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Chapter 4

EARLY CONCEPT'S OF AEROSPACE SYSTEMS*

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One of the most urgent problems in present-day cosmonautics is the construction of aerospace systems for multiple application.

In turn, the most urgent problem for aviation and cosmonautics historians is the study of the evolution of concepts from which modern opinions have become formulated regarding aerospace systems. In this connection, there is a special interest in studying the ideas, suggested at the initial stage, regarding the theoretical foundations of cosmonautics, i.e., in the first third of the 20th Century.

Even at that early stage the attention of investigators was attracted by the idea of use by spaceships of "lift-drag ratio quality" during atmospheric flight. This possibility was mentioned for the first time in the literature in an article by Esnault-Pelterie in 1913. In the middle of the 1920s, the concept of using the lift-drag ratio had already been published by several investigators. In 1924, F.A. Tsander attempted for the first time to develop the first technical project for a spaceship with lift-drag ratio and carried out an analysis of its advantages over the purely rocket ship. Starting at the end of the 1920s, the concept of using the lift-drag ratio began being discussed in a majority of the scientific works on cosmonautics. It is reflected in the popular writings of that time and even in science fiction books, in whose pages winged vehicles appeared.

From the middle 1920s interest began to appear in the use of atmospheric air for the propulsion of space vehicles. In 1924, K.E. Tsiolkovsky, having pointed out the advantage of using air as an oxidizer, suggested to eject air by "special composite turbines". In the same year, Tsander suggested the use of atmospheric air for increasing the mass of a rocket engine jet.

Subsequently, in publications of Tsiolkovsky, Tsander, and R.H. Goddard, the concept of using atmospheric air in propulsion systems was further developed, and, the details of propulsion systems were specified. These propulsion systems were supposed to be used both for space vehicles and as special first stages in aviation.

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However, the idea of using atmospheric air in propulsion systems did not get the support of all the investigators in the sphere of astronautics. For instance, H. Oberth and E. Sänger considered it more realistic to focus on the use of rocket engines. Thus, even in the first third of the 20th Century, there were two opposing points of view on the use of atmospheric air in propulsion systems, and this persists to the present.

In publications appearing during the first third of our century the questions were examined of organizing communication with orbital stations by means of regular Earth-space-Earth flights. One of the first to mention this possibility was Tsander, who in 1924 suggested using a winged spaceship for the transport of goods and people to and from interplanetary stations. Supplying orbital stations from Earth or the Moon by means of special transport rockets was suggested also by M. Valier. In 1926, Tsiolkovsky published a plan for the mastering of cosmos in which the supply of the orbital stations was envisaged by means of rockets having a suitable lift-drag ratio. Sänger later pointed out that one of the main problems in the development of rocket airplanes was to establish communication with orbital stations.

Thus, regular transport flights to orbital stations were suggested as far back as the first third of the 20th Century. Moreover, this seemed to be one of the main duties of space transport systems, which in many respects resembles present-day opinions on the use of aerospace vehicles.

Little attention was paid in earlier days to questions of multiple uses of space vehicles. Such questions were then secondary in comparison to the problem of accomplishing space flight. Still, the possibility of multiple use was mentioned. In 1923, Oberth -- speaking of the cost of building a space rocket -- remarked that "with proper handling, it is capable of 100 lift-offs." And in 1929, Tsiolkovsky expressed an opinion on the possibility of using elements of a rocket train.

Thus ideas, which are the basis of the present-day concepts of aerospace systems, were put forward about half a century ago, i.e., long before the development of practical work in this sphere. This reflected the existing tendency in the first third of the 20th Century for aviation methods to be connected with the beneficial use of atmospheric air for cosmonautical enterprises. This process was supported by a whole series of reasons.

Even at the early development stage of the theory of space flight it was determined that the possibility of its accomplishment depended on the ability of spacecraft to develop the required speed, which in its turn, was controlled by the exhaust velocity of combustion products and fuel mass-construction mass ratio. Research conducted at the time revealed limited possibilities of raising these parameters with the use of chemical fuel. The elucidation of this limitation stimulated the search for alternate scientific and technical solutions. Suggestions offered can be divided into two groups:

1. Those involving increasing power-producing possibilities of spacecraft (for instance, combustion of metals, the use of nuclear energy, solar sail, etc.)

2. Those involving increasing the potential possibilities of spacecraft by application of new schemes and construction solutions (for instance, gradation, ground means for boosting, etc.).

It is quite obvious that the founders of space-related rocketry were quite familiar with the widely advertised achievements of aviation. Moreover, many of them were more or less connected with aviation, and some, as for instance Tsiolkovsky and Esnault-Pelterie, were quite active in this sphere. For them, the borrowing of ideas, methods, schemes and constructive decisions from aviation was a natural process.

The use of aviation achievements made it possible to reduce to some extent the number of problems requiring priority solutions and to concentrate the attention of investigators on solution of principal questions.

The desire to use techniques tested in aviation are noticeable in many spacecraft projects. This is evident in the arrangement of spacecraft having lift-drag ratio. In the first third of the 20th Century, various types of aerodynamic arrangements were suggested (with controllable brake panel, with carrying body, and with wings). Of these, the most widely used has become the tested winged airplane scheme.

The tendency to use known and verified principles and construction techniques is also noticeable in suggestions for spacecraft propulsion systems. As examples, suggestions have been made for various modifications of internal combustion piston engines, to be applied to spacecraft in which the thrust build-up should be completely or partially due to the jet effect of exhaust. These, being jet engines in principle, should have remained piston engines in the scheme.

The same example is the modification by Tsiolkovsky of the well-known airplane scheme -- the flying wing. He suggested increasing the lift-drag ratio of the spacecraft during landing to join together several spindle-shaped bodies. It is a remarkable fact that later on Tsiolkovsky seemed to have returned this idea to aviation, by suggesting to apply the scheme -- developed by him for spacecraft -- to airplanes.

In these and in many other examples the tendency is seen to use new ideas in combination with known and perfected schemes and elements, borrowed from aviation practice. The investigators of that time saw in this a possible means of intensifying the development of cosmonautics.

The temptation to use the achievements of aviation coupled with the realization by a majority of investigators of the difficulties in the means of accomplishing space flight have resulted in the appearance, during the first third of the 20th Century, of plans for the development of aeronautics in which it was suggested that airplanes gradually evolve into spacecraft (with construction of a number of intermediate types of space vehicles). In this case, it was assumed that these space vehicles would have an independent value even outside of cosmonautics proper, in particular for resolving problems inherent in aviation.

At that time, the most urgent problem was to find methods by means of which it would have been possible to upgrade considerably the specifications of atmospheric vehicles. The questions connected with this took up a notable place in the work of the cosmonautics pioneers, in which the possibilities were discussed of using rocket engines in aviation and the use of the spacecraft itself or its component parts for transorbital transport flight.

As cosmonautical concepts blossomed in the 1920s, investigators began coupling aviation methods with those of space flight. Particularly during the second half of that decade, increased contacts between cosmonautics and aviation were built up for the benefit of both. During the early 1930s, these ideas were discussed in publications by most space flight investigators, particularly Tsiolkovsky and Tsander. These publications exhibit both novelty and significance.

A majority of ideas developed during the first third of the 20th century applying aviation methods to cosmonautics retain their value even today. However, the forms of implementation expected at that time differed considerably from modern thought. This is primarily explained by the difference in the development levels of science and technology. On the basis of knowledge existing at that time, it was difficult to compare the complexity of implementing different variants of technical solutions and to forecast the emergence of new problems (for instance, involving flight at hypersonic velocities). This frequently caused an over-optimistic evaluation of the possibility of borrowing directly from the then-existing state of aviation know-how. There was also a tendency to under-estimate progress during the difficult period of cosmonautical development.

It is remarkable that, though many investigators assumed development of aviation systems into cosmonautics, their own opinions have undergone a seemingly reverse solution. This process, resembling development of space systems at the present stage, was shown in the fact that methods studied for the solution space flight problems have changed from "purely" rocket ones to a combination with aviation methods. At both stages of the development of cosmonautics (construction of theoretical foundations and practical development) the solution of the principal question regarding the possibility of space flight by means of dynamic rocket methods was followed by the search of ways for perfecting methods typical of aviation technology. Moreover, if during the first third of the 20th century the main stimulus for this was the apparent ease and rapidity of solving the problem of space flight, at present questions of economy and flexibility of using the space systems have become dominant.