

Introduction to Vertical Flight

Lecture 2

Dr Djamel Rezgui
djamel.rezgui@bristol.ac.uk



Objectives

- A brief History of Helicopters and Autogyros
- Configurations of Helicopters and Autogyros



Rotorcraft Configurations

Helicopters



1930s - present

Compound
Helicopters



1920s - present

Autogyros



Helicopters and Autogyros – A Brief History

The successful application of the aircraft propeller preceded that of the helicopter rotor.

This was not due to any shortcoming in rotor design..

....But rather the low engine power for a given weight.

It took 30 years of engine development to achieve a sufficient power to weight ratio.

There is currently no manned powered helicopter!

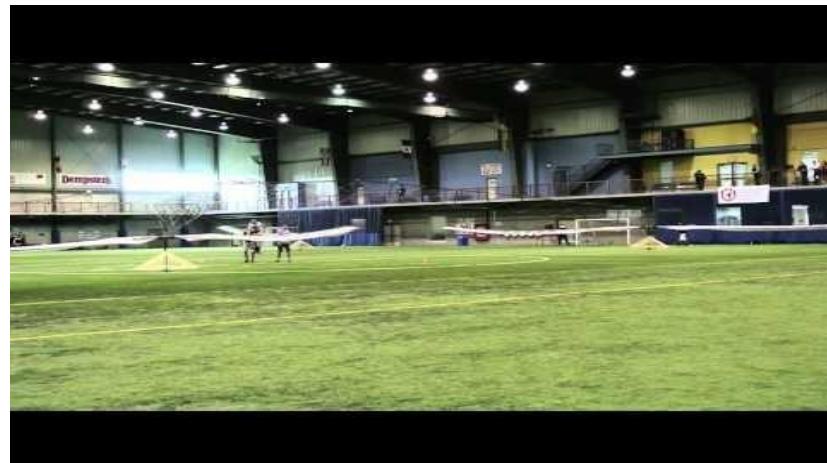


Helicopters and Autogyros – A Brief History

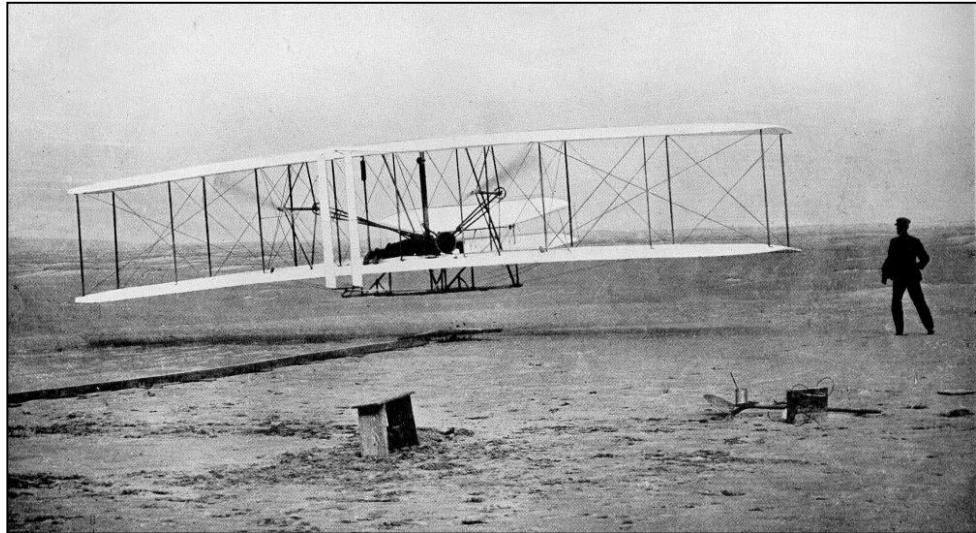
AHS Igor I. Sikorsky Human Powered Helicopter Competition was established in 1980

A prize of \$250,000.00 is pledged by Sikorsky Aircraft Corp.

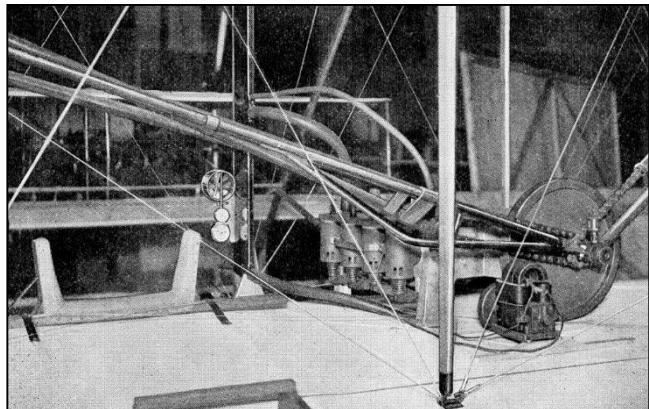
AeroVelo's "Atlas" human-powered helicopter won the AHS Sikorsky Prize in 2013.



Helicopters and Autogyros – A Brief History



The aircraft weighed 1150 lbs fully laden



24 bhp engine weighs 240 lbs

*Wright
flyer*



Propellers - 66% efficient

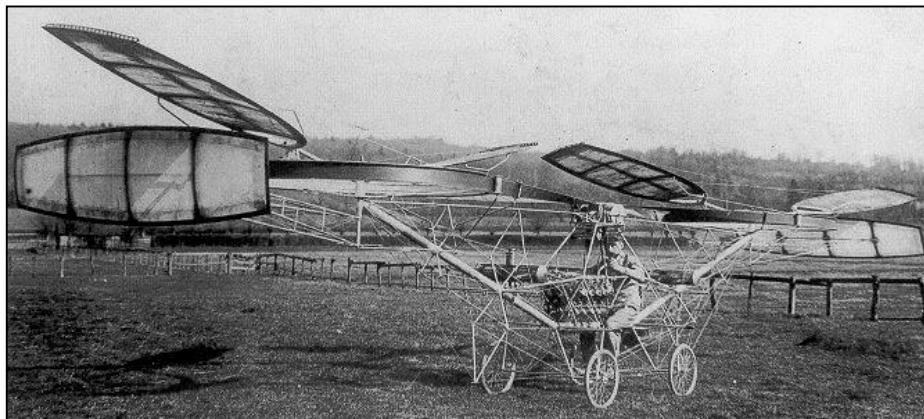
$$\eta_p = \frac{TV}{P} \quad \text{So that at 30 knots, } \underline{\text{L/D}} = 6$$

Helicopters and Autogyros – A Brief History

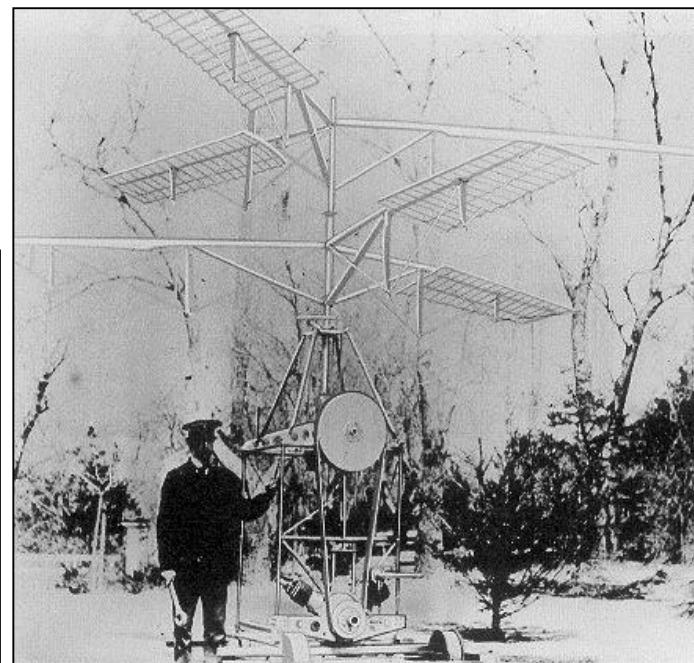
$L/D = W/T$, so for the Wright Flyer the propeller **thrust** is **1/6** the aircraft **weight**.

To take off vertically, **Thrust > Weight**. This requires thrust $> 6 \times$ Wright Flyer's thrust for no extra weight - clearly these early attempts could never succeed.

Some just left the ground but had no control and were always tethered.



Cornu 1907 first manned aircraft to hover



Sikorsky 1909 (unsuccessful)

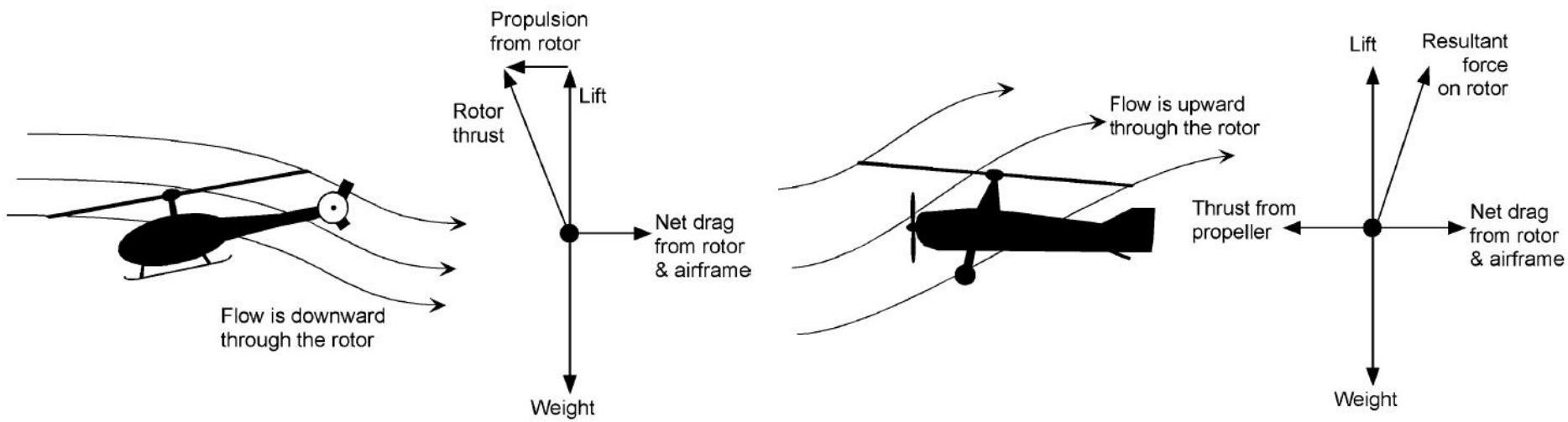
Helicopters and Autogyros – A Brief History

So the **first rotary winged aircraft** that flew (in the generally accepted sense of this word) was in 1923 and it **did not have a powered rotor** !



Cierva C8 Autogiro™ (1926)

Helicopters and Autogyros – A Brief History



Helicopters and Autogyros – A Brief History

Cierva's Autogiro™ couldn't hover, but that was never his intention.

It did produce a lifting force independent of translational speed – that was!

It didn't stall

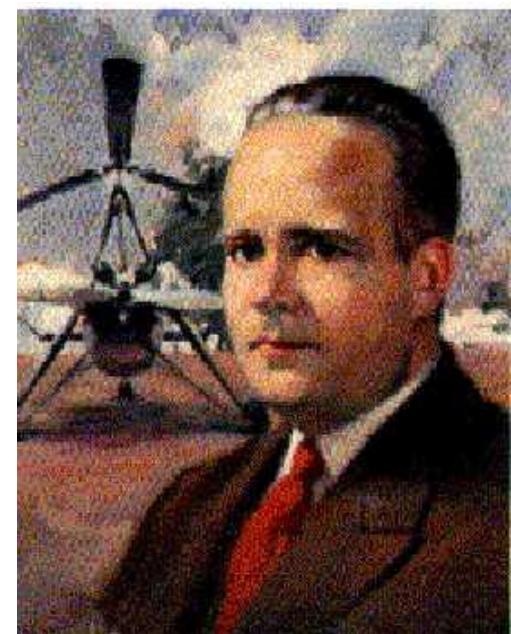
The lifting rotor is a simple device in axial flow (hover and climb).

In edge-wise flight it's anything but simple!

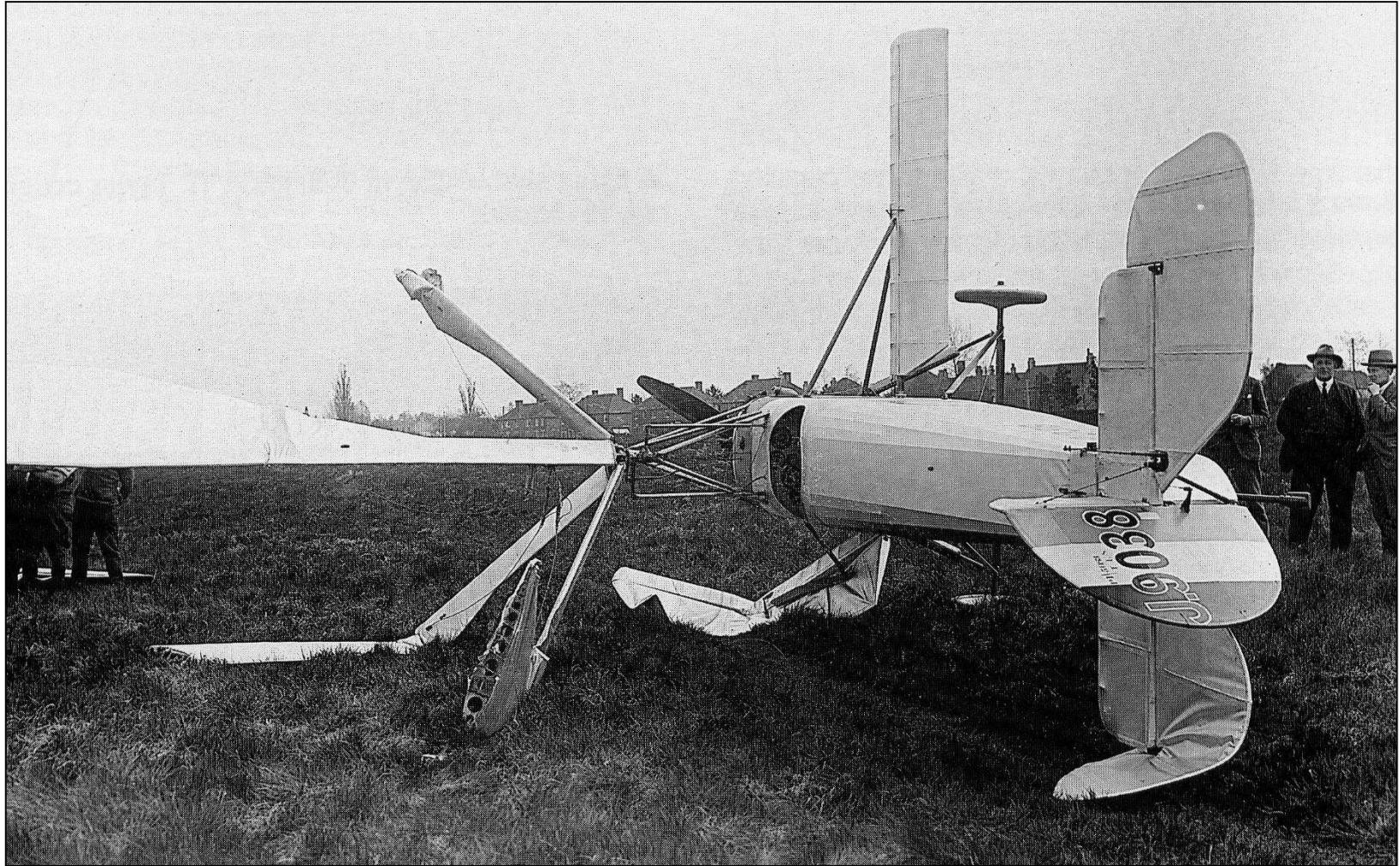
And that is what makes it so interesting

So Cierva was thrown in at the “deep end”.

But he survived

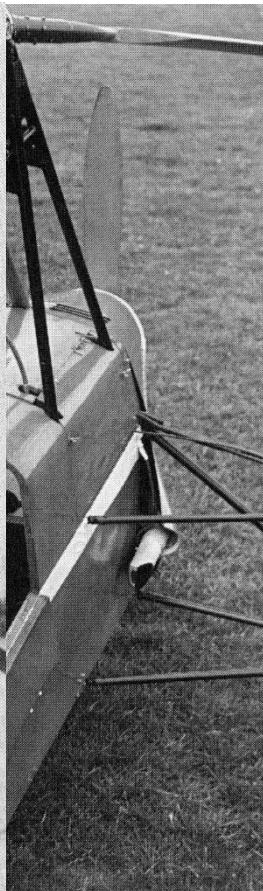
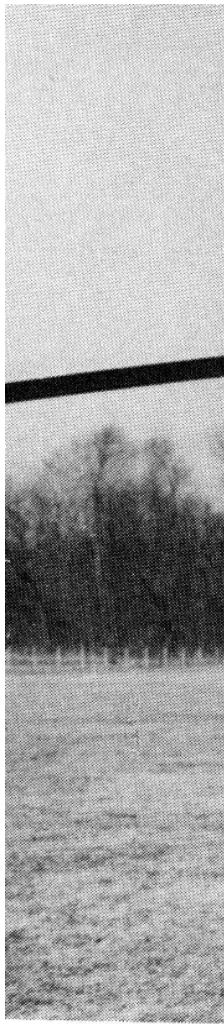


Helicopters and Autogyros – A Brief History



....but his early aircraft didn't, for reasons to be discussed in future lectures.

Helicopters and Autogyros – A Brief History



.....but the autogyro did succeed and it paved the way for the helicopter !

Helicopters and Autogyros – A Brief History



Pitcairn PCA – 2

First rotorcraft to land at the White House, U.S.A.

From Left to Right

Orville Wright

President Herbert Hoover

Jim Ray (Pilot)

Colonel Young

Senator Bingham

Harold Pitcairn

Helicopters and Autogyros – A Brief History



Helicopters and Autogyros – A Brief History

Famous aviatrix Amelia Earhart



Amelia Earhart with Beech-Nut Pitcairn PCA-2 Autogyro in 1931

1928 - First women to fly across the Atlantic Ocean (as a passenger)

1930 First woman autogyro pilot

1931 – Set new autogyro altitude record of 18,415ft

1932 - First women pilot to fly solo across the Atlantic Ocean

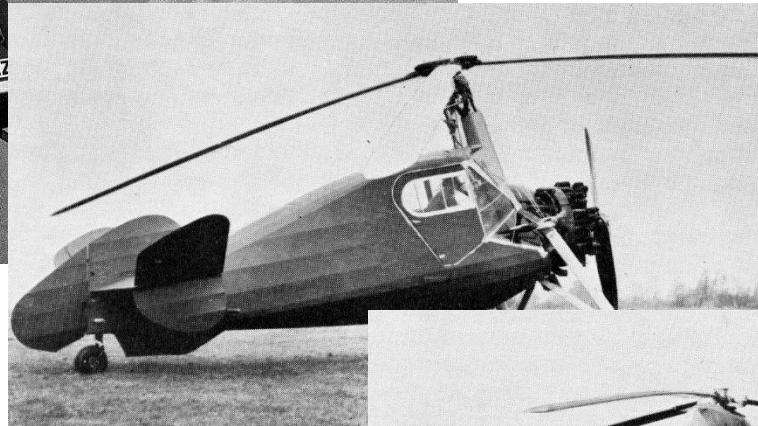
1935 - First person to fly solo across the Pacific Ocean (from Hawaii to California)

Helicopters and Autogyros – A Brief History

And in Britain, where it all started.....



Avro/Cierva



Westland C29

Westland CL20



Helicopters and Autogyros – A Brief History

Then came the helicopter

which did everything the autogyro could do but much more importantly it could hover - the one thing the autogyro would never be capable of doing ! For the majority, the autogyro was history and of no further interest.



Cierva C30 MK III making a jump take-off from Hounslow Heath on July 23, 1936

December 9th 1936 Cierva lost his life (aged 41) in a fixed wing aircraft accident. The KLM Airline DC-2 on which he was flying to Amsterdam crashed shortly after take-off from Croydon Airport in thick fog.

**THIS MARKED THE END TO
ANY FURTHER SIGNIFICANT
AUTOGYRO DEVELOPMENT.**

Helicopters and Autogyros – A Brief History

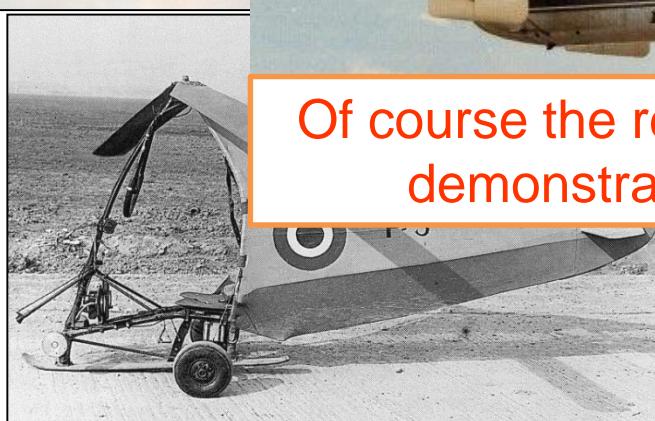


Helicopters and Autogyros – A Brief History



Dr Igor Bensen developed the basic design into a form that has been adopted by nearly all sport autogyro designers to date.

Helicopters and Autogyros – A Brief History



Of course the real future for the autogyro was demonstrated over half a century ago!



Helicopters and Autogyros – A Brief History

Consider the safety record:

The Pioneering Years

- | | |
|--------------------------------|---|
| January 17 th 1923 | – First successful flight of an Autogiro. |
| December 19 th 1932 | – First Autogiro fatality |

This was a remarkable safety record: - during this pioneering decade...

hundreds of Autogiros (many prototypes) and newly converted pilots flew

accumulating 35,000 hours and over 2.5 million miles

in the UK, Spain, USA, France, Germany, Soviet Union & Japan

They were flown by pilots who understood the basis of autorotational flight.

Helicopters and Autogyros – A Brief History

Consider the safety record:

The Pioneering Years

January 17 th 1923	– First successful flight of an Autogiro.
December 19 th 1932	– First Autogiro fatality

Cierva lost his life as a passenger in a DC3 out of Croydon.

Pitcairn died from two gun shot wounds to the head.

Hafner lost his life in a sailing accident in the Severn Estuary.

Bensen died of natural causes.

None of them died from an Autogyro accident

So why has the accident rate soared, to the extent that the CAA grounded some types of autogyro, notably the Air Command ?

Helicopters and Autogyros – A Brief History

Breguet-Dorand Coaxial Helicopter

1936 – Closed circuit flight of 27 mile which took just over 1 hour, flying at 500ft.



Focke-Achgelis Fa 61

1936 – Closed circuit of 50 miles at speed of 76 mph at 8000ft.

Helicopters and Autogyros – A Brief History

It was the Focke-Achgelis Fa 61 that stole the show by virtue of quite amazing level of control (for such an experimental aircraft).



Helicopters and Autogyros – A Brief History

Invention of the helicopter is often, wrongly, attributed to Igor Sikorsky. However, he did develop his own machine which set the mould for most designs thereafter.



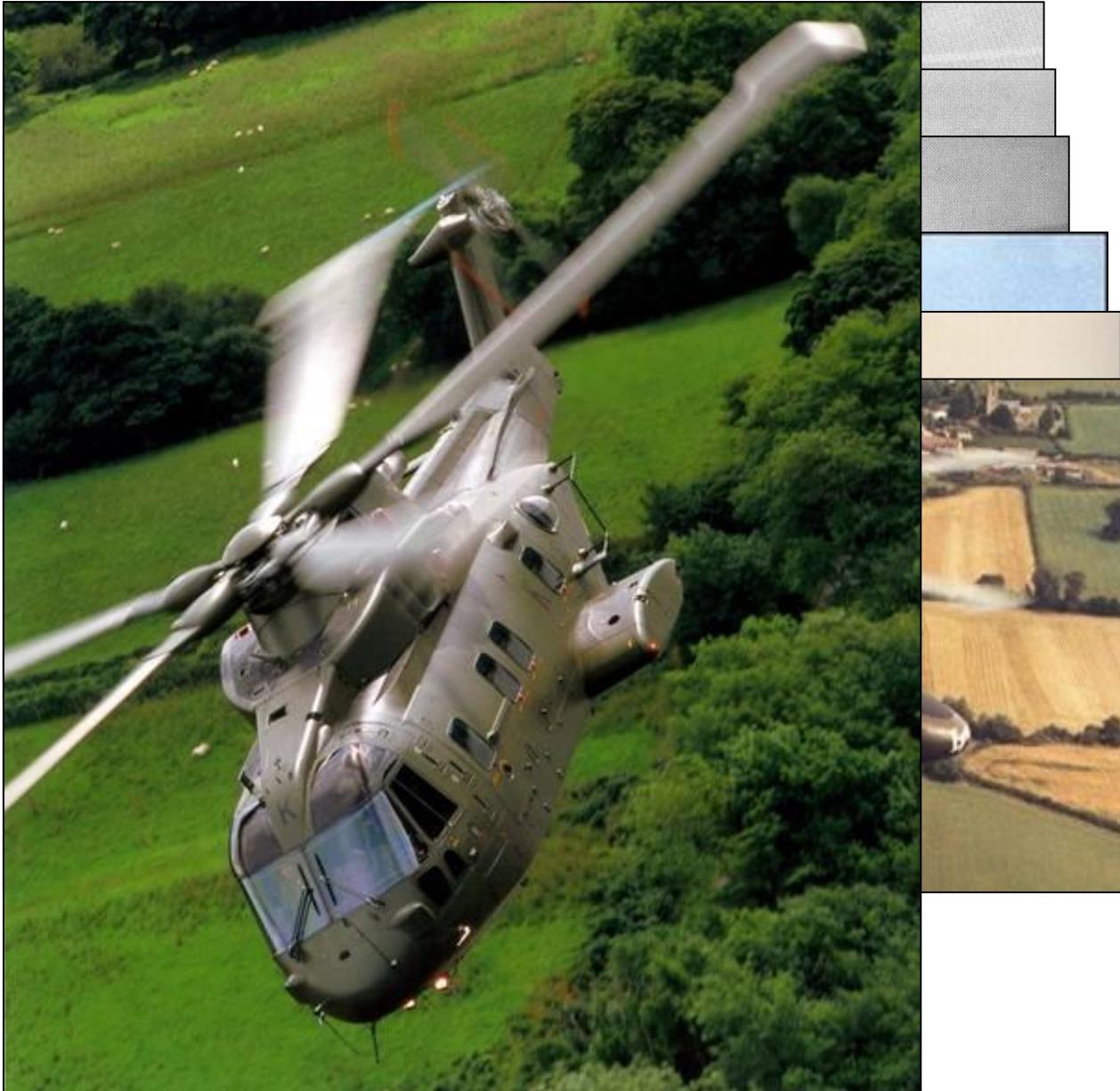
VS-300-C-5a with Single Main Rotor

Helicopters and Autogyros – A Brief History

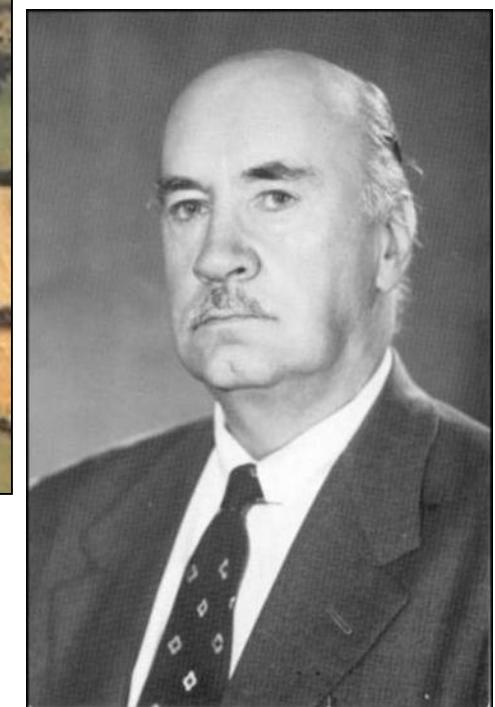
Sikorsky's developing
VS-300-D-1 now becomes
the standard “penny
farthing” configuration.



XR-4a Collective and
Cyclic pitch control by
virtue of a swash plate.



Sikorsky pioneered the single main rotor and open tail rotor which has remained the most common configuration –particularly from the Westland's stable.



Helicopter Configurations



Helicopter Configurations

The coaxial Helicopter



Helicopter Configurations

The Tandem Helicopter



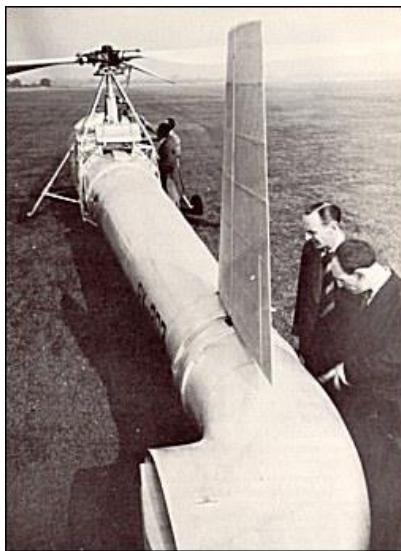
Helicopter Configurations

The Syncropter Helicopter



Helicopter Configurations

The NOTAR



Helicopter Configurations



Main Helicopter Parts

(Penny Farthing Configuration)

