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Chapter 5

The Great Results and Perspectives of the Development of Rocket and Space Engineering*

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Introduction

The Rocket and Space Engineering (TR & SE), even at the achieved level of its development, is of great importance for science, the national economy and defense. It is difficult, today, to identify a branch of industry which would not be interested in the development of TR & SE. The following are examples of this:

- o The creation of communications satellite systems, which promoted radio and communication in the world;
- o The creation of geodetic satellite systems, which increased the precision of geodetic measurements, made easier the process of map verification, and which helped towards the prospecting of mineral deposits;

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- The creation of weather satellite systems, which significantly increased the reliability of weather forecasts;
- The creation of navigation satellite systems, which made the navigation of vessels and aircraft easier;
- The creation of observation systems for global events which take place on the Earth. These systems were the basis for the creation of the national means for the control of armaments.

Humanity, in its development, was faced with a series of problems connected with its survival on the Earth. These are the problems of energy, ecology, food and others, which make life more complicated for the people on Earth.

Developmental industrialization, agricultural methods and predatory use of natural resources are changing the surroundings. This prompted the ecological problem. Extraction of natural resources from the Earth's womb causes the exhaustion of their stocks. Humanity feels the shortage especially keenly right now due to the fast expenditure of fuel and coal. This has provoked the energy problem. In this connection, when the production of electric energy with the help of Atomic Electrical Stations became widely spread, it made the ecological problem worse. The growing population of the Earth and decreasing squares of fertile soil (because of the erosion of the soil, the decrease of harvesting, artificial seas for Hydro Electric Stations) worsened the food problem. Rocket and Space technology may provide significant support in the solution of these problems. But, first of all, it is necessary to develop the international space program for the solution of these problems, and to decrease significantly the expense of putting payloads into near Earth orbits and deep space.

All mankind (the peoples of different countries) takes an interest in this, as it is connected with the survival of humanity on Earth and with providing it a better material and spiritual life.

The solution to these problems can not be provided by one country, since major funding is required. So, for solution of these problems, expanding international cooperation in space and further exploration of space are necessary.

The Postwar Perfection of Ballistic High Range Rockets as a Base for the Creation of the Rocket and Space Technology

The development of the German Ballistic Rocket A-4 (V-2), and its military application towards the end of World War II, became the starting point for the design of similar rockets in the U.S., U.S.S.R., and other countries.

The Postwar period 1945-1957 was the period for the perfection of these missiles. Automated, intercontinental ballistic missiles, with significant accuracy providing for the destruction of highly protected targets, appeared in 1957. Since that time, a rivalry between the states having nuclear guided weapons began, and mankind was threatened by the menace of atomic war. Work on the first generation of intercontinental ballistic missiles with heavy warheads laid down the foundations for the development of satellite launchers able to launch payloads into near Earth orbits. The first Soviet intercontinental ballistic missile "R7" (the Russian designation) successfully placed into orbit the first Soviet Sputnik on October 4, 1957, and later on April 12, 1961, a three-stage launcher, designed on the basis of the R7, placed into orbit the spacecraft "Vostok" with the first astronaut, Yuri Gagarin. At the beginning of 1958, the U.S. ballistic missile Jupiter put into orbit the first American satellite, and, in 1962, with the help of the Atlas ballistic missile, the spacecraft "Mercury" with astronaut John Glenn went into orbit.

Many other manned spacecraft were placed into orbit by ballistic missiles afterwards, and, for launching automated spacecraft, the first generation of ballistic missiles was used.

Military ballistic rockets of the next generation were designed for carrying lighter payloads that provided higher levels of mobility and protection of military complexes. All of that became possible due to further improvement of control systems and nuclear warheads for the rockets. But further exploration of space has required increasing the payload taken from the Earth into near Earth orbits. So, in the U.S., for the landing of two astronauts on the Moon and their return to the Earth in the framework of the "Saturn-Apollo" program, there was designed a launcher "Saturn-V" able to take into orbit a payload of a mass over 140,000 kg. In the U.S.S.R., for a similar voyage under the program "N-1 - L1" for the landing on the Moon and return back, a launcher N1 was designed, able to take into the orbit a payload of about 95,000-100,000 kg. The program "Saturn-V - Apollo" cost the American people over 25 million dollars, not counting expenditures for preceding work connected with this program.

Our country, in spite of large and beyond its capacity expenditures, after the "Saturn-V - Apollo" Program was finished, lost interest in such activities and canceled them, in spite of the great amount of work done, which was nullified.

The Decreasing of Expenditures on Taking Payloads into Near Earth Orbits Determines Further Development of Rocket and Space Technology

The excessively large U.S. expenditures on the "Saturn-V -Apollo" program forced them to find new vehicles for taking payloads into orbits for further exploration of space.

The most rational direction of decreasing these expenditures was the design of reusable vehicles for taking apparatus into space. After the "Saturn V - Apollo" program was finished, the U.S. created the "Space Shuttle." When the U.S.S.R. canceled the "N1 - L1" program, it also started work on the creation of a similar system, called the complex "Energia - Buran." But neither the SPACE SHUTTLE system nor the ENERGIA-BURAN system provided decreased expenditures for taking payloads into orbit compared with those which took place when preceding rockets were used. The specific cost of taking apparatus into orbit (the cost of taking into orbit a unit of mass) with the help of the Space Shuttle has exceeded the estimate by approximately 100 times. That forced the Department of Defense of the U.S. to revise its position concerning the use of the Space Shuttle for taking space apparatus into space and to sign contracts with firms constructing single use launchers. The specific cost of taking into orbit a unit of mass with the help of the rocket complex "Energia - Buran" is not less than that of the Space Shuttle. From my point of view, that happened because of the following failures: insufficient estimations of all expenditures for taking payloads into orbit with the help of reusable space vehicles in comparison with present launchers; and insufficiently substantiated choice of dimensions of these apparatus (see supplement 1.). Nevertheless, work on the creation of reusable transport space vehicles is going on all over the world.

Schemes of the Launchers Under Consideration

During an analysis of the different vehicles for taking payloads into orbit, one should remember that, for the return of these devices or their parts back to the Earth for their second use, it is necessary to pay by decreasing the mass of payload in comparison with single use launchers. These decreases are connected with an additional mass of elements of construction needed for the return of a payload.

Also, it is necessary to consider that single-stage vehicles in comparison with two-stage ones are taking into orbit much lesser payloads when other conditions are equal. This comes from the following correlations (see supplement 2).

The most interesting projects of space shuttle vehicles for putting a payload into near-Earth orbit, both in our country and abroad, are:

1. Conventional Take-Off and Landing (CTOL) vehicles
2. Vertical Take-Off and Conventional Landing (VTOCL) vehicles
3. Vertical Take-Off and Landing (VTOL) vehicles.

These vehicles have single- or two-stage structures. The simple single-stage CTOL vehicles, like NASP (U.S.) and Hotol (GB), are attractive, but they have the following shortcomings:

1. Their payloads are less than the payloads of two-stage vehicles
2. The development a new engine needed for these vehicles is very risky, because such an engine must work at heights and speeds of great ranges. Furthermore, new heat-resistant materials are needed.

The mass of a wing of a single-stage CTOL vehicle is greater than that of a VTOCL vehicle, because additional take-off loads appear. That was at the bottom of the development of the two-stage VTOCL vehicles.

The single- and two-stage CTOL vehicles place in near-earth orbit less payload than VTOCL vehicles, but they don't feel the need of safe places for landing the first stage launchers. In addition, it is necessary to take into consideration the expenditure for the reconstruction of a first stage launcher.

VTOL vehicles put into orbit more payload than the CTOL vehicles, and, so lately in the U.S., McDonnell-Douglas is working on a single-stage VTOL space shuttle vehicle, the "Delta Clipper."

I think that the two-stage VTOL vehicles are deserving of particular attention. In this case, the heat-resistant materials are needed only for the returning block, and the heavy first stage may be made of ordinary materials. There is no necessity to develop a complicated engine as well. Realization of returning and vertical landing of launchers at the launch-site opens a new direction in the development of aviation.

A Role of a Man in Space

To solve the main earthly problems, mankind doesn't feel the need for prolonged space flights. According to the estimation of experts, the majority

(80%) of immediate tasks to be solved in space don't require man's presence. They can be solved by terrestrial control devices.

Man-in-spaceflights need subsidiary life support equipment. This equipment is very expensive. It is necessary, therefore, to minimize space-man assistance. Future interplanetary flights and the migration of mankind into space will require a long-term investment in space.

It is necessary to remember that the efficiency of a human being in the cosmos is essentially lower than that on Earth, and, for supporting human life in the cosmos, special arrangements should be undertaken. That is why, during the elaborating of a new long term space program, these circumstances should be taken into account. This is what will drive the essential decrease of expenses and will yield the possibility of moving the money from long-term space programs to the creation and development of highly efficient space vehicles used for taking automatic apparatus into space.

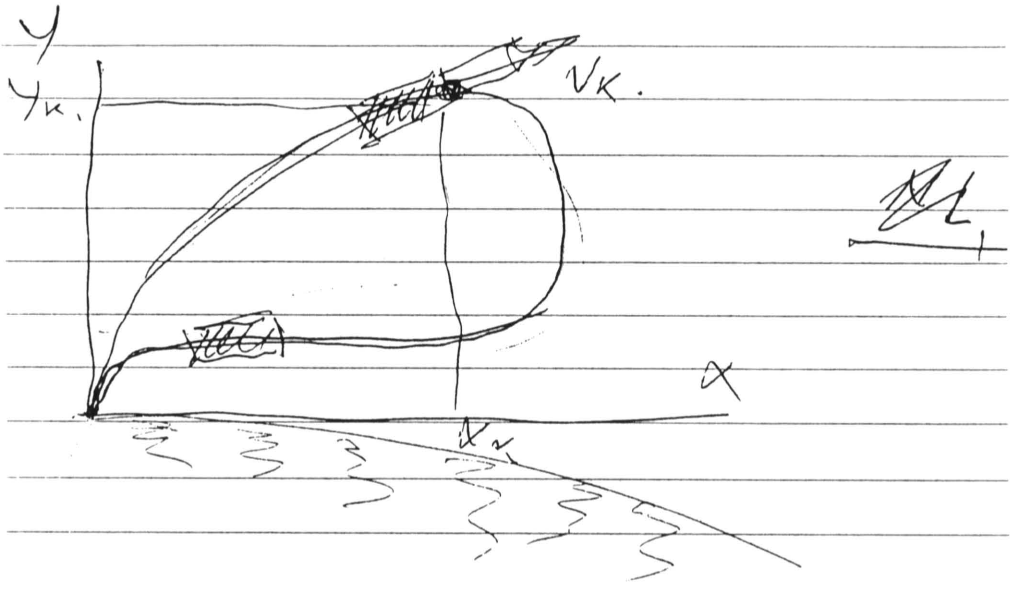
For the solution to the most imminent problems, the long-term space station is required, from time to time visited by cosmonauts. That is necessary for the long-term existence of cosmonauts in space.

For the periodical visiting of these stations by cosmonauts, the more reliable transport complexes which provide the safe return of the cosmonauts should be created.

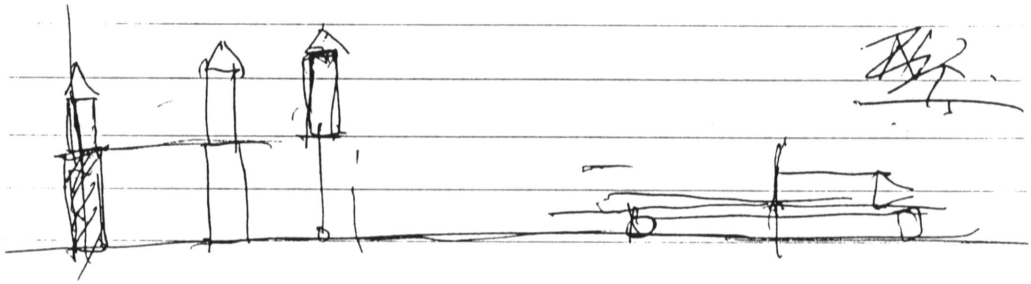
Conclusion

During the last few years, some groups of people lost interest in the further development of rocket and space technology. Even in our country, which opened the cosmic era of mankind by the launching the first man made satellite, and by launching into orbit the first cosmonaut, Yuri Gagarin, the tasks for the development of this technology were essentially decreased. This was caused in our country, as well as in the U.S., because there was no deep understanding of the aims of further exploration and conquering of outer space. For what, and in what order, should space be explored? What tasks in accordance with this should the rocket and space technology solve? When known, these tasks, the minimal necessary complex required for their solution and the required automatic and piloted apparatus taken into the space, could be determined. By the same apparatus, with respectively distributed equipment, different tasks can be solved, and that will yield decreased expenses.

Further exploration of space requires big funds, and this scares some politicians. Such expenses are above the strength of a single country, but they are connected with the problems of survival faced by the whole of mankind. That is why the present and future exploration of space is possible only by international cooperation. Humanity should draw respective conclusions from the preceding history of rocket and space technology development; when it was done for the military and prestige interests, and when it took place during the so-called Cold War between the capitalistic and socialistic systems, it was to the prejudice of the living conditions on the Earth. It is necessary to found an international organization for the coordination and installation of a level of participation by different countries in the development of rocket and space devices, which are necessary to solve the problems of the survival of people on Earth. Mankind, if it wishes to prolong its life on Earth, should explore space, and first of all the nearest space. But this is possible only by means of further perfection of rocket and space technology.



Supplement 1



Supplement 2