ROYAL AERONAUTICAL SOCIETY
LOUGHBOROUGH BRANCH

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Commercial Helicopter Operations
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This was a data-rich journey delivered with a passion that comes from experience, and in stages guided everyone present from the origins of helicopters to a glimpse of the challenges that helicopters face today.

After the introduction the first slide, with two 1930s airliners – Douglas Dc3 and DH91 Albatross - tilted thoughts away from helicopters, but that was to stress the attainments that fixed-wing aircraft were able to rack-up in the era when rotary-wing vehicles were just appearing. There followed a picture of a Cierva Autogyro overflying the FA Cup Final at Wembley in 1935, shown here, and note the overlaid caption – it conveys the detail of information provided almost minute after minute.

The autogiro was rotary-wing, but the rotor was not powered (except for brief pre-rotation of rotor to shorten take off run), and it could not hover (other than in a stiff wind). It was the Russian engineer and pioneer aircraft designer, Igor Sikorsky, that first took to the air under a powered vertical rotor in 1939. It had stabilising tail rotors to counteract the main rotor drive torque that would cause the aircraft to spin in the opposite direction to the main rotor. Several very honest statements were attributed to the pioneer:

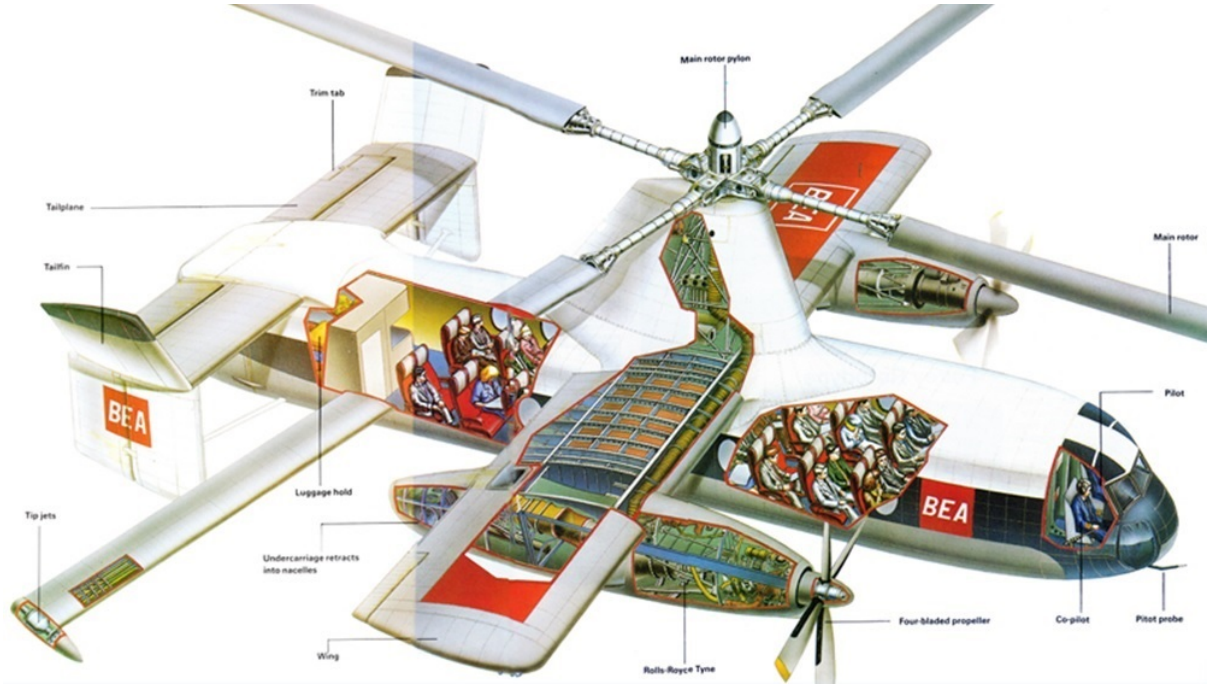
- "My first helicopter was so reluctant to fly forwards we considered turning the pilot's seat around"
- "When will the helicopter fly faster than the aeroplane? – Never!"
- "When will the helicopter be as efficient as the aeroplane? – Never!"
- "But the helicopter will be able to do many things that an aeroplane is unable to do"
- "When someone needs to be saved an aeroplane can only drop flowers, but the helicopter will provide a means of rescue"

These were referred to on occasions on travelling through the 80 years that have passed: and there cannot have been a more honest expression of the "does and don't" of the helicopter.

Sikorsky was joined by many other significant rotary-wing specialists: Arthur Young (Bell), Frank Piasecki (his tandem-rotor has evolved into the Chinook), Stanley Hiller – all in the USA, with Europeans such as Anton Flettner (Germany) and Raoul Hafner (Austria – later came to the UK). It was the way that aspirations evolved in the UK post-WW2, much of it driven by Hafner's enthusiasm, that attention was focussed.

Several ideas for city-centre operations were described, most of which were too ambitious. e.g.: runways atop city centre buildings failed to meet expectations. Helipads are often found at hospitals. The London Heliport (at Battersea), opened in 1959 is still in use: and now surrounded by high-rise buildings, as this recent view shows.

There was a tour of several UK developments from the small to the massive: Bristol Sycamore and 193 (the 'Belvedere' in RAF use), the Westland S51 and S55, and the large and spindly Cierva/Saunders-Roe Airhorse – three rotors driven by a single Rolls Royce Merlin engine – and more. The most significant and ground-breaking proposal, and one that was tested and flown, was the Fairey Rotodyne.

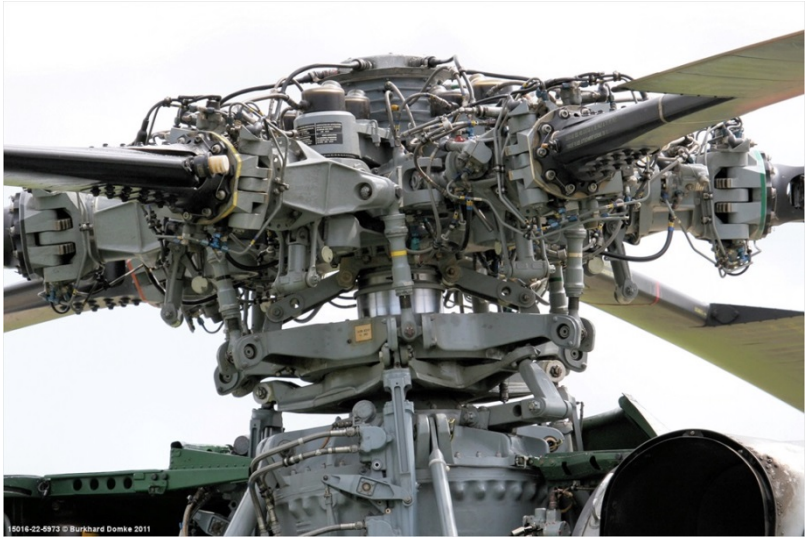


The most unique feature of that aircraft was that it combined rotary-wing and fixed-wing aircraft attributes, and there was commonalty, but different modes of propulsion in each of these two operational modes, turboprop gas turbine in cruise and tip-located air-jets that drove the rotor in the helicopter portion of the flight envelope. There was duplication in the design that assured safety in the event of an engine failure. The flying controls were conventional helicopter, with cyclic and collective for helicopter mode and with further 'mixing' when in fast forward flight and the main rotor autorotating.. The use of tip jets removed the anti-torque tail rotor and the complex

transmission systems to transfer power to the main rotor. It was developed, flown and widely demonstrated, and with a fuselage larger than a Chinook it has often been cited as having been overlooked. However – most people who saw the aircraft in flight would say that on even the clearest of days it was an aircraft usually heard before it was visible.

Attention turned to performance, and special interest was given to describe the very distinct differences between an aeroplane and a helicopter. These were well expressed by an experienced rotary-wing pilot, and the specific to helicopter aspects described included:

- **ground effect** – the cushioning impact of downward flow from the rotor when a helicopter is close to the ground
- **forward speed limitations** – the relative airspeed of rotor blades is a combination of rotational speed and the speed at which the helicopter is flying over the ground: so the 'advancing' blade on one side, and the 'retreating' blade on the other side are in relative flows that are very different.
- **rotor-blade articulation** – is a direct requirement that evolves from the asymmetry already described, and that allows the angle of each blade to the airflow to vary. This requires to complex rotor head whereby the blade can articulate to minimise asymmetric effects, and allow the pilot to adjust the blade angle either cyclically or collectively using two independent control levers.



This photograph shows the typical mechanical rotor head for a high-performance helicopter.

The actuators and their mountings comprise the vital mechanism allowing each blade to change angle during each revolution (cyclic) or in harmony with the set of blades (collective).

With the fundamentals covered, the limitations they set in operations were considered. This included an appraisal of the speed-drag characteristics of the helicopter (generally), and an insight of vital flight conditions that need to be fulfilled to 'autorotate' safely. He discussed normal and limited power manoeuvring near to the ground, in clear and obstacle limited situations, and the scope for one-engine out flight with a multi-engine helicopter, These were linked to descriptions of the overall speed-drag relationship – that bear similarities with fixed-wing aircraft, but have very notable difference in the low-speed regime. The issues that arise from elevated platform operations (on building and locations such as lighthouses) were also referenced.

Having set the scene for the diversity of operations that can be performed, and the limitations that need to be appreciated to avoid flying into unacceptable flight regimes, the speaker had presented details vital to understanding the strengths and limitations of helicopter. At this point attention turned to how safety regulations are used to ensure that capability is regulated in day-to-day operations. The presentation referred to commercial operations overall.

All aircraft used in commercial operations are required to be awarded a certificate of airworthiness (C of A) and that is linked to a unique aircraft registration. The servicing and operation of the aircraft requires specific processes to comply with requirements that require appropriate licensing of aircrew, maintenance and handling staff. In Britain this is the responsibility of the Civil Aviation Authority (CAA). Largely common rules with the European Aviation Safety Agency (EASA) are applied. Helicopters are largely smaller than commercial fixed-wing aircraft and cost per unit of payload is an unavoidable downside for using a vehicle that has so much more operational flexibility than the fixed-wing alternative.

It was pointed out that low production volume for civil operations, and the comparatively low utilization aspirations for helicopters in military service hampers R&D investment at source. The extra care that is also necessary, and the greater likelihood of maintenance being conducted on demand also leads to attendant high labour content and costs,

The certification costs for low sales volume, also high insurance costs, the fact that many technical 'surprises' arise and when international operations are conducted – providing services to industries that are not immune to political uncertainty and instability, both at home and overseas, all contribute to uncertainties that add to the overall cost of the provided services. The speaker outlined questions that an operator had to analyse:

- Do the people, to whom you are trying to direct this complicated and expensive service, really need it ?
- Secondly and more importantly, can they afford it?
- Does your helicopter operation add value to their requirements?
- Do you have the right people, ideas, initiative, sound management methods and money?
- Resilience?

This kind of reasoning has led to a number of basic business models, amongst UK operators:

1. Ad-Hoc Charter and some Longer Term contracts
2. Aircraft Management and Ad-Hoc Charter towards more Aircraft Management
3. Short Term and Long Term Contracts

An example was cited, and based on a fleet of 3 x Bell 407 helicopters used on commercial operations – and limited to daytime and visual flight rule operations. And assumed to attain 1,000hrs p.a. utilisation per aircraft. The operation was assumed to be capable of providing these basic services:

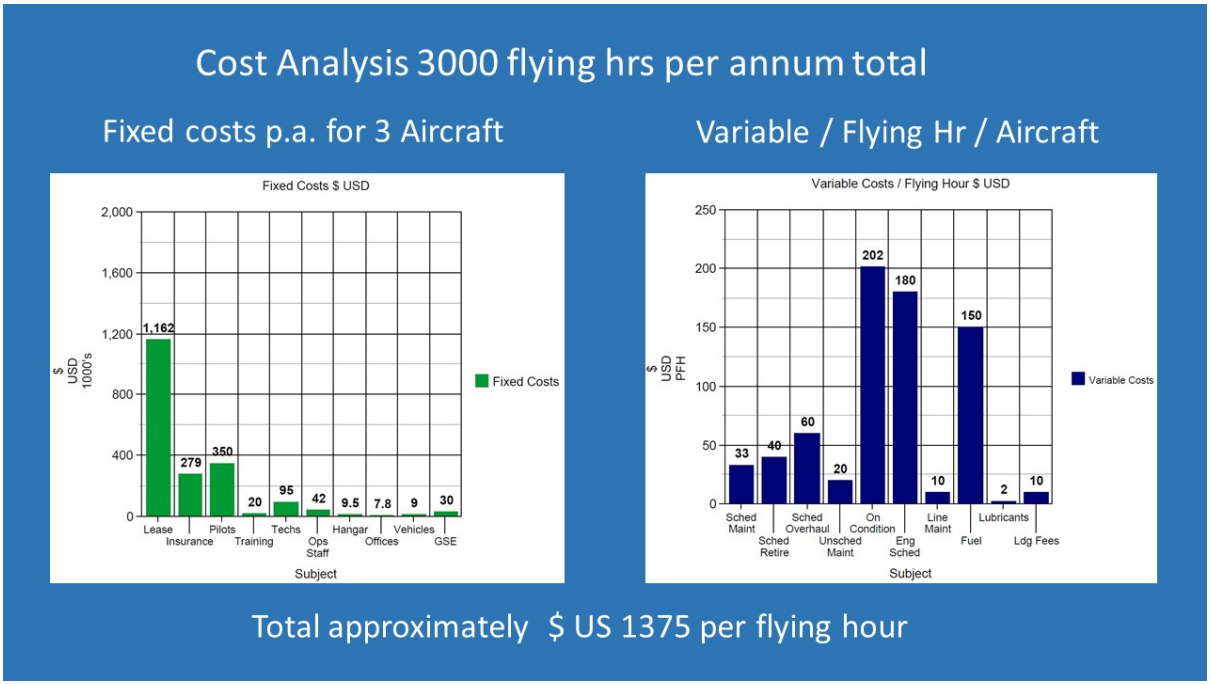
Underslung Lifting	Filming	Geological Survey
Electrical Survey	Pipeline Survey	Seismic Support
Pleasure Flying	Passenger Transport	

The costs that would need to be recovered from operations were listed thus:

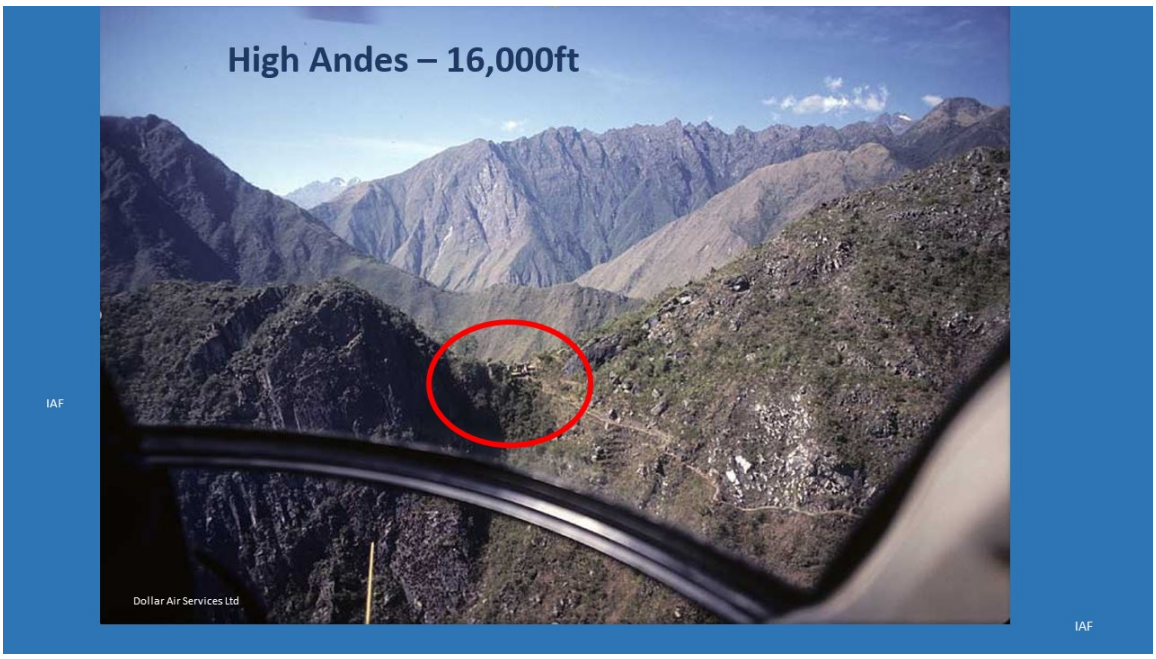
FIXED COSTS	**VARIABLE COSTS**
Lease / Long Term Note	Scheduled Maintenance – Airframe
Insurance	Ground Support Equipment
Pilots	Scheduled Retirement Items
Training	Scheduled Overhaul – Airframe
Technicians	Unscheduled Maintenance
Ops. Staff	On Condition Maintenance
Hangar Rental	Engine Scheduled Maintenance – PBH

Office Rental	Line Maintenance
Vehicles	Fuel & Lubricants
	Landing/Navigation Charges

Engineering downtime was segregated across: line, minor and major procedures, and beneficial aspects that need to be applied include the development of tailored maintenance programmes, in-service component lives improvements. and design for maintainability. An example of costs that would accrue for such a business were outlined graphically (below).



One aspect of helicopter operations that distinguishes it from conventional aircraft operations is the diversity of potential utilisations. The range of examples cited reveals some of the most exciting, interesting and eclectic of utilisations.



This photograph shows a high-altitude operation that demanded good weather (visibility and low wind to minimise turbulence) and a helicopter with a considerable lift capability in order to carry any substantial load at the quoted altitude.

It is not unusual for there to be a requirement for helicopters to offer flexible response and support to civilian operations in regions affected by warfare, and commercial operator support of military activities is often necessary. The most significant risk there is often the vulnerability to attack upon supply bases.

Returning to home-based services, several examples cited included:

- Utilities supply and maintenance - water, gas and electricity
- Fish farming (carrying live shoals between sites – conveyed as an underslung load)
- Lighthouse maintenance and re-supply (now done routinely at unmanned sites)
- Marine pilot transfer (to minimise time taken to ferry port pilots between vessels)
- Off-shore windfarm maintenance (growing volume of demand)
- Super yacht operations (not detailed – but could be carrying celebs or caviar?)

North Sea gas and fuel exploration and in-service support has been the most significant commercial helicopter operation undertaken in the UK. It started using Westland Whirlwind Srs.3 (19 Feb 1965) and has grown in size over over 50 years. Nowadays larger loads can be carried, and the Sikorsky S61 was an example: a design that could perform a water-landing in the case of an emergency. Facilities such as the 'Flotel' were developed too, this being a platform near the oil and gas fields that accommodated 6 aircraft, had 250 beds, and included a hospital. This is a facility that has a beneficial impact on the overall cost to companies that operate in such areas, and above all ensures considerable improvement of the utilisation of resources, and the best emergency support to off-shore rig crews. The availability of helicopters with greater range, able to operate out and back with reserves, is the most-wanted of types, but payload-range trade-off looks set to be fundamental limitation for some time. The capability of military helicopters to refuel mid-air is an unlikely option for commercial helicopter operators.

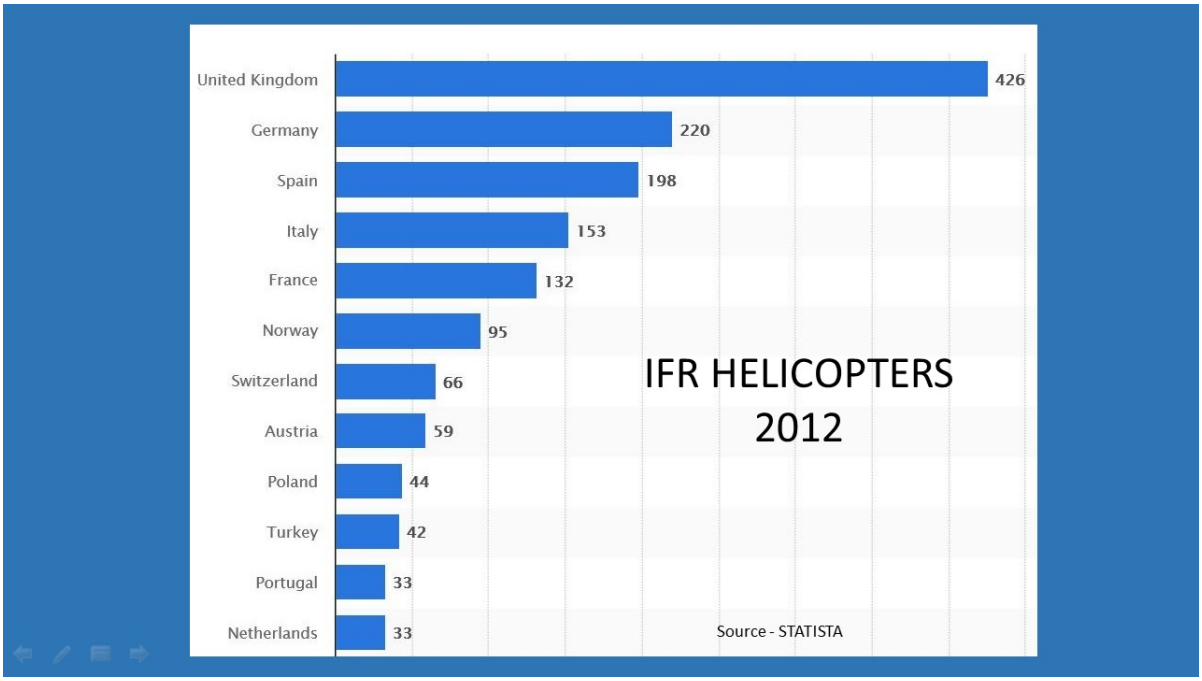
The two slides below show not just the impact of North Sea based operations on the UK helicopter population, but the impact of the often inclement weather conditions on the need to regard instrument-flight operations as commonplace.

CIVIL HELICOPTERS: TOP 10 COUNTRIES

RANK	COUNTRY	TURBINE	SHARE
1	USA	6,667	27%
2	RUSSIA	1,881	8%
3	CANADA	1,733	7%
4	BRAZIL	1,234	5%
5	AUSTRALIA	778	3%
6	ITALY	674	3%
7	UK	663	3%
8	JAPAN	617	3%
9	MEXICO	588	2%
10	FRANCE	542	2%
	OTHER	8,910	37%
	TOTAL	24,287	

RANK	COUNTRY	PISTON	SHARE
1	USA	3,084	30%
2	AUSTRALIA	1,084	11%
3	BRAZIL	578	6%
4	CANADA	570	6%
5	SOUTH AFRICA	566	6%
6	UK	413	4%
7	NEW ZEALAND	381	4%
8	RUSSIA	339	3%
9	FRANCE	311	3%
10	CHINA	272	3%
	OTHER	2,668	26%
	TOTAL	10,266	

SOURCE: Flightglobal's Fleets Analyzer database (September 2015)



The presentation concluded when Igor Sikorsky's mantra was re-introduced:

- "When will the helicopter fly faster than the aeroplane? – Never!"
- "When will the helicopter be as efficient as the aeroplane? – Never!"
- "But the helicopter will be able to do many things that an aeroplane is unable to do"

This was a presentation that covered a wide range that embraced history, technology, regulations and more. The facts supported the core topic of commercial operations, and ably supported a review that was rich in detail, well-illustrated and delivered with a structure, some humour, and a clarity that can be attributed to extensive experience and knowledge.

There was warm appreciation from the 130 attendees, who were able to relate to much overall, and yet were also spontaneous in expressing their appreciation too for a balanced and thorough appraisal of a significant, and often overlooked, specialist arena in modern aeronautical operations.

Lecture notes by Mike Hirst