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FLYING WING

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Abstract. The aim of the article is to analyse the functionality of Flying Wing design by TU delf and KLM. Flying wing design is a design mainly used in military. This design was used for a strategic bomber which needed to have a long specific range while carrying a heavy payload. This design consists of a single wing which serves as well as a fuselage. This wing fuselage needs to meet airlines requirements.

Keywords: flying wing; fuselage; design

1. INTRODUCTION

The air transport market where the air carriers are trying to find a compromise between the costs of operating, revenues and prices for the services provided, new types of more efficient engines, improved aerodynamic design or modifications in aircraft construction are entering the market. The largest share of the civil air traffic market is made of the aircrafts using a semi monocoque structural type of fuselage with a wing hinge at its root at the bottom of the fuselage without braced struts. The standard engine mount is on the bottom of the wing.

KLM in cooperation with TU Delft University based in the Netherlands, has started to innovate the new aircraft design type. Structurally, the entire aircraft will consist of a single wing in which the crew, passengers, cargo and fuel will be located. The aircraft has no tails. The engines will be located on the upper side of the wing in the rear, this design will allow up to 20% fuel savings on long-distance transport.

They drew inspiration for the design from military bombers YB-35 operating in World War II and subsequently a more modern type of American B-2. Every bomber should have the long-range prerequisites associated with aerodynamic finesse and high load capacity. Those are the prerequisites that KLM and TU Delft are trying to implement in the new generation of transport aircraft.

The wing wide enough to accommodate the pilot, engines, fuel, landing gear and other necessary equipment will have an enlarged leading edge compared to the classic wing and long fuselage. This will result in higher resistance and thus lower efficiency than with a conventional type of construction. The best solution in this case is to keep the wing reasonably wide and then equip the aircraft with a series of controls to suit all the piloting needs of the aircraft. At supersonic speeds, where the drag rises , it is necessary for the wing to be thin, therefore the use of a given design type at supersonic speeds is not expected [1].

2. METHODOLOGY

The new design can be compared in size with the Airbus A350 airliner, which is primarily focused on long-haul flights. The Airbus A350 is 67 meters long compared to the same wingspan and 141,000 liter fuel tank. The dimensions of the storage space are 223 m^3 or 11 pallet locations. The new prototype, whose storage volume is 160 m^3, means a significant reduction and it will probably not be possible to use the form of pallet loading into the storage space [2].

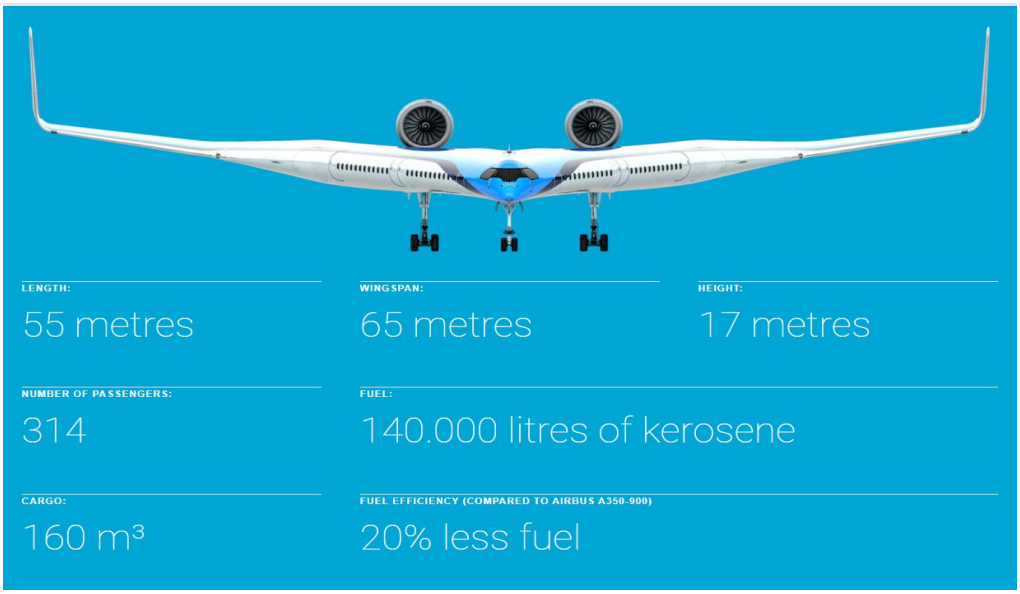

Figure 1 Basic Parameters
Source: TU delft Flying-V

All types of the aircraft must have sufficient stability to be able to return to their original balanced position after being struck by wind or other steering influences. The prototype uses the design of a flying wing with the wings converging backwards. The center of gravity of the aircraft must be located in front of the neutral point and the wings must be raised upwards to achieve sufficient stability, which reduces the overall coefficient of lift. The design is aerodynamically clean, which leads to a reduction in overall drag, which affects its overall consumption and range.

Due to the lack of conventional stabilization surfaces, maneuverability is limited and wings flutter may occur. That makes a major obstacle to conventional piloting. For this reason, an artificial control system better known from the Airbus series of aircraft is installed in a given type of aircraft construction, where the pilot does not control the primary flight controls by direct transmission. The engines must be located close to the center axis of the aircraft, which reduces the total weight of the load it will be able to carry.

3. RESULTS

By comparing with a similar type of aircraft that is already used in air traffic, we can evaluate the overall impact of the new prototype on ground handling and airport equipment. The mobility of the new prototype is still questionable, but in terms of dimensions, it can be assumed that at airports that are certified for A350 aircraft, there should be no problem with normal aircraft movements on runways, taxiways and aprons intended for it.

From the point of view of the flight preparation and the interaction of the aircraft with ground handling, we can exclude the pallet loading of the transported cargo for the time being, which will be significantly reflected in the speed between the flight preparation in the field of baggage handling. In general, in the winter season or in meteorological conditions where there is a risk of ice creation, it is necessary to perform deicing of the aircraft using appropriate chemicals.

The construction of the aircraft in a deicing procedure represents a great benefit. Almost the entire aircraft is in one level and the application of a chemical that prevents the formation of ice is therefore easier and handling needs to be moved less to reach all necessary parts of the fuselage, where there is a risk of icing or the surface is covered with snow. The deicing problem can occur when some of the chemicals get into one of the engines located on the top of the wing.

The deicing mixture itself contains elements of alcohol but is not flammable by itself, each type of engine must be tested to be able to absorb a certain amount of water and still continue to function. Provided that deicing chemical residues enter the engine during the deicing, there should be no risk of flooding or engine damage.

The preflight check which is performed by the pilot-in-command before each flight, is facilitated by the overall shape of the aircraft by detecting potential damage that may have occurred both during the flight and aircraft taxiing on the ground or after ground handling interactions with the aircraft. Boarding bridges, which are part of each hub airport, will mainly be used for boarding and disembarking passengers. Another challenge for ground handling will be the creation of a load sheet and an emphasis on balancing the aircraft so that the aircraft is within the set safe limits. [3]

3.1 Cabin configuration

The internal structure of the aircraft was presented in a basic configuration where the business class will contain 48 seats, economic 266, which is a total capacity of 314 seats. The configuration of the aircraft will be adaptable to the requirements of the airline. The total width of the cabin in the individual V-shaped arms is 6.1 meters, which is wider than the Boeing 777 series. The internal height of the cabin measured from floor to ceiling is 2.1 meters, which is equivalent to the lower deck of the A380 aircraft.

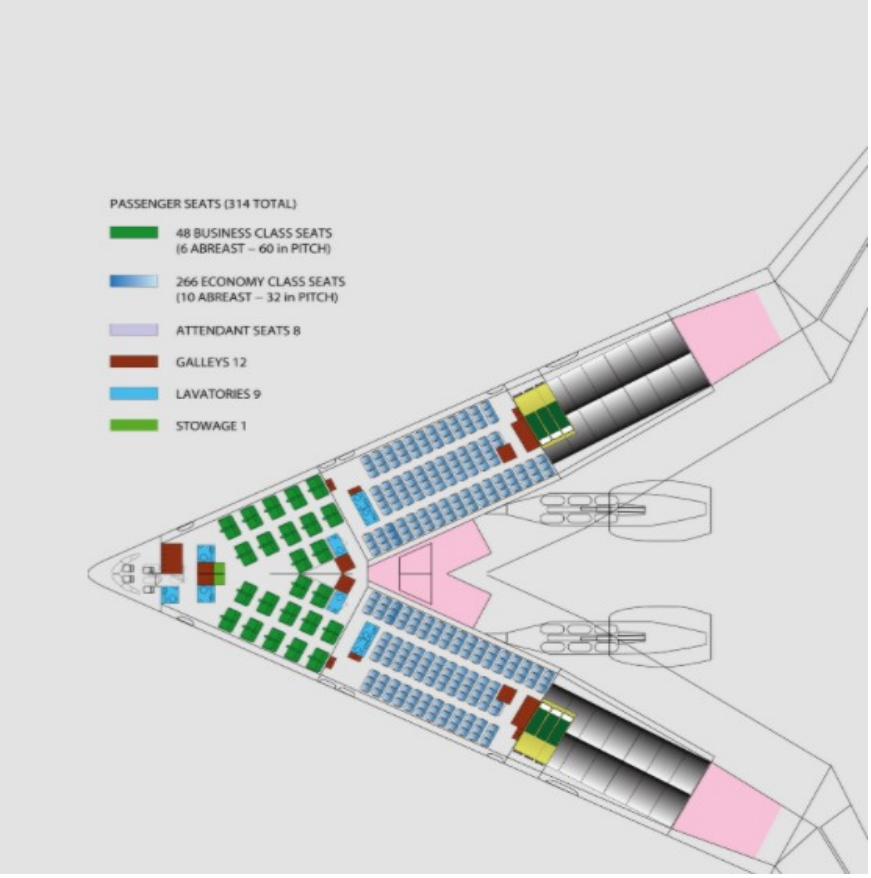

Figure 2 Cabin configuration
Source: TU Delft Flying-V Technology

New types of seats will be an innovation in cabin equipment. KLM has decided to incorporate 4 types of places where passengers will be able to spend their free time. The first type will be group seats, which we can familiar with from the train where the passengers will sit facing each other in a

configuration of 4 seats. The next type will be classic seats that we can recognize from regular air transport, the third type will be lounge seats that will provide more space for various activities of passengers during the flight. [4]

The last fourth type will be laying beds, which we can also know from train traffic. Of the total number of passengers on long-haul flights, up to 60% of passengers want to sleep on their flight. The question remains how the individual seats will be equipped with security features during emergency landings. It is also questionable how the laying seats will work during landings and takeoffs, and whether the passengers who choose the laying bed seats will also have classic seats. In the case of laying beds, it will be necessary to solve the problem of oxygen masks during sudden decompression.

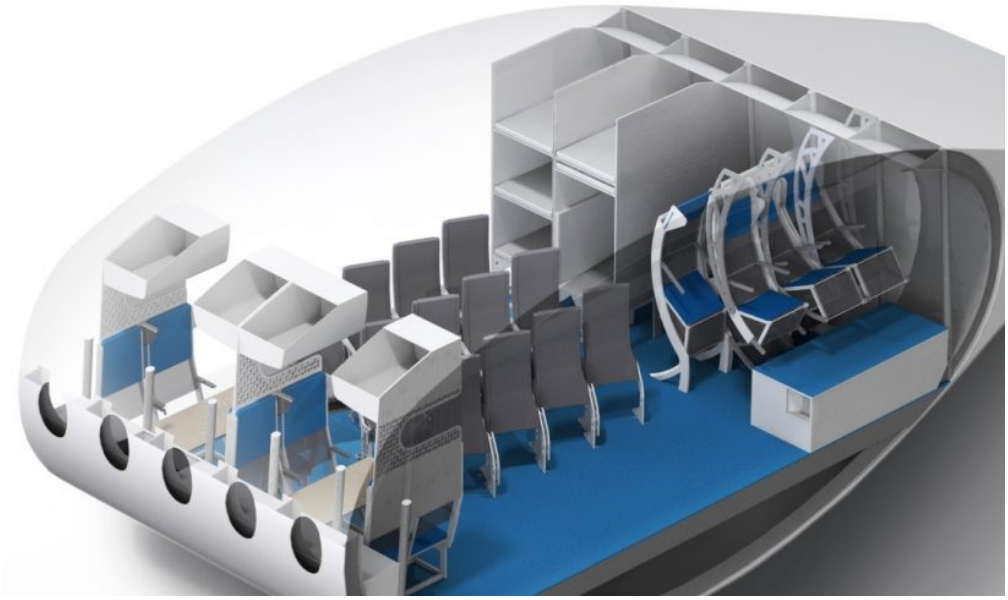

Figure 3 Inside cabin
Source: TU Delft Flying-V Cabin

4. DISCUSSION

Compared to the competing A350, the wing area of the new prototype is doubled, which results to capability of generation sufficient amount of lift by itself without lift augmentation devices and can achieve an approach speed of 140 knots without using flaps. This significantly reduces the overall maintenance costs of the aircraft, because the moving part was removed from the wing, which was also subject to maintenance due to frequent use during approach and take-off. Due to the high lift factor, the aircraft needs speed brakes to increase the drag for descent, which are located in the rear of the aircraft at the opening of the main landing gear legs. The overall shape of the aircraft places great emphasis on the correct balance of the aircraft.

At increased angles of attack, lateral stability decreases and subsequent return from the uncontrolled stall is almost impossible. For this reason, automatic flight envelope protection will have to be implemented in the aircraft. This system is currently used in civil air traffic by a series of Airbus aircraft with a fly-by-wire transmission, which ensures that the aircraft will operate only within the reserved safe limits. The pilot never has 100% control of the aircraft during the flight. Each of the crews will have to emphasize the correct distribution of passengers and cargo to ensure sufficient stability.

The assumed maximum angle of approach during take-off and landing will be approximately 12.5 °, the reference speed for take-off under the MSA will be 150 knots. The optimal angle for the take-off configuration will be 8.5 °. Moving the aircraft's center of gravity forward by 5% will cause the optimal take-off angle to increase to 10 °. [5]

5. CONCLUSION

The arrival of a new aircraft type design for civil air traffic was a matter of time and a logical approach by the airlines in order to increase the efficiency of air traffic. The unique design taken from the military operation still faces many obstacles before entering the market. In terms of safety of flight characteristics, it will be necessary to implement a series of elements that will protect the flight envelope itself.

Thanks to the aerodynamically structure and the position of passengers and cargo in the wing of the aircraft itself, the aircraft is able to provide up to 20% fuel savings on long-haul flights. The aircraft is dimensionally comparable to the competing A350. The dimensional parameters do not constitute an obstacle for the ground movements of the aircraft. The overall shape of the aircraft is favorable in terms of ground handling in the deicing procedure of the aircraft, where it is easier to cover the whole area of the aircraft.

The entire upper part is almost at one level, which will allow the personnel performing the application of deicing and anti-icing chemicals to carry out their activities from one stationary place, or they need to move significantly less. The new design of the aircraft type in the civil air traffic market will be the right step and development of aviation. In recent years, there has been no major change in the overall shape of transport aircraft structures. Another possible implementation for a new type of aircraft will be an engine with an alternative drive.

It is estimated that this prototype will hit the market around 2030. We can assume that during that time there will be more progress in the development of power units and the prototype will be equipped with the most economical drive. With favorable consumption and a reduction in the total number of moving surfaces and aerodynamic shape, it will cause a significant reduction in the cost of operating air traffic.

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