Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

COMAT 2020 & eMECH 2020

Brasov, ROMANIA, 29-31 October 2020

DESIGN OF AN UNCONVENTIONAL HELICOPTER WITH NOTAR SYSTEM AND CANARD TAIL

Ursache Marian
Transylvania University, Brasov, Romania, marian.ursache@student.unitbv.ro

Abstract: *The purpose of this paper is to describe a helicopter prototype with a Notar system and a Canard tail, which has the function of transforming it into an airplane flight. Starting from a real helicopter, it was designed the all parts of them in CAD software and then were modified some structural parts so to obtained an airplane fligth.*
Keywords: *helicopter components, airplane, design, NOTAR system.*

1. INTRODUCTION

Air transport is one of the fastest means of transport being used both in commercial, tourist, military and humanitarian. Their diversity has increased in recent years, both in form, capacity, speed. Studies in the field of aeronautics investigate various problems regarding the construction of helicopters and / or airplanes, either by finding lighter materials, but with increased rigidity, or by designing light structures with reinforcing elements, or by optimizing the rotor and other propulsion elements. This paper aimed to design a hybrid structure in terms of functionality, and the possibility of transforming a helicopter into an airplane.
For this this project the following components have been developed in Solidworks software next components:
- Helicopter prototype
- Notar system
- Helicopter cyclic plate
- Helicopter main rotor

2. THE PRINCIPLE OF TRANSFORMING THE HELICOPTER INTO AN AIRPLANE

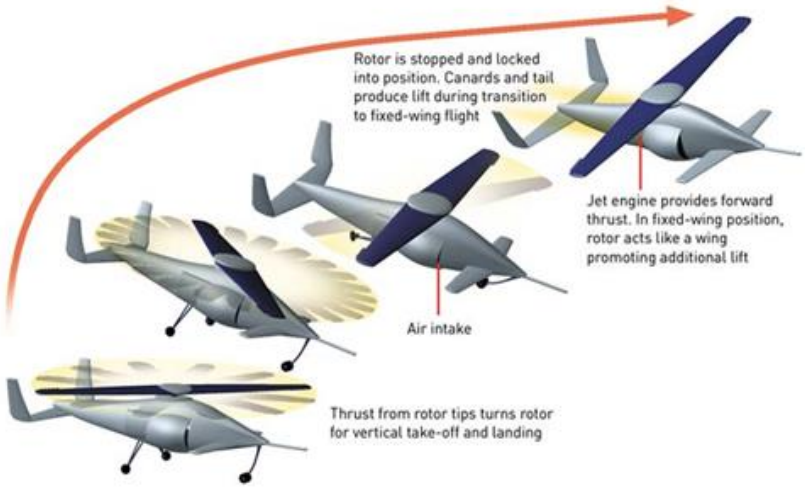

Figure 1: Schematic transformation from helicopter into aircraft

2.1. System description

First step is to use helicopter lift principles. In flight at high altitude rotation of principal rotor will be stopped and the blades will have wing function. Together with NOTAR system and CANARD empennage this will allow to flight like an airplane.

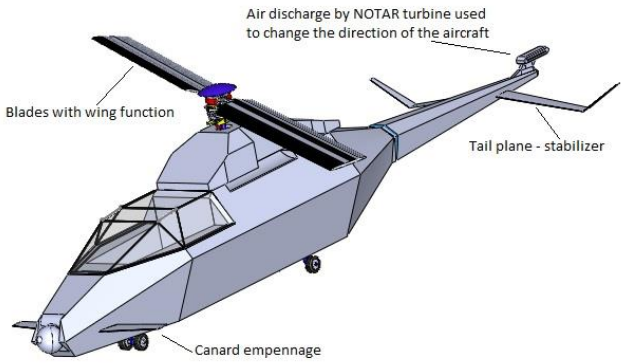

Figure 2: Helicopter prototype

3. NOTAR SYSTEM

3.1. Description

NOTAR is the name of the anti-torque system that replaces conventional systems with a fan. Developed by the Mc Donnall Douglas Hellicopter System full name is No Tail Rotor. The system uses a fan inside the tail to produce a large volume of low-pressure air, which exits through two slots and creates a flow in the boundary layer of air along the tail using the Coanda effect. Modifications to the boundary layer direct the flow of air around the tail, creating traction relative to the movements shared to the fuselage by the effect of torque in the main rotor. The direction of the turn control is acquired through an aerated, rotating drum at the end of the tail, called the steering jet thruster. Notary supporters believe that the system offers a quieter and safer operation.

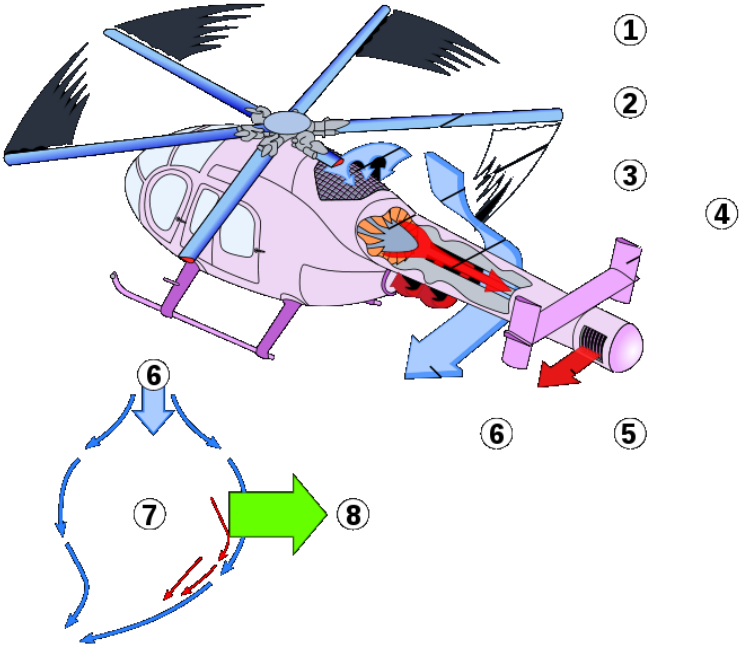

Figure 3: Description of NOTAR system functionality (1.Air intake, 2.Fan with variable blades, 3.Tail with "Coanda Slots", 4.Vertical stabilizer, 5.Air jet directing cone, 6. Air current deflector, 7. Air circulation inside the section, 8.Antitorque)

3.2. NOTAR system functionality

Although the concept, which uses the Coanda effect, took some time to define, the Notary system is simple in theory and works to provide steering control just as a wing develops bearing capacity. A variable pitch fan is included in the fuselage section just before the front of the tail and driven by the main rotor transmission. This low pressure fan through two slots on the right side of the tail, causing the deflection of the main rotor on the

tail, produces load-bearing, and thus a measure of steering control. It is complemented by a direct jet engine and vertical stabilizers (Figure 3).

4. NOTAR SYSTEM PROTOTYPE DESCRIPTION

This virtual model was designed using Solidworks Software and is composed by next components:
- Stator Bottom and Top
- Rotor
- Spindle which allow rotation of Rotor and bearings as can be seen in the figure.4
- Variable blades that make it possible to adjust the air flow in the system Fig.5
- All components where designed at the 1:1 scale and respecting design and technical rules

The fixed turbine assembly consists of a 3-stage fan and a 4-grid stator. The fixed part of the turbine has the role of absorbing the air from outside the helicopter to transmit it to the variable blades on the opposite side of the turbine.
The blower part of the turbine is composed of a fan with variable blades that helps to change the flow of exhaust air to the outside.

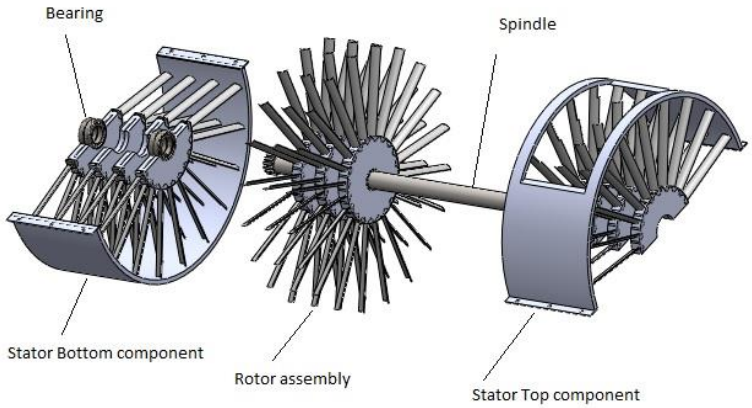

Figure 4: NOTAR system components

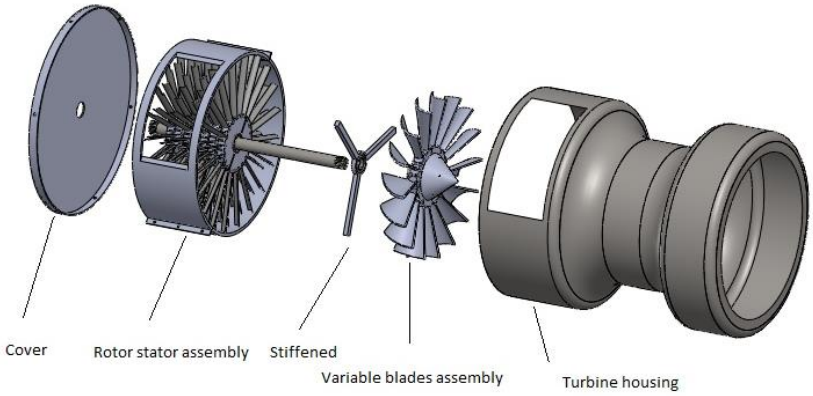

Figure 5: NOTAR system assembly

5. NOTAR SYSTEM ADVANTAGES

The benefits of the Notary system include increased safety (the rear rotor being vulnerable), and greatly reduced external noise. Helicopters equipped with the NOTAR system are among the quietest certified helicopters.

6. CYCLIC PLATE CONFIGURATION

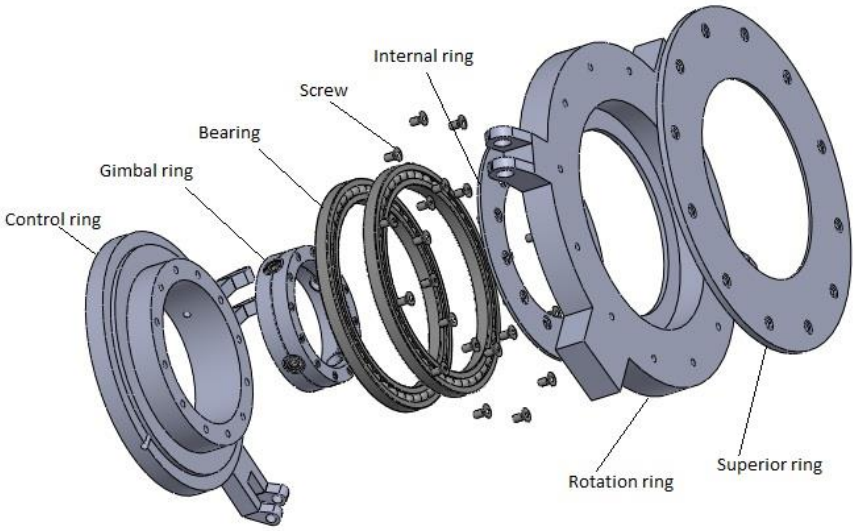

Figure 6: Helicopter cyclic plate Solidworks prototype

The cyclic plate transfers the inputs of the collective and cyclic step controls of the main rotor from the fixed to the rotating components.
The collective inputs are transmitted through the control lever of the control unit of the main gearbox to the sliding sleeve of the cyclic plate. The collective inputs move the cyclic plate up and down on the support cylinder. This movement is transferred to the rotation control bar, determining the field angle of all the blades of the main rotor to be changed simultaneously with the same amount. The resulting variation allows the helicopter to climb or fly faster or slower.
The cyclic inputs are transmitted through longitudinal control rods and side control levers of the transmission box unit with a cyclic plate control ring. A cyclic input through a cardan shaft changes the angle of inclination of the control ring and the bearing. Depending on the tilt axis, this affects the longitudinal or lateral movement of the helicopter.
In unison movement of the rotating ring of the bearing by tilt, the rotary controls are moved up and down on the orbital path of the rotor rotation. This up and down movement of the rotary control mechanism changes the pitch angle with each rotation. At the same time, it causes the rotor disk tip to change direction and traction. Also allowing the helicopter to move on its axes of rotation respectively ascent and descent.
The control of collective and cyclic entries can be applied individually or superimposed.

7. MAIN ROTOR ASSEMBLY AND FUNCTION

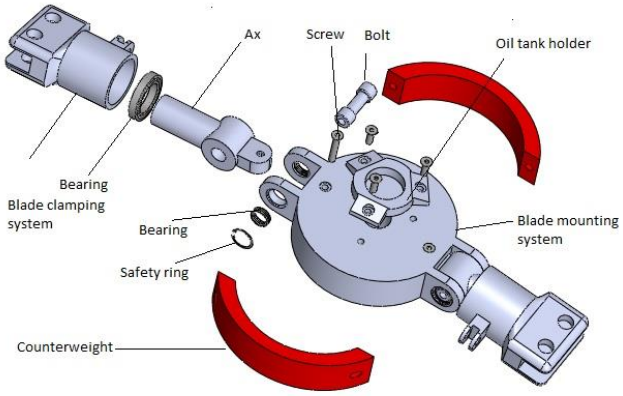

Figure 7: Helicopter main rotor Solidworks prototype

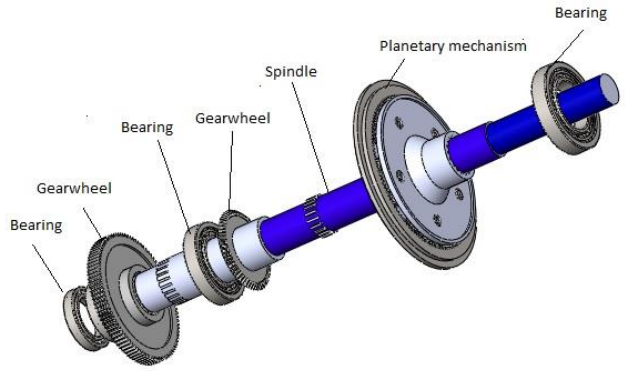

Figure 8: Helicopter transmission box Solidworks prototype

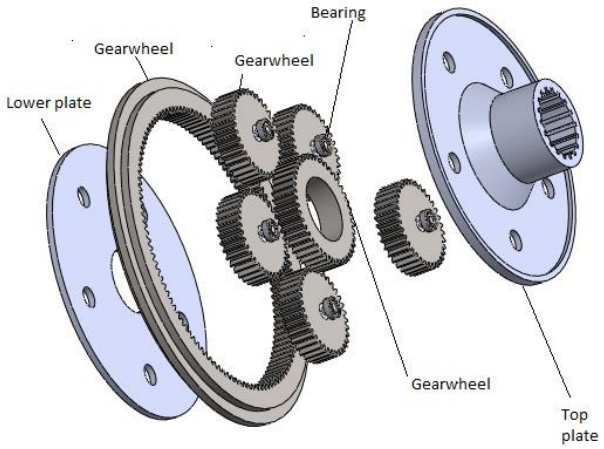

Figure 9: Helicopter planetary mechanism Solidworks prototype

The purpose of the gearbox is to take and transmit power from the motors to the main rotor and the anti-torque rotor and to reduce the speeds received from the motor to them. The transmission box also takes over the load force produced by the main rotor, reducing them with the help of the shock absorbers with which it is fixed on the helicopter body.

8. CONCLUSIONS

- Helicopter needs smallest surface for take-off and landing (can land on buildings, on almost any surface)
- The airplane has a higher flight speed than a helicopter

REFERENCES

[1] Postelnicu A., Deliu Gh., Udroiu R., Theory, Performance and Construction of Helicopters, Ed. Albastra, 2001
[2] Wikipédia (Fig.1 and Fig.3)
[3] Ursache .M , Transylvania University, Aerospace Constructions, License project 2010