



Article: *Spacecraft of capsule, winged and hybrid type*

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#### ABSTRACT

First, the historical background of manned space projects is presented: capsule type (Soyuz, Gemini, Apollo) and the winged type (Space Shuttle, Buran, Hermes). Special attention is paid at advantages and drawbacks of both types. On the base of this analysis a new concept of a manned reusable spacecraft is outlined and justified in detail. The concept (patented) combines the features of the both types, hence the name, hybrid.

The basic idea is that the wings of the hybrid spacecraft are folded down and protected by a front shield during ascent and decent when flying through the atmosphere with the front shield first (similar to a capsule). After atmospheric braking the front shield is jettisoned, the wings are deployed and the spacecraft lands on a conventional runway. In contrast with the winged spacecraft (as well as of a lifting body type) the thermal insulation could be made using high temperature alloys (not tiles) with the exception of the front shield protected by ablative insulation. An additional advantage of the hybrid spacecraft consists in the principle of control during atmospheric descent by rotating it in roll (similar to a capsule, again); this very effective concept is realized by using quite small reactive control engines rather than large aerodynamic control surfaces with powerful actuators to produce high rotating moments.

As a whole, the original concept could result in a spacecraft that will combine a number of attractive features of both types: the capsule type (compact launch configuration, compatibility with an escape system, quite effective protection during atmospheric portion of flight, the same direction of overloads on astronauts during ascent and descent), and the winged type (additional maneuverability during approach and landing on a runway).

Both the foldable wings and front shields are well known and widely used but only in this combination they are able to ensure an effective way to bring a spacecraft back to the Earth from space orbit.

As an example, a 7-tons option of the hybrid spacecraft (to be launched by the Soyuz launcher) is conceptually designed and considered in more detail; it demonstrates the basic idea and shows its potentials. For this initial option, it is also proposed to use the Soyuz service module and other components to a maximum extent. To improve approach and landing, a small air-breathing engine is added. In order to increase safety, the spacecraft is equipped with an escape system; thus, the whole crew compartment could be separated on a launch pad or in flight and land using a backup parachute.

In principle, the same method could be also applied to other spacecraft: the Senzhou of China, for example, in order to turn it into reusable space vehicle capable of landing on a runway, as well as to European and Japanese cargo transfer vehicles (ATV and HTV).

An additional advantage of the concept proposed is that similar approach could be used when designing an interplanetary manned probe. A recovery module would eventually bring its crew back to the Earth landing on wings on a runway. This feature seems rather attractive in connection with the new American space initiative (in designing CEV).



An important advantage of the concept is also the fact that it would not require new technology, greatly reducing the risk of future projects. The proposed concept seemingly brings the times closer when spacecraft will return to Earth quite similar to conventional aircraft. This would provide an opportunity to some well-developed, developing and ambitious countries to have a chance in outer space and increase a number of nations in space adventures. The report could greatly save efforts, time and resources during phase A of development (advanced studies) and B (project definition), and later as well.

