CHANGE, Combined morpHing Assessment software usiNG flight Envelope data and mission based morphing prototype wing development

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CONSORTIUM

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Morphing in aircrafts has been studied and used throughout recent time in order to increase their flight envelope. This characteristic is of the upmost importance in order to offer a greater efficiency, versatility and performance during the assigned mission. Moreover an aircraft with the capability to adapt itself to each given situation is prone to achieve positive results to a range of different missions instead of requiring a specific aircraft to conduct one specific mission.

The main objective of this project is to study and develop a novel morphing system which integrates up to four different morphing mechanisms into in a single wing and to demonstrate this new ability in flight. This system would take advantage of all the performance improvements achieved by adopting its wing shape according to the mission requirements of each flight phase.

Therefore, this project envisions to mitigate the required energy (and thus fuel consumption) to maintain the aircraft's flight and to perform the necessary flight maneuvers by offering the capacity to mold the exterior of the aircraft in order to enhance the necessary aspect of flight so as to lessen the required energy, such as lift over drag ratio, efficiency in aerodynamic control, lower stall velocity or to change to a better planform to perform a required maneuver.

In order to prepare the basis for an eventual cognitive morphing on-board controller which ability is focused in the autonomous control of all morphing system of the wing, it is necessary to develop a software that is capable of rendering the most efficient morphed wing based on the information of the current phase. This software would therefore, be able to conduct an assessment of the introduced flight conditions of the wing and display the accordant morphed wing (using a database with all current morphing systems) capable to fly with the highest performance.

Four main flight phases (Take-off, loiter, high-speed dash and landing) will be considered.

Various approaches for the efficient solution (Camber, twist, swept back wing, telescopic wing...) will be simultaneously considered.

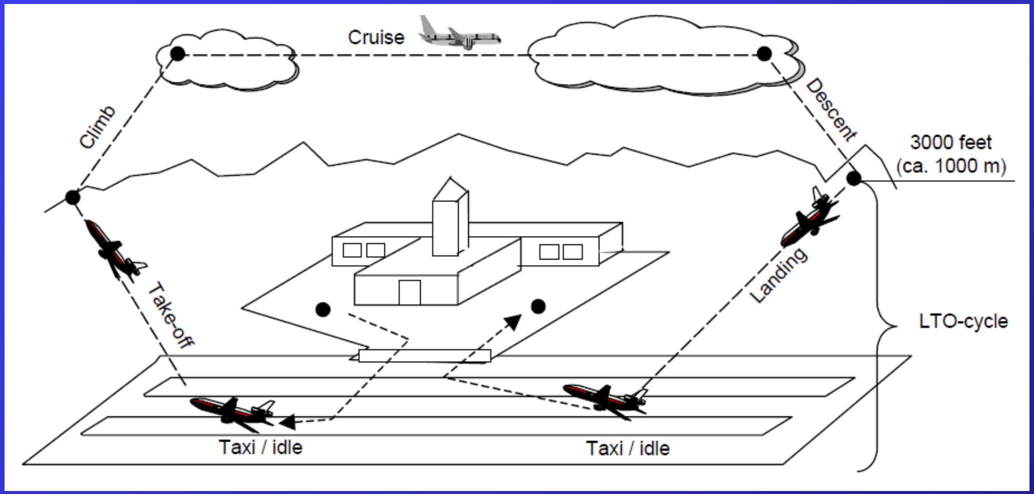
Various materials will be considered, and if necessary developed, for aerodynamically efficient as well as structurally durable and producible wing/ control surfaces.

The design will first be verified by computational aerodynamic and structural analyses. The produced wing/ control surfaces then will be subjected to ground vibration tests, wind tunnel tests and flight tests.

METU responsibilities will mainly focus on the structural design of the wing. The studies primarily concentrate on the landing phase and also on the take-off phase. The approach will consider both the aerodynamic and structural analyses of camber and twist effects.

METU will also take part in the wing integration activities, wind tunnel tests and flight tests of the produced wing.

The project will be expected to provide a reduction in both CO2 and NOX emissions due to an always efficient wing design.



Landing and take-off cycle (LTO), which comprises all activities near the airport; and the cruise section, which is defined by all the activities taking place above 1000m. [1] and [2] estimate that 5-20% of the fuel consumed throughout the flight is due to the LTO cycle. Hence an optimum wing for LTO can provide lower emission.

Because the cruise section of the flight is usually the longest one, the aircrafts are designed to have the greatest performance during this phase. In a typical B737-800 mission, with all the required flight phases (take-off, climbing, cruise, descent, loiter, landing), the fuel burnt in the cruise phase is only 16% of the total burnt fuel and that, the remaining 84% are burnt in flight phases which aren't optimal for the designed wing [3]. This is where project CHANGE wants to implement its concept. A NASA study revealed that only "1% of reduction of fuel consumption can produce savings of as much as $140.000 each year for each aircraft" [4].

The concepts to be developed in CHANGE can enable an aircraft to recover from situation prone for accident. The innovative wing could change its shape in an emergency situation, such as the involuntary stall of the aircraft's wing or engine malfunction, thus being capable to salvage the aircraft from an impendent crash (e.g. in the case of a wing stall situation or engine malfunction, the wing could increase its planform area, thus decreasing the stall speed and increasing the L/D ratio of the aircraft. This would enable the aircraft to recover its flight preventing a possible accident, since it would now be able to fly at a lower speed and glide farther).

The wing to be developed in Project CHANGE will alter its shape in order to fly with the highest performance possible during the whole course of the flight. The increase in performance will also increase the amount of lift over drag because of the increase in the laminar flow over the wing that is responsible for decreasing the level of noise emitted from the aircraft's flight.

By increasing the performance during the extent of the flight, both the wing and software to be developed within the project will increase the comfort of the passengers in the course of the flight.

In a climbing or descent situation, the passengers will not feel discomfort since the wing will be at all time at its peak performance, performing the required action more smoothly than usual.

[1] Rypdal, Kristin, "Aircraft emissions", Good Practice and Uncertainty management in national greenhouse gas inventories, Background paper for the energy sector.

[2] Innovative Cooperative Actions of RD in EUROCONTROL Programme CARE INO III; Dynamic Cost Indexing, Technical Discussion Document 4.2, Including climate impacts of NOX in a Dynamic Cost Indexing tool.

[3] Technical Discussion Document 7.0; "Outline instructions for calculating emissions and associated costs and impacts", Innovative Cooperative Actions of Research and Development in EUROCONTROL Programme CARE INO III; Imperial College London.

[4] Gilyard, Glenn; Geogie, Jennifer and Barnicki, Joseph; "Flight test of an adaptive configuration optimization system for transport aircraft", NASA Center for AeroSpace Information, January 1999.