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DEFINITION OF A ROTORCRAFT



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Front cover: *A typical helicopter configuration, the AgustaWestland AW139.
AgustaWestland photo.*

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Eurocopter X3. Eurocopter photo.

BACKGROUND

The FAI Sporting Code is recognised worldwide as defining all aspects of internationally recognised aeronautical achievements and associated records. The code has developed definitions of aircraft types with some considerable care and has evolved these definitions as required to suit new configurations of air vehicle as they have come to the fore.

Recently, resurgence in the unconventional rotorcraft has occurred in the USA, Europe and possibly Russia. In particular Sikorsky has test flown the X2 and Eurocopter the X3, both of which have shown by demonstration an ability to outpace the traditional edge wise rotorcraft in respect of speed, agility, operating ceiling and rate of climb. Of these artefacts, speed, ceiling and rate of climb are all recognised candidates for FAI Class and Absolute records.

This note suggests that the time is right to request that the FAI revise the stated definition of aircraft types so as to correctly identify and reward the ingenuity and skill of the teams that create aerospace products that advance the state of the art. All standard definitions used below are taken directly from the FAI Sporting Code, as available from the FAI via their web site.

DISCUSSION

The FAI Sporting Code defines a 'Rotorcraft' as an "aerodyne that derives the whole or a substantial part of its lift from a rotary wing system." An 'aerodyne' is "an aircraft, heavier-than-air, that can be dynamically sustained in the air by the reaction of the air upon surfaces in relative movement."

A 'helicopter' is defined by the FAI as "a rotorcraft which, in flight, derives substantially the whole of its lift from a power-driven rotor system whose axis (axes) is (are) fixed and substantially perpendicular to the longitudinal axis of the rotorcraft."

It is perhaps worthy of note that the tilt rotor configuration is specifically defined in its own right within the definition of Class E Rotorcraft. The convertible nature of this configuration clearly makes a strict comparison with rotorcraft configurations that cannot convert from one mode of flight to another virtually meaningless. This is a good example where records awarded to one configuration must be judged as recognition of endeavour that is different in a fundamental way from records awarded to another. It is for this reason that the FAI defines different types of aeroplanes and rotorcraft in the first place.

It is clearly important that the definitions used by the FAI properly and correctly differentiate between fundamentally different configurations of rotorcraft. The traditional helicopter derives both lift and longitudinal thrust from a power driven rotor that is substantially perpendicular to the axis of the rotorcraft. The FAI definition makes no mention of longitudinal thrust, only lift acting substantially perpendicular to the axis of the rotorcraft. It is a matter of great achievement that the edgewise rotor unsupported by fixed lifting surfaces and operating in the most complex aerodynamic conditions is able to achieve high speed. The speed record for a helicopter relying substantially on thrust generated by an edgewise rotor for lift and forward propulsion is an achievement to be uniquely celebrated and not confused with other rotorcraft configurations that may be equally worthy of reward but for different reasons.



Sikorsky X2. Sikorsky photo.

The Sikorsky X2 would today be classed as a helicopter according to the FAI definitions but cannot achieve high speed without the aid of a propulsor acting in concert with the advancing blade concept rotor. At high speed main rotor drag is minimised by keeping the rotor disc sensibly aligned to the direction of flight, in which orientation it cannot produce substantive longitudinal thrust; lift is assigned to the rotor and forward thrust to the propulsor. The ingenuity that should be rewarded is that the classic advancing/retreating blade restrictions of the edge wise rotor have been overcome without reliance on fixed lifting surfaces by application of the ABC configuration.

Similarly, the use of fixed lifting surfaces operating in conjunction with a traditional edge wise rotor and auxiliary propulsors can achieve a variety of performance improvements when compared to a classic helicopter by separating out lift from longitudinal thrust. This is a recognised configuration that has flown in experimental forms over many years but is currently best appreciated in the guise of the Eurocopter X3, which has demonstrated substantial performance benefits over the conventional helicopter. Ironically this configuration may not even be sensibly covered by an approved FAI definition and so may be ineligible for reward in respects of recognised records. If the fixed lifting surface generates a large proportion of the overall lift available then the X3 may not be considered as a helicopter or a even a rotorcraft when operating at speed. It is clearly not a tilt rotor or a tilt wing and neither can it be defined as a vertical take-off and landing aeroplane since this must, according to the FAI, derive its lift at low speed from engine thrust.

It is suggested that the current FAI definitions of aircraft types is inadequate to describe the emerging class of rotorcraft that are aiming to enhance performance by the separation of lift and longitudinal thrust forces.

RECOMMENDATION

The addition of a fixed lifting surface, auxiliary propulsor, or a combination of both to the classic helicopter configuration defines a 'compound helicopter'. This term is well established and should be used to differentiate these rotorcraft from the classic edgewise rotor helicopter that generates substantially all lifting and longitudinal propulsion from the same power driven rotor(s).

To establish and differentiate helicopters from compound helicopters the following definition is suggested:

- a) The helicopter is defined as "a rotorcraft which, in flight, derives substantially the whole of its lift and longitudinal thrust throughout the flight envelope from a power driven rotor system whose axis (axes) is (are) fixed and substantially perpendicular to the longitudinal axis of the rotorcraft."
- b) The compound helicopter is defined as "a rotorcraft which, in flight, and at slow speed derives the substantial proportion of its lift from a rotary wing system but at speed can generate lifting and longitudinal thrust from a suitable combination of rotary wing system, fixed lifting surface(s) and auxiliary propulsor(s)."

The proposed adaptation of the current FAI definitions would clearly separate out configurations that are worthy of reward in their own right and which cannot be properly compared with each other. In addition the combination of a rotating wing system, fixed wing and auxiliary propulsors can be captured whereas at the moment no suitable categorisation appears to be available.