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Chapter 23

About the Development of the Means of Putting Payloads into Low-Earth Orbit*

V. P. Mishin†

Introduction

One of the most important phases of a space mission is to put payloads from the Earth into near-Earth orbits. This phase is determined by the necessity to sustain great gravitational loads. Decreasing the cost of putting payloads into orbit is one of the main ways to decrease the total cost of space exploration activity.

The first question that we should ask ourselves is why do we need to explore space? What benefits in improving life standards on Earth will rocket technology development offer? What is necessary is the development of nation-wide long-term oriented programs of space development.

The tasks of space exploration must be formulated and the priorities must be outlined. By considering the formulated tasks the minimal cost complex of tools for their solution could be defined. The proportion between manned and unmanned missions could be optimized. Various means could be used for solving the same problem and this is the point of attempting a cost reduction.

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† National Committee for History of Sciences and Technology, Russian Academy of Sciences, Moscow, Russia.

Why Do We Need to Explope Space?

Mankind needs to explore space to broaden the knowledge of the Universe, the Earth and other planets, to understand Earth-Solar interaction and its influence on the climate of the Earth. We need more information to understand the processes of its atmosphere. The mastering of Space should be made for the need of Mankind:

1. The creation of systems of satellites of various kinds (communication, navigation, meteorology, mapping, geology, Earth monitoring, monitoring for preventing military conflicts, etc.).
2. The creation of space industries and space laboratories in which space environment characteristics could be used (weightlessness, deep vacuum, highest and lowest temperatures, unlimited potential of solar energy).
3. The use of space components in the creation of distant control networks for dangerous industries with unmanned control systems.
4. The creation of space transportation systems for extremely long routes around the Earth.
5. The creation of effective rocket technologies for solving ecological, energetical, nutritional and other problems which have arisen on Earth.

Questions About the History of the Development of Rockets for Putting Payloads into Space

Intercontinental ballistic missiles (ICBMs) for carrying heavy warheads established the basis for creating booster-launchers able to put payloads into near-Earth orbits. In the USSR the R-7 ICBM played this role for the first artificial satellites. In the USA the Jupiter ICBM was used in orbiting the first American satellite.

After that, the first manned spacecraft were orbited. In the USSR, the three-stage Vostok booster-launcher put into orbit the Vostok spacecraft with the first cosmonaut inside—Yuri Gagarin. The Vostok booster-launcher was the counterpart of the R-7 ICBM. Gemini spaceships were orbited by booster-launchers developed on the basis of Atlas and Titan ICBMs.

The first satellites and spaceships were followed by both military and civilian satellites and also space probes for Solar System planetary exploration. Masses of payloads have been constantly increasing; the cargo from the Earth to space has been increasing too. Greater masses of payloads are a must for orbiting the Moon and landing a human being on its surface, and a successful return to the Earth.

While ICBM clones covered all the tasks for early spacecraft orbiting, the next steps in space exploration required heavier booster-launchers for heavier payloads orbiting the Earth in near-Earth orbits. That required the development

of new heavier launch systems, that greatly increase the costs of orbiting payloads.

The Necessity of Creating Economical Reusable Launch Systems

The creation of less expensive reusable launch systems could be one of the ways to decrease launch costs for an increased cargo flow into orbit. The first attempts in this direction were made in the USSR and in the USA. Unfortunately both the Space Shuttle and Buran could not reduce costs of payload orbiting. The specific cost of orbiting a payload using the Space Shuttle is a hundred times greater than was expected. That forced the US Department of Defense to change its position and to start new Contracts for booster-launchers. The specific cost of orbiting a payload by the Energia-Buran launch complex is four times greater than orbiting it using Soyuz or Proton booster-launchers.

New more economical launch complexes for orbiting payloads are sought nowadays. Only a substantial reduction of the cost of space missions can secure a solution to the problems of Mankind.

The growth of industry, agricultural methods, and the active use of natural resources change the environment. That creates an ecological problem. Industry and agriculture use natural resources, and the process decreases the amount remaining. That creates an energy drain. Nuclear power stations are used and that worsens the ecological problem due to dangerous wastes. The increasing population of the Earth, and the decreasing area of fertile soil creates nutrition problems. Rocket technology could help to solve the problems by decreasing the costs of payload orbiting for the payloads, which is vital for solving the above-mentioned problems.

Several Approaches to Creating a Reuseable Launch System for Near-Earth Orbit

All the schemes of payload orbiting can be sorted into four groups:

1. Single-stage and multi-stage;
2. With horizontal start and horizontal landing;
3. With vertical start and horizontal landing;
4. With vertical start and vertical landing.

Single-stage systems are simple, but they have shortcomings:

1. A specific payload compared to greater amounts for multi-stage systems;
2. The need for new complex engines usable both in the atmosphere and in space.

Single-stage systems with wings for horizontal start and horizontal landing can orbit less payload than single-stage systems with vertical start and vertical landing, because systems with wings are heavier (reinforced wing structures, exposed to high thermal stresses during atmospheric re-entry). Systems with wings require big and expensive runways. Engines of such systems have to work equally well in space and in the atmosphere. Development of these engines is a difficult and risky enterprise.

Two-stage systems with vertical launch and horizontal landing were designed to solve these problems. They have wings on orbital stages only, and the wings could have a lighter structure than systems using a horizontal start have. The same concept formed the basis for systems using heavy planes as the basis for initial stages, for example the Antonov-225 Hotol or the Anontov-225 second stage (fuel tank and spaceplane).

Recently the US started work on a single-stage reusable rocket with vertical start and landing—the Delta Clipper. Unfortunately, no multi-stage systems of this type are under consideration. Those multi-stage systems with vertical landing stages could orbit payloads with a bigger specific weight than the single-stage version could. I think that the two-stage system of such a type is the best choice. The first stage lands near the start site and can be used again.

The biggest weight benefit could be obtained from two-stage systems; when you go further to the three-stage system the benefit is marginal. The engine of the second stage could be put into orbit and then be integrated into the system. It could land on its own, making it a lot easier than for the single-stage Delta-Clipper. There is no need to reserve huge land areas for stage landing. Payloads could be put into different orbits with different inclinations. A combination of air-breathing engines with lifting planes could be used for landing of the first stage. Air-breathing engines could be used for vertical landing of the second stage also. These engines would be control thrusters. I think that this system will decrease costs because it is reusable and no land has to be reserved for landing procedures. Space vehicles can be launched in different directions by this system.

During the analysis of different launching systems one should be aware that reusable systems have less specific weight of payload than traditional booster-launchers. That is the payoff for the additional mass of structure.

Criteria for Comparing Reusable Launch Systems

Different criteria should be used for comparing different launching systems. These criteria could be: the specific cost of orbiting payloads considering the costs of development for the boosters; the time necessary for such a program; technical risk; etc.

Specific costs could assessed, but it is extremely difficult to assess technical risk. You cannot assess the time and funding necessary for the program objectively.

About Automated and Manned Launch Systems and Spacecraft

No long-term manned space missions are necessary for solving the urgent problems of Mankind. Such missions would be necessary for interplanetary flights, but this is a very distant perspective. Mankind has more urgent problems connected with our native planet—the Earth. Manned missions need the creation of life support systems and many other additional systems for safe flight and landing. That costs a lot and decreases the payload orbited.

Assessments have shown that most of the urgent tasks of space missions could be solved by automated spacecraft. The contemporary level of technology of launching, docking, and spacecraft orientation is such that it can minimize human involvement. That should be taken into consideration in developing new programs. That would decrease costs and make it possible to transfer funds from long-term manned missions to the development of highly effective unmanned space systems.

Conclusions

It should be noted that rocket and space technology can help in solving the problems of Mankind. Indeed, rocket and space technology are helping to make human life better.

The long-term program of researching and mastering space should be developed for a more rational allocation of funds. Since all Mankind is interested in this, further works in this direction should be through international cooperation.

The priority in developing programs should be given to the design of new reusable hardware. Highly-effective reusable systems could cut costs of payload orbiting.

Russia, the country that opened the new era of Mankind—the Space Era—will be one of the leaders in this process of the exploration and mastering of Space.