Proposal for One-time Use Wings for Small Fixed-Wing Space Shuttles

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Abstract

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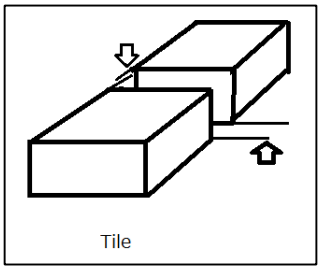
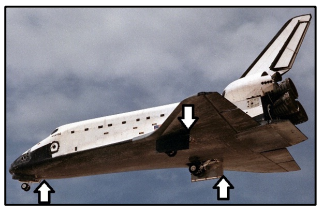
The existing space shuttle (or the round-trip spacecraft) is equipped with main wings at the time of its launch and it is impossible to prevent a damage by the first boost's high heat and vibration completely. Furthermore, it can be exposed to high heat at the time of re-entry. The main wings, necessary for its safe flight, are overused and it is unavoidable to impair its flying performance at the time of the reutilization in the present reutilization circumstance. A passenger airplane has a design concept to protect its main wings even by the separation of engine at pylon and this design concept should be applied to a space shuttle as well.

Therefore, a safety with disposing only main wings in consideration of reutilizing both airframe and main wings in the present circumstance is examined from a viewpoint of a pilot for a fixed-wing airplane.

The existence of wheel compartment doors at the bottom of heat-exposed airframe also increases a risk. For this matter, I would like to suggest to implement the attachment and detachment process for the above mentioned main wings at a place as shipbuilding yard after designing a structure that a shuttle can land in a large river without landing wheels. I also considered to avoid the cost increase by utilizing the existing reliable parts and structure of the shuttle without any modifications.

1. Issues for the existing shuttle





Firstly, when we focus on a reutilization of main wings generating most of the lifting force and a safety for airframe reutilization in consideration with a structure of fixed-wing airplane, the reutilization of main wings can be considered as a higher risk than the reutilization of airframe. A shuttle is operated based on a design concept of reutilizing everything in the orbiter. Main wings, gaining a lifting force at the time of flying as a fixed-wing airplane after atmosphere re-entry, are the parts with the largest area in the orbiter and integrated with the airframe bottom as one of the most heat-exposed areas.

Although the surface is covered by heat-resistant tiles, the tile's difference in height and a portion between tiles generate unfavorable turbulent flows for lifting force generation. Using the heat-resistant tiles is to be supposed for the material reutilization but if one-time use is supposed, another choice can be the possibility as using a proven material with superior heat resistance.

Secondly, although wheel compartment doors at the bottom of heat-exposed airframe exist without any accident so far, a physical gap exists at the doors and bottom and the wheel compartment naturally exists inside of the airframe. If a high heat inflows by any chance,

the possibility cannot be denied that it could damage the central system of airplane and flight control system. In addition, although the relevant portions are equipped with shields, the shield cost and the number of processes should be reduced.

Thirdly, after the airframe with high heat makes a landing, the flight crews cannot get off the shuttle until the airframe is cooled down. All flying objects in this regard can be considered, with an assumption of high risk in flying phases, as a setback for emergency escape at the time of landing.

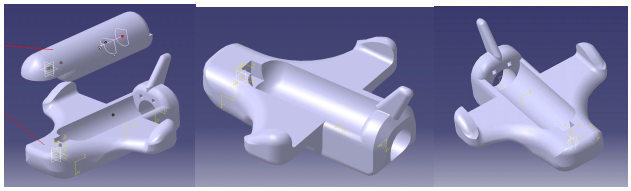
In consideration with those three aspects, I would like to explain a possibility of the risk reduction by a design concept that main wings can be utilized only for one-time use.

2 Concept of one-time use for main wings

Design concept
When a protection against high thermic fluid for a shuttle's return focuses on receiving high energy initiated from a bottom of airframe, a structure of a flying boat can be referred as receiving a water pressure on its upper portion from its airframe bottom at the time of landing in the water. In this section, the common ground is explained as a reference that the bottom receives high pressure and high temperature with the integrated structure of main wings and bottom portion.

A flying boat has a shape to reduce the influence on its airframe by fluid energy from the bottom. It is considered that this airframe shape can be applied for space transportation vehicles at the time of re-entry.

The common ground to lead the above speculation and the speculation to deny the main wings reutilization is a structure that a command ship is placed on a boat form with main wings. For example, I would like to propose a design with a separation of the reutilization of "Command Ship" and One-time use of "Main Wings, Tail Surface, and Bottom Portion of airframe" as shown in the illustration.



2.1 **Expectation of alternative expansion for main wings' heat-insulating material**

Although the main wings for shuttle adopt a countermeasure mainly with using heat-resistance tiles, this adoption is based on a design concept for a countermeasure against heat with reutilization of main wings and if the design concept is for one-time use of main wings, the alternative expansion for material can be expected because it is enough to take a one-time role to protect the high heat.

Including utilizing the one-time use of Ablation heat-resistance material (Ablation TPS) used for Apollo space ship as an alternative, it is possible to adopt a low cost and suitable material with heat insulation capability for one-time flying.

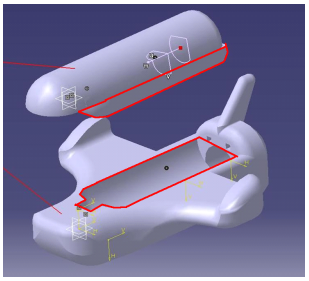
2.2 **Adopting a wing configuration with a presumed damage on main wings**

The issue of destruction for main wings generating a lifting force must be avoided for flying objects.

By discarding main wings after a single flight, it makes possible to adopt a main wing configuration with a presumed destruction zone in advance.

It is a design concept that assumes the portion as shown in blue is destroyed with high heat after discarding the portion as shown in green and avoids a destruction of the main wing configuration as shown in red, necessary for minimum lifting force generation.

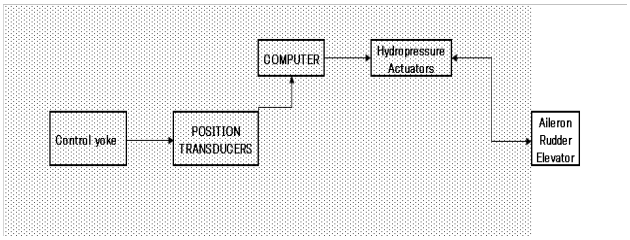
2.3 Connecting main wings and airframe



The connecting portion of main wings and airframe needs to obtain a structure for not being influenced by damage on airframe even if high-pressure gas inflows into the connecting portion as a redundancy, and the heat-resistance tiles of the existing shuttle should be placed onto the bottom of airframe (the red frame). However, a small number of the detached heat-resistance tiles are estimated because the area is narrower than the present bottom portion and it is not directly exposed to the friction of the atmosphere. With this reason I consider there is not much influence on the number of manufacturing processes and cost. For the connecting structure, I consider it can be applied to the shield structure used for the door or wheel compartment door of the existing shuttle.

2.4 **Flying control system**

I consider a separation of main wings and airframe does not influence on flying capability. In modern days, a flying system has been shifted to a fly-by-wire system and the flying intention for pilots steers ailerons and a rudder via computer. This system is shown as the diagram below and I consider it should not be contradictory to the design concept of one-time use for main wings because the highlighted does not need a large correction of the flying system due to its being placed on the airframe side.



2.5 **Splashdown in a large river**

The merits of splashdown in a river are to avoid the high heat inflow from a wheel compartment door as described above and to correct a situation where crews cannot get off the shuttle until the airframe is cooled down. The splashdown in a river is possible with the same flying technique as landing on the runway.

When main wings are for one-time use, attachment/detachment of the main wings at a shipyard type of infrastructure are suggested after collecting a splashdown shuttle. The existing shuttle has overall length 37.04m and overall width 23.79m and the size can be accepted in a large marine vessel dock.

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2.6 **Corrosion prevention (Rust prevention)**

The seawater contains Cl−. The corrosion rate of steel at ocean site is higher than at inland site. At coastal site, a weather-resistance steel cannot be used without paint application. However, if a splashdown takes place in the river, the constituent of Cl− is average 5-6 mg/l for the Japanese rivers and it is lower than the standard value of tap water (200mg/l). Because the amount of chloride ion in seawater is approximately 19,000mg/l, the influence by seawater does not take place in the rivers.

There is a possibility for a formation of brackish water area where seawater inflows but it is difficult to consider that sea salt particles can be generated there. Because high-density seawater has a character to slide into the lower layer in the brackish water area where seawater is mixed with river water, the amount of salt content from the lower layer water that is taken into droplets or splash generated by wave-breaking and bubble burst as a phenomenon on near water surface would be very small amount. Because a occurrence of wave-breaking and bubble burst, a cause of sea salt particles generation to lead salt damage, is also suppressed in internal water area where waves are vanished by effect of coastal levee, a splashdown in a large river might be influenced by a choice of materials but I consider the re-entry method should not be denied completely.

2.7 **Conclusion**

This theoretical literature explains only the aspects that a designing suggestion for a fixed-wing airplane and its operation don't contradict each other. Right or wrong for the establishment of airplane system needs to have individual study such as software, installation of wire harness, material engineering, and fluid engineering. The confirmation of the capability needs to have an experience and knowledge of expert in each field and the synthetical viewpoints of the experts are needed whether the design system mentioned in this theoretical literature can be established or not. I will be grateful if you review the suggestion by the author as a pilot is matched with the experience of experts in each field.

Lastly, I sincerely appreciate for Professor Yasuhiro Morita of JAXA to provide me the clues for the theme and I, as a pilot, would like to offer heartfelt condolences to astronauts died as pilots by the Colombia accident.

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