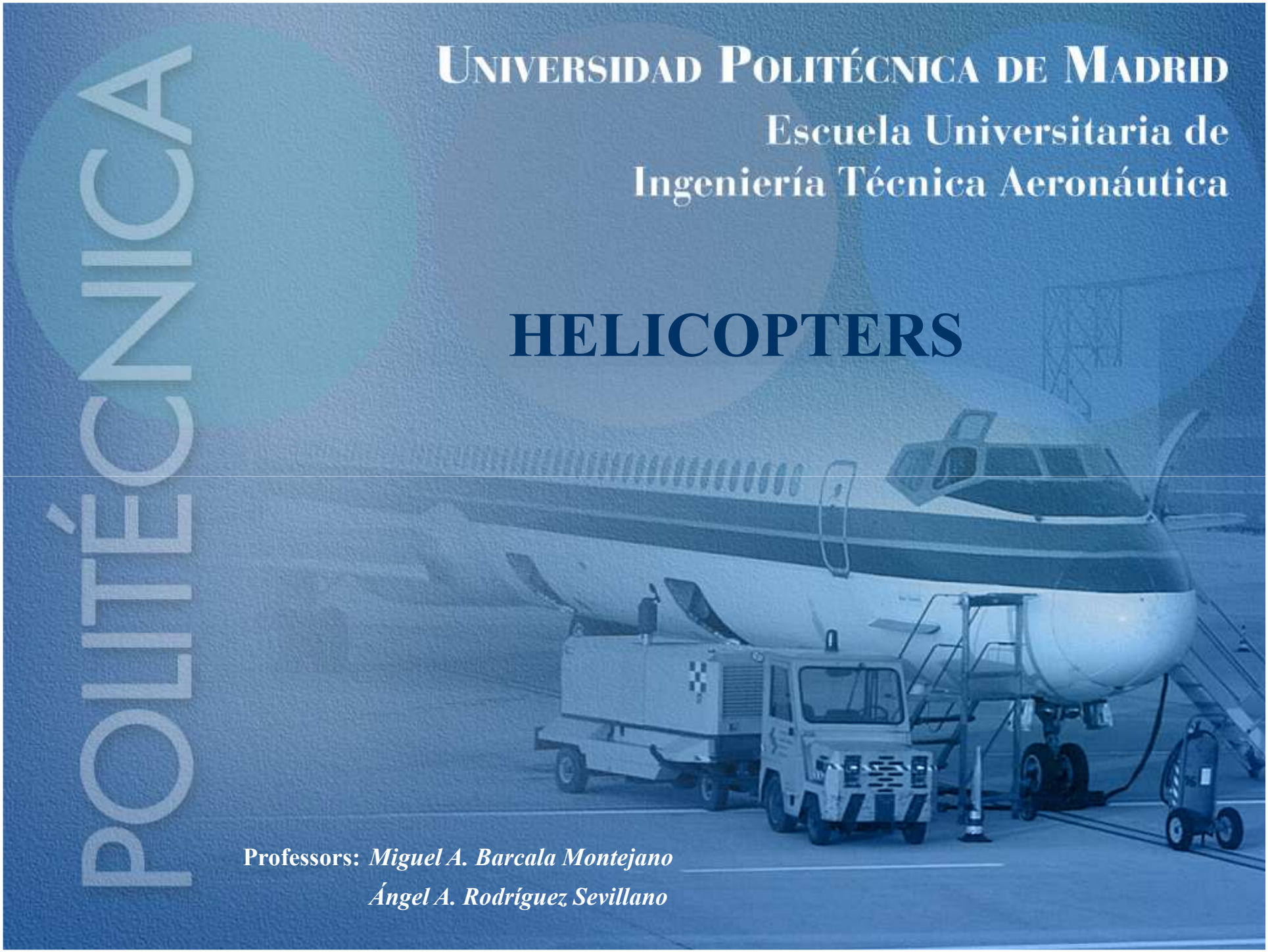
Escuela Universitaria de
Ingeniería Técnica Aeronáutica

HELICOPTERS



Professors: *Miguel A. Barcala Montejano*
Ángel A. Rodríguez Sevillano

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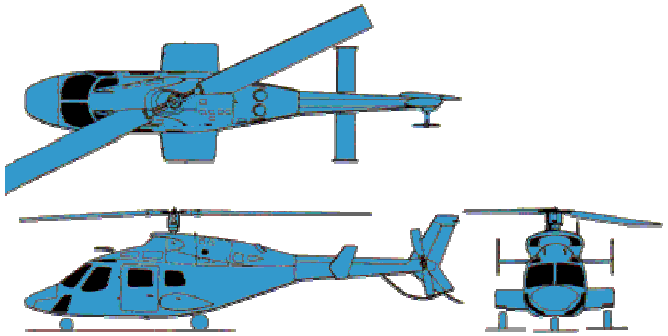
GENERAL DESCRIPTIONS AND TYPES



- Rotary Wing Aircraft.
- Introduction to the Helicopter.
- Definitions and Types of Helicopters

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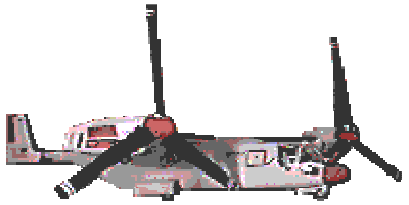
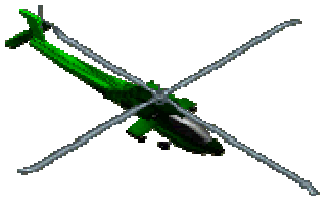
Introduction to the Helicopter

- Rotary Wing Aircraft
- What is a Helicopter?
- Types of Helicopters





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what are the different types of rotary wing aircraft?

Questions to determine the type of helicopter

Is it an aircraft whose wings rotate around a shaft (rotor)?

Is the lift provided by the rotor? The rotor consist of blades that rotate around the shaft.

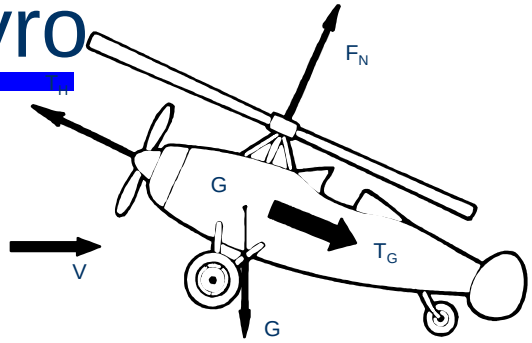
Do the blades of the rotor rotate due to the power plant?

Does the rotor provide the horizontal movement of the helicopter?

As a result of the above, does the aircraft have a vertical take off?

Different types of Rotary Wing Aircraft

Autogyro



- The lift is provided by the rotor.
- The blades of the rotor turn as a result of the aerodynamic forces.
- The horizontal movement is provided by a conventional power plant.
- Take off and landing cannot be vertical.

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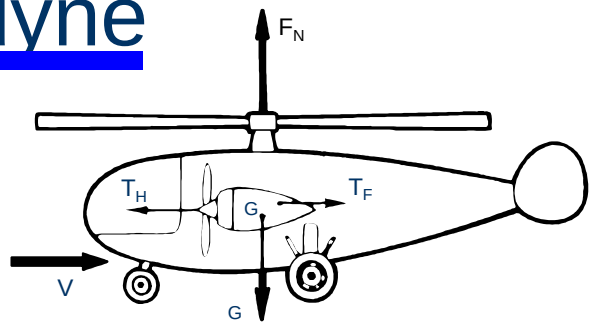
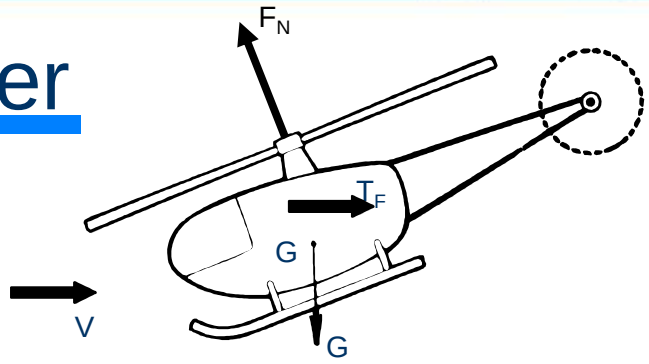
Gyrodyne



- The lift is provided by the rotor.
- The blades of the rotor rotate due to the power plant.
- The horizontal movement is provided by a arbitrary power source.
- Yes, take off and landing are vertical.

Helicopter



- The lift is provided by the rotor.
- The blades of the rotor rotate due to the power plant.
- The horizontal movement is provided by the same rotor.
- Yes, take off and landing are vertical.

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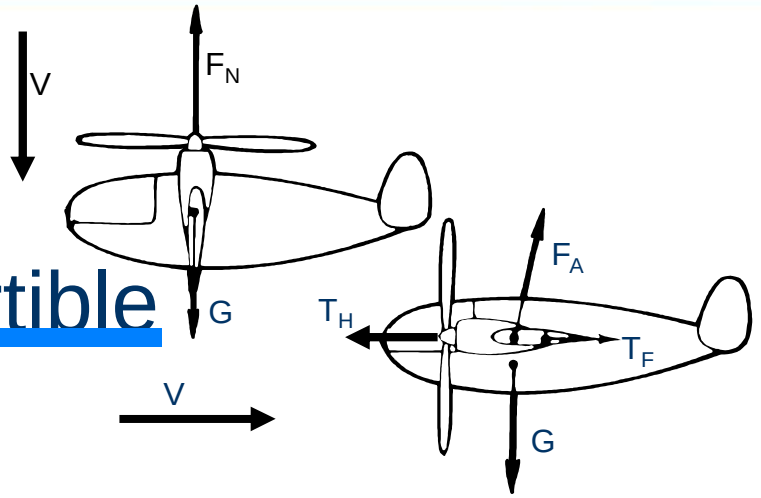
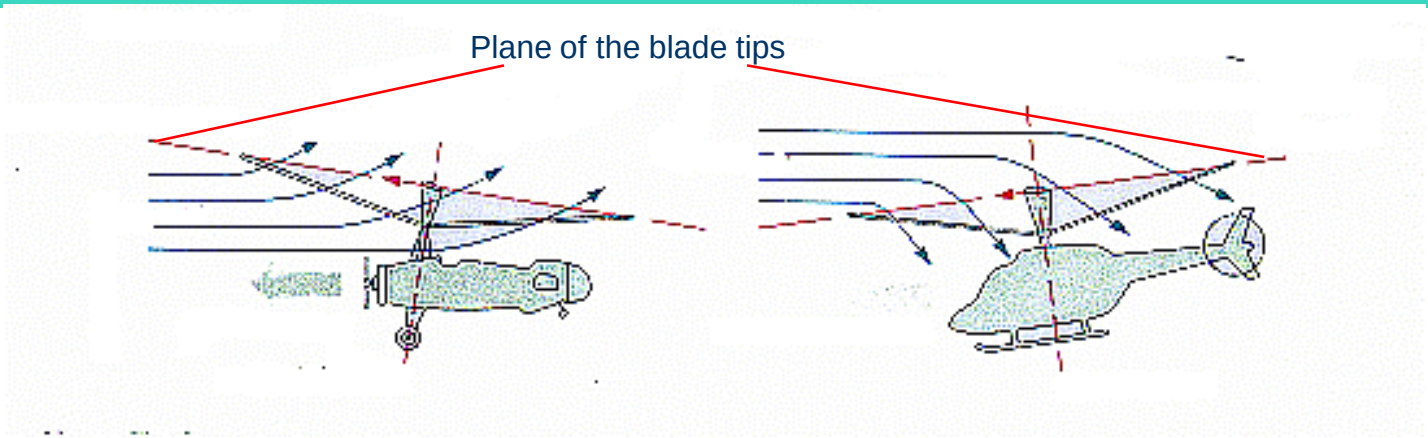
Convertible



- In the operation of landing and take off, it is an aircraft with rotary wings.
- During horizontal flight, it is a conventional aircraft.

Autogyro, Helicopter

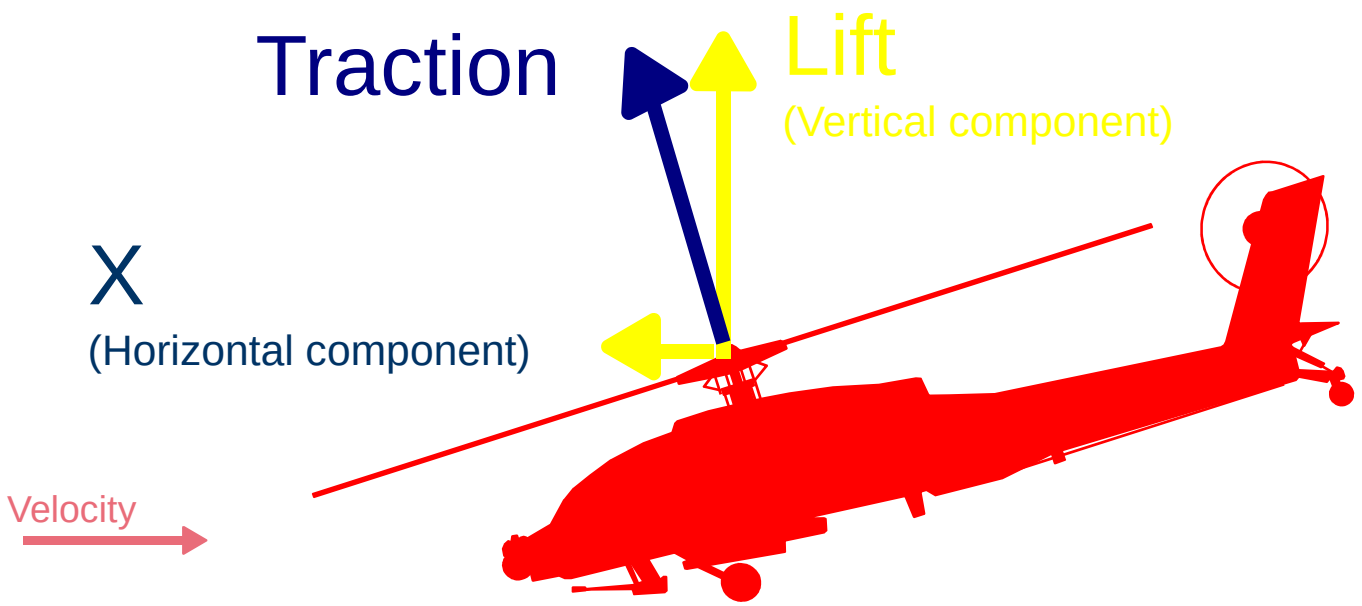


The autogyro is an aeroplane. It travels in the forward direction due to the propeller engine. The lift is produced by the rotary wings. They rotate because the aerodynamic forces are always inclined forward of the axis of rotation, making the rotor incline towards the rear. The air is enters the rotor from below.

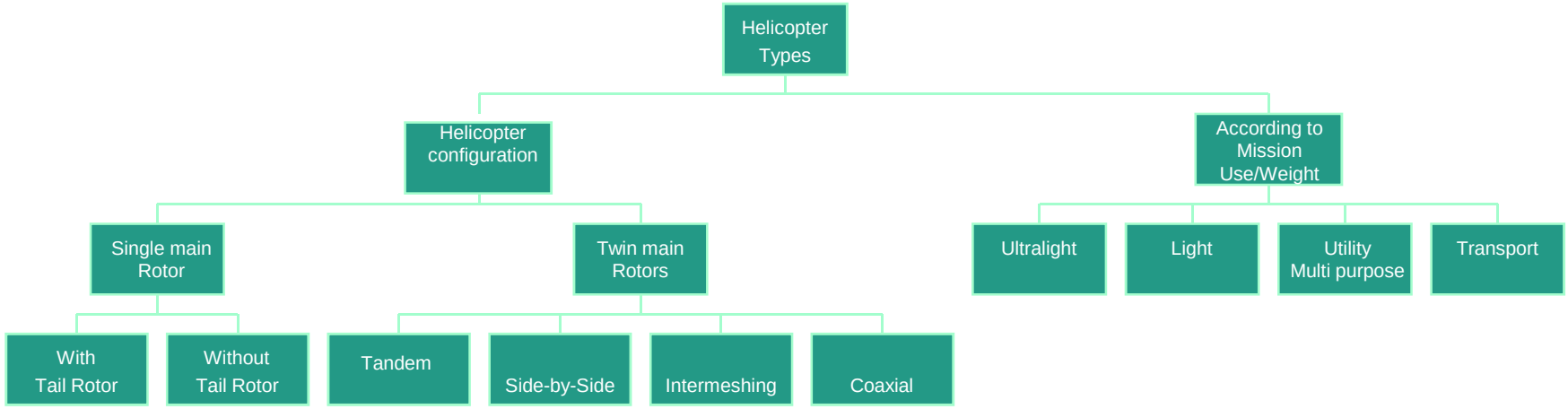
The helicopter is totally different. Here the rotor provides the propulsion as well as providing the lift. The rotor is slightly inclined forward. The aerodynamic forces are backward and much power is needed to maintain rotating the rotor. The air enters the rotor from above.

What is a Helicopter?

A helicopter is an aircraft, with rotary wings (rotor), that weighs more than the air. The rotor rotates by the action of a power plant. The rotor generates the movement and lift of the aircraft. Therefore, it is an aircraft with vertical take off and landing.



Rotary Wing Aircraft





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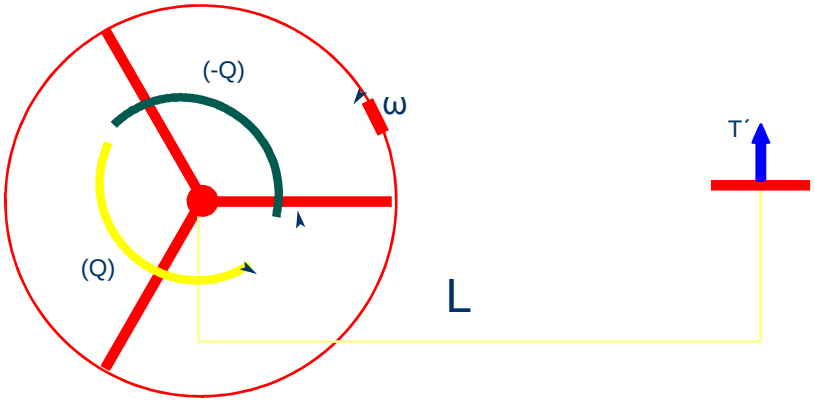
PRINCIPAL ROTOR; why does the tail need a rotor?



ω ➡ Velocity of rotation

Q ➡ Torque

-Q ➜ Fuselage torque reaction

T´ ➜ Thrust of the tail rotor

L ➜ Distance between the principal rotor and the tail rotor

When driving the principal rotor in the direction of rotation, by applying momentum to the rotor shaft, immediately an opposite momentum appears that causes the fuselage to rotate in the opposite direction. To prevent this from occurring, a tail rotor is added, driven by the same power plant as the principal rotor. The traction for this is:

$$-Q + T' \times L = 0$$

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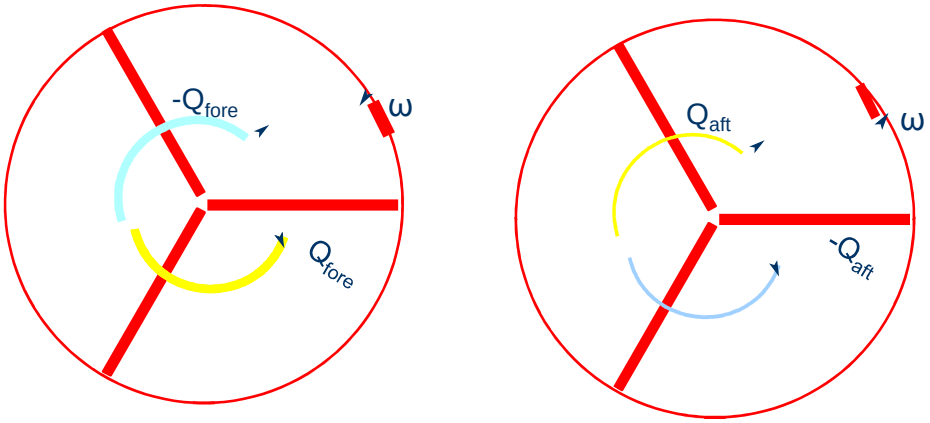
Types of Helicopters. According to their Layout



-Q $_{fore}$ ➜ Torque reaction for the front rotor

-Q $_{aft}$ ➜ Torque reaction for rear rotor

Q $_{frw}$ ➡ Driving torque of the front rotor

Q $_{aft}$ ➡ Driving torque of the rear rotor

Both rotors are rotating in opposite directions ~~the same direction~~ by applying power to the shafts, so that the torques of the rotors are equal and opposing. ~~immediately two momentums appear of opposite reaction on the fuselage, and so:~~

$$Q_{fore} = Q_{aft}$$

There is no need for any system counteracting the drive torque.

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A Main Rotor with a Tail Rotor

Sikorski 60 (SH-3D)

A main rotor; Without a Tail Rotor

MD 500 NOTAR

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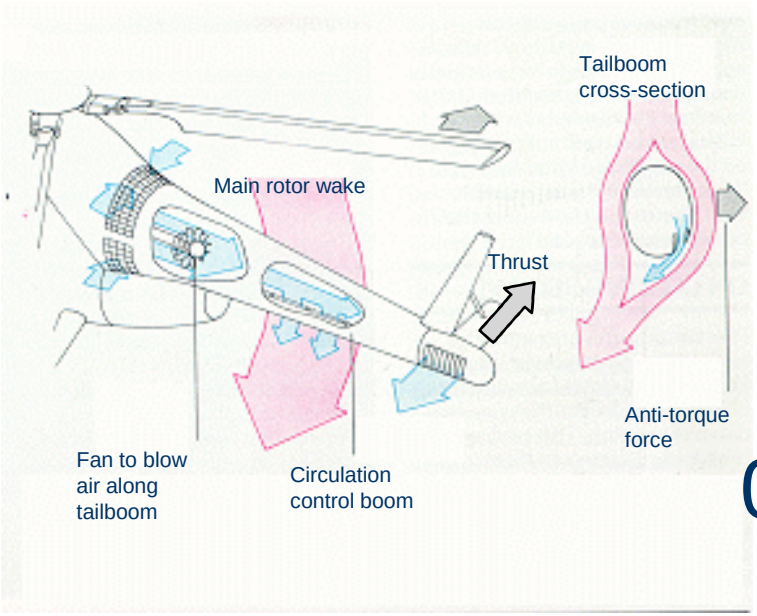
NOTAR TECHNOLOGY

What is NOTAR Technology?

l ➜ Distance of main rotor and circulation control area



l´ ➜ Distance of rotor and traction of the tail

F_{M-E} ➜ Force, Magnus effect

T´ ➜ Traction of tail

-Q ➜ Fuselage torque reaction

$$0 = -Q + T' \times l' + F_{M-E} \times l$$

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Two rotors ➢ Twin Tanden

Rear Rotor

Front Rotor

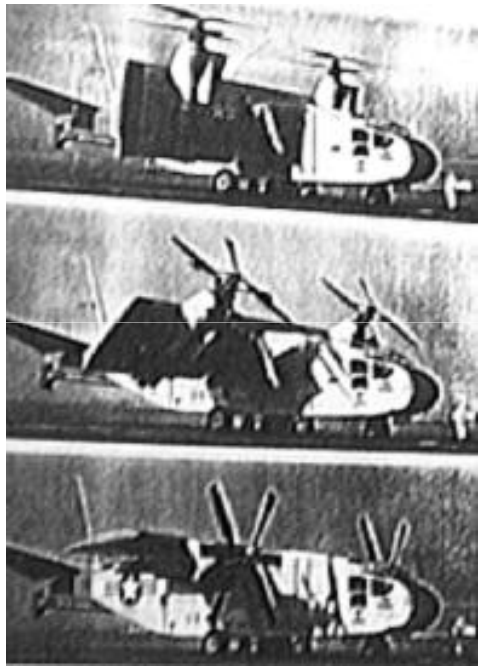
Boeing-Vertol 107

Two Rotors ➢ Twin Side-by-side

Platt-le Page Aircraft Co.
XR - 1 (1944)

Mil Mi-12

Two Rotors side-by-side ➢ Tiltrotor (1) (Convertible)



1959 : Hiller X-18 t

World's first transport-size VTOL aircraft

1964 : Vought-Hiller-Ryan XC-142

Designed from the X-18, was the winner of a contract for a tri-service (unified designation system for a helicopter) VTOL transport plane. With a max weight of 19000 Kg and a top speed of 690 Km/h remains the largest VTOL aircraft ever to fly until the development of the V-22 Osprey. Only 5 units were built

Two Rotors side-by-side ➢ Tiltrotor (2)

Bell V-15

Bell - Boeing V-22

Engines: 2 * Allison T406-AD-400
Speed in Helicopter mode : 185 km/h
Speed in Airplane mode : 638 Km/h
Rate of climb: Max: 707 m/min
Service Ceiling: 7925 m
Range: 953 km
Weight: Empty: 14800 kg
Weight Max: 27442 Kg
Max Internal Payload: 9072 Kg
Cargo hook capacity: 4500 Kg
Width: 25.55 m
Length: 19.09 m
Height: 6.63 m
Rotor Span: 11.58 m
Disc Area: 105.36 m2 each

First Flight : March 19, 1989

Two Rotors ➢ Twin intermeshing

K - HH - 43

Two Rotors ➢ Twin Coaxial

Kamov KA - 50

The blades rotate in opposition, and a tail rotor is not necessary.

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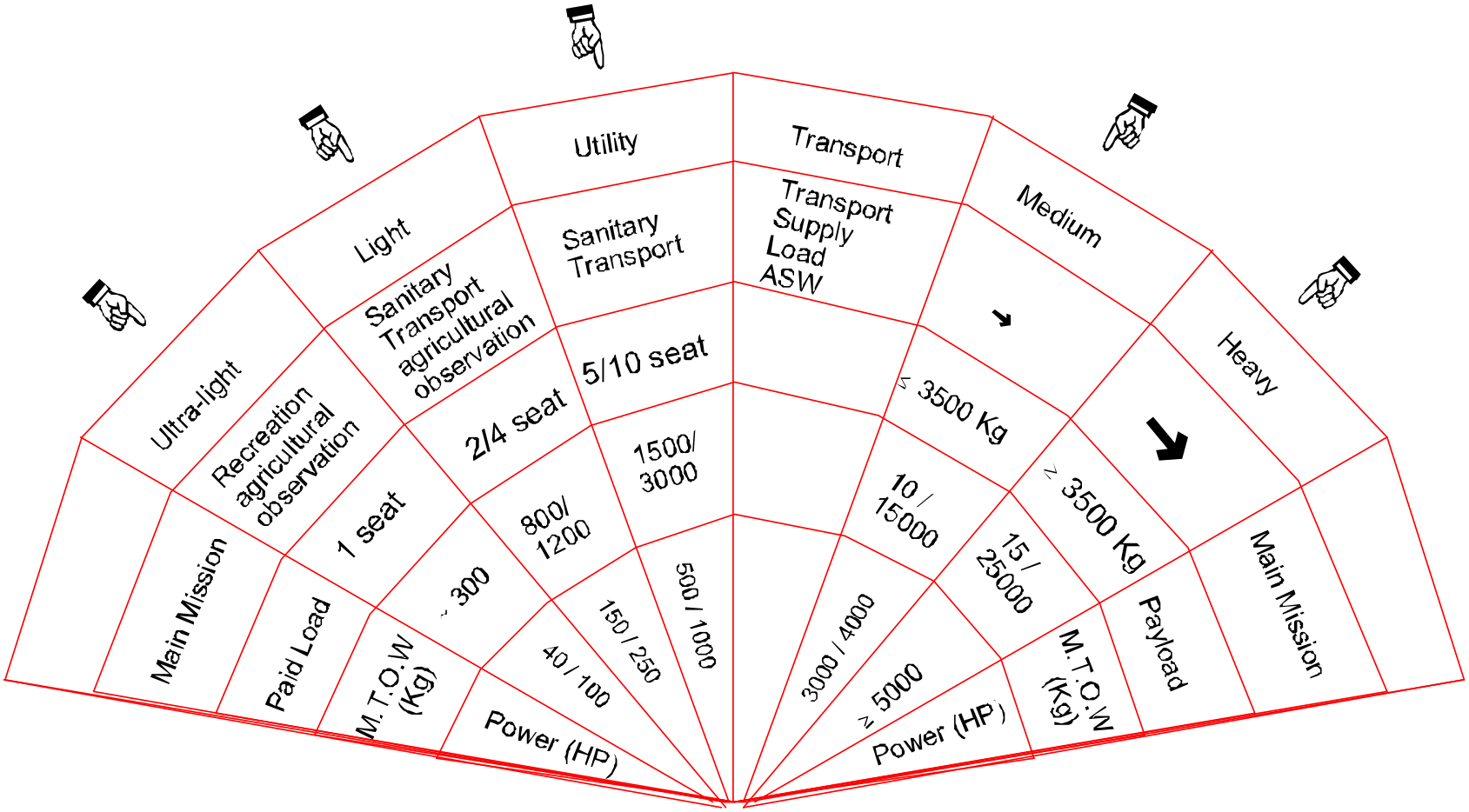
Types of Helicopters. According to their Layout



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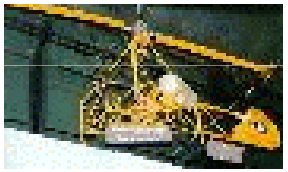
Types of Helicopters. According to Mission Use and Weight

Ultra - Light

U.A.V.



XH-20

It is powered with ram-jets mounted at the tips of the rotor blades. It has no tail rotor. Its weight is 1.250 Newtons.

Rotor diameter: 8.18 m
Length: 9.40 m
Height: 2.67 m
Weight: 480 kg
Engine: 1 Avco Lycoming HIO-360 of 190 hp
Speed: Max: 150 km/h
Range: 370 km
Service Ceiling: 3100 m

TH-55 / Hughes 300

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Types of Helicopters. According to Mission Use and Weight

Light

It incorporates the Fenestron (enclosed tail rotor)

SA - 341 Gazelle

Seats: 2 + 4
Rotor diameter: 10.70 m
Length: 10.91 m
Height: 3.15 m
Weight: 1288 kg - Max : 2500
Engine: 2 Allison 250-C20 of 425 hp
Speed: 230 km/h
Range: 720 km
Rate of climb: 456 m/min
Service Ceiling: 2350 m
Disc Area: 90 m2

AS 355 Ecureuil

First world's turbine helicopter to be produced Engine Turbomeca Astazou II of 530 hp

SA -3130 Alouette

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Types of Helicopters. According to Mission Use and Weight

Utility

Agusta-Bell 212 H-1N

Seats: 2 + 12
Rotor diameter: 14.63 m
Length: 17.46 m
Height: 4.48 m
Weight: 2882 kg - Max : 5080 Kg
Engine: 2 Pratt&Whitney PT&T-3B 1300 hp
Speed: 185 km/h
Range: 437 km
Rate of climb: 402 m/min
Service Ceiling: 3960 m
Disc Area: 168.11 m2

Agusta-Bell 204 UH-1B

Seats: 1+9
Rotor diameter: 14.63 m
Length: 16.20 m
Height: 4.48 m
Weight: 1080 kg - Max : 2135 Kg
Engine: 1 Lycoming T5311A
Speed: 170 Km/h
Range: 425 km
Service Ceiling: OGE 1400 m; IGE 3150 m
Disc Area: 168.11 m2

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Types of Helicopters. According to Mission Use and Weight

Medium Transport (1)

Seats: 2 (Crew) + 20
Engines: 2 * 1830 HP turboshafts
Speed : Max 300 km/h
Rate of climb: 480 m/min
Endurance: 5 h 30 min
Weight Empty: 5400 kg
Weight: Max: 8700
Rotor Span: 16 m
Length: 19 m
Height: 5.5 m

EUROCOPTER NH-90

Sikorski UH-60 (BlackHawk)

Seats: 3 (crew) + 11
Engines: 2 x 1500 HP
Speed: 265 km/h Max: 296
Service Ceiling: 5790 m
Range: 600 km
Weight Empty: 4944 kg
Weight Max: 9185
Rotor Span: 16.36 m
Length: 19.76 m
Height: 5.13 m
Disc Area: 210 m2

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Medium Transport (2)

Seats: 2 (crew) + 21
Rotor diameter: 15.60 m
Length: 18.70 m
Height: 4.92 m
Weight 4200 kg
Weight Max : 9000 Kg
Engine: 2 x 1780 hp
Speed: 280 km/h
Range: 635 km
Rate of climb: 528 m/min
Service Ceiling: 4600 m
Disc Area: 191 m2

Aeroespatiale AS 332B Super Puma

Heavy Transport

Capacity & loading: 2 (crew) + 44
CH-47D :
Engines: 2 * 3750 HP
Speed: 256 - 291 km/h
Range: Ferry: 2020 km
Service Ceiling: 4570 m
Weight Empty: 10475 kg
Weight Max: 22680 Kg
Rotor Span: 18.29 m
Length: 30.18 m
Height: 5.68 m
Disc Area: 525.34 m2

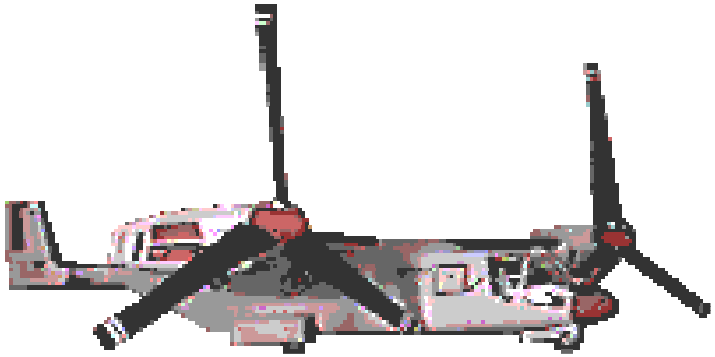
Boeing CH -47 Chinook

Sikorski S - 64

Crane

Crew: 2
Engines: 2 * 4800 HP
Speed: 184 - 220 k/h
Range: Ferry: 500 km
Service Ceiling: OGE 2300 m IGE 3650 m
Weight Empty: 4325 kg
Weight Max: 15000 Kg

The End



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