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Chapter 16

Realized and Non Realized Projects of the Soviet Manned Lunar Program*

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The Soviet manned lunar program, which was unsuccessfully implemented between 1967 and 1972, is well known at the present time thanks to numerous Russian publications in recent years. It is also known that this program was connected with the use of the L-1 [Zond] and L-3 manned spacecraft. The first of these was intended for a spaceflight around the Moon, while the second one consisted of circumlunar and landing modules, to provide for the landing of a cosmonaut on the surface of the Moon.

However much less is known about the preceding and subsequent projects, some of which were initial steps of the L-1/L-3 program and proposals for its prolongation, while others were its competitors.

Every historical investigation has, in general, two purposes (which never were gained, as rule): to study any mistakes in the past in order to not repeat them, and to adopt a useful experience for future use. According to these purposes it is interesting to analyze the realized and non-realized projects of the Soviet manned lunar program from these two points of view.

Firstly, what mistakes were made by the selection of the lunar program version, and did any rejected versions have better prospects than the ill-fated L-1/L-3 program? Secondly what ideas originating with these projects would be adopted for future projects involving lunar or even Martian manned missions?

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Initially it is necessary to talk about the sequence of the creation of the above-mentioned projects and about their contents. The first project to be realized was proposed by Serguei Korolev in 1962. It proposed assembling a lunar complex in Low Earth Orbit [LEO]. This complex would consist of three identical rocket units [boosters] and the special L-1 spacecraft intended for an overflight of the Moon without an injection into circumlunar orbit by a crew of 1-3 men. Assembly would be accomplished with the assistance of a modified spacecraft of the "Vostok" type with a cosmonaut-fitter on board. The project had the "Soyuz" name [its concept is shown in Figure 1]. It is interesting that two names [L-1 and Soyuz] were transferred to following programs which were derived from this project and had quite different destinies in spite of a mutual initial purpose.

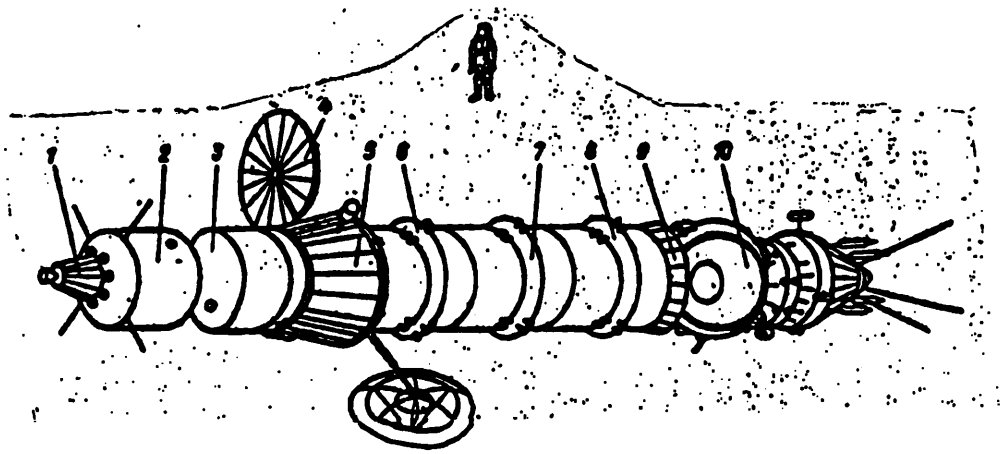

Figure 1 An initial concept of in-orbital assembling by the "Soyuz" project: (1) nose propulsion unit; (2) living compartment; (3) re-entry capsule; (4) solar array; (5) aggregate compartment; (6), (7), (8) rocket blocks; (9) ejected compartment of last block; (10) "Vostok" space capsule.

A second version of this project being approved by S. Korolev in 1963 foresaw a docking in LEO of the "Soyuz" spacecraft and one booster block; they should be refueled in orbit by special spacecraft-tankers. The "Soyuz" spacecraft of this project was very similar to the known present design of this spacecraft, i.e. one consisting of an instrument/aggregate compartment, a re-entry capsule of a headlight shape, and a dwelling module ejected before re-entry. This version suggested a fulfillment of two sequent tasks: a confirmation of docking technology and an overflight of the Moon. So, the development of the "Soyuz" spacecraft was initially aimed at lunar missions.

However, the above-mentioned proposals were not the sole Soviet manned lunar projects at that time. Indeed, in 1960 Vladimir Chelomey began the devel-

opment of the LK-1 project. This project, contracted by Chelomey in 1964, foresaw the creation of a one-seat LK-1 spacecraft which would be launched by the UK-500 heavy launcher [the future "Proton"] then in development in one of Chelomey's Design Bureaus [The "Salyut" DB of the Khrunichev Space Center at present]. According to this project, the LK-1, having a conical-shaped re-entry capsule and instrumental compartment but without any dwelling module, would be injected into a trajectory around the Moon without a docking in LEO.

Later, by way of spacecraft optimization, Chelomey's colleagues found a mass reserve for the accommodation of a second cosmonaut. However, they did not receive an opportunity for this project's realization.

The development of a project for landing a Soviet man onto the surface of the Moon was performed in Korolev's Design Bureau in parallel with the "Soyuz" project development. A preliminary draft of the N-1/L-3 project was signed by Korolev at the end of 1964. When in early 1965 the American achievements in the "Apollo" program began to become clear, as well as the fact that difficulties were associated with an orbital assembling and refueling [surrounding the "Soyuz" project], Korolev proposed to join existing half-ready developments for the purpose of a first manned spaceflight to the Moon and, in this fashion, to at least leave the Americans behind in this field. In December 1965, he presented the L-1 project which foresaw the use of Chelomey's UR-500 LV with the 'Block-D' of the N-1 as the upper stage and the L-1 spacecraft, a modified version of the "Soyuz" spacecraft. A decision of the Soviet leadership was made in favor of Korolev's L-1 project and development of Chelomey's LK-1 was halted.

The following unsuccessful realization of both the N-1/L-3 and L-1 projects is well known at the present. The N-1/L-3 program was halted in 1974 after four failures of the N-1 launcher while the L-1 spacecraft were launched twelve times in unmanned modes but only one mission was completely fulfilled [Zond-7] while five missions could be considered as partially successful. In 1970, the L-1 program was halted because even in the case of performing a manned mission this Soviet achievement would not be a counterbalance for the American landing on the Moon.

The "Soyuz" program was considered in the late 1960s as a supporting one for the L-3 program. Its purpose—providing spacecraft docking in LEO in order to confirm docking technology and cosmonaut training—was successfully achieved. A following use of the "Soyuz" spacecraft, as a ferry vehicle for orbital stations, was an "adopted technology" and had no relation to any lunar program.

V. Chelomey did not resign himself to his removal from the Soviet manned lunar program. In November 1966, he proposed a new project for a landing on the Moon by the so-called 'direct' concept, i.e. without any docking in circumlunar orbit.

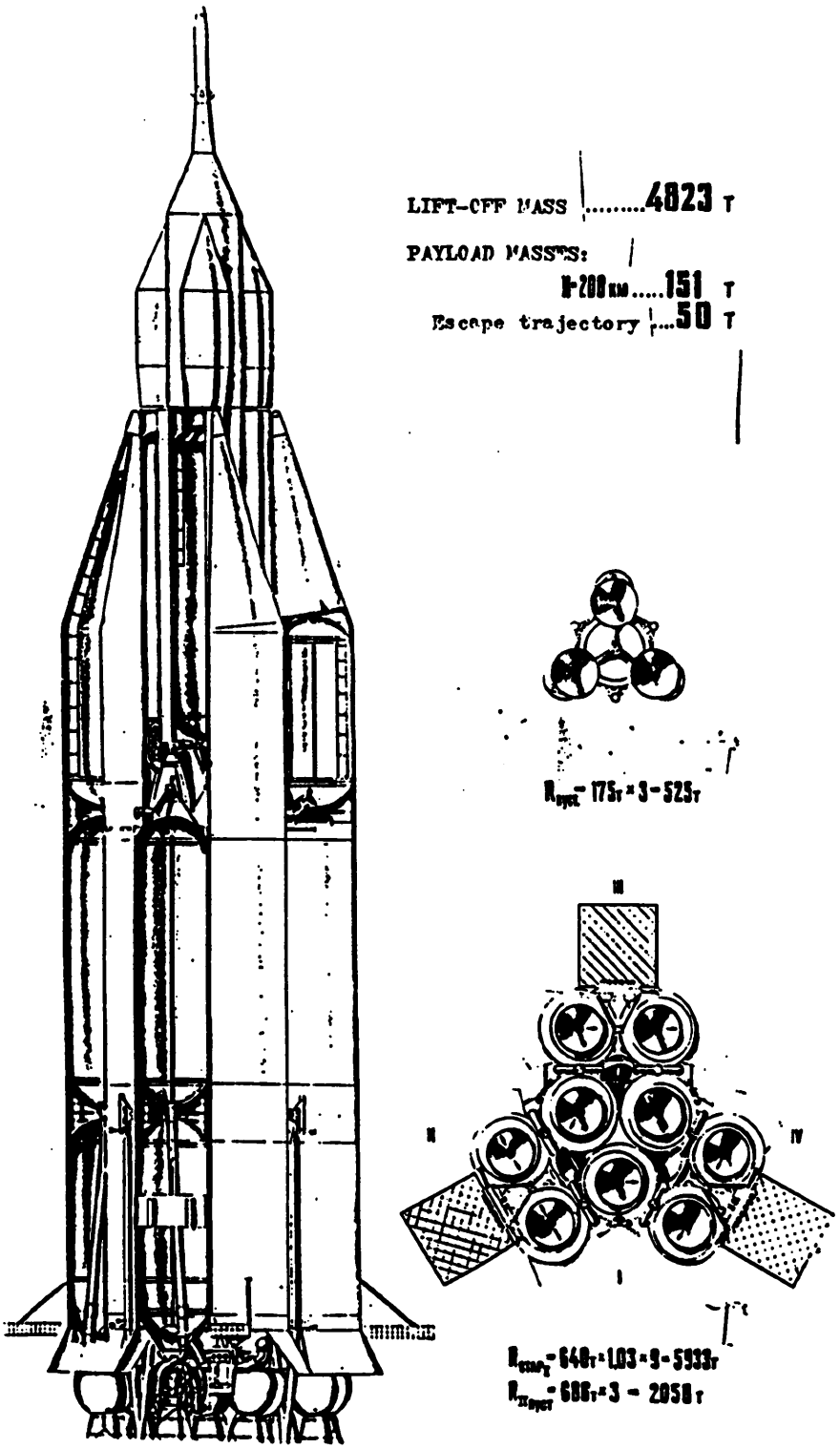

Figure 2 The UR-700 super-heavy lift vehicle project.

The LK-700 spacecraft, having a re-entry capsule, which was very similar to a design developed for the LK-1 project and intended for the accommodation of two cosmonauts during a whole mission, would be injected together with an upper stage into the parking LEO and after that was transferred to a flight trajectory to the Moon by this stage. Braking for entry into circumlunar orbit and for a following landing would be provided by a special braking stage of the spacecraft. This stage should be ejected before a landing which was provided by the engine of the spacecraft itself as well as the lift-off after the end of operations on the lunar surface and corrections of trajectory before a re-entry into the Earth's atmosphere.

Such a scenario required a higher mass of spacecraft and additional stages and, consequently, a heavier payload for a launcher. Chelomey's designers developed a project for a new UR-700 super-heavy launch vehicle which was based on technologies adopted from the UR-500 [Proton] and would inject more than 150 tons into LEO. A general view of the UR-700 is shown in Figure 2 while its brief description is given in the Appendix to this paper.

It is difficult to say at present what the real intentions of Chelomey were when he proposed his project during a full-scale deployment of work on the N1-L3 program in 1966.

Gluschko proposed using for LEK launch the "Vulkan" [Volcano] super-heavy launch vehicle which would be derived from the "Energia" LV by the addition of an oxygen/hydrogen upper stage and by increasing the number of strap-on boosters. The launcher would have a payload of about 200 tons in LEO that would provide a direct delivery of LEK [even together with a sufficiently large moon-rover installed onto it] without any in-orbit assembling.

This project was a realizable one from a technical point of view and seemed a promising one because its realization, especially regarding the launcher, paved the way even for Mars manned missions [a permanent dream of space pioneers including Gluschko]. However such a realization required a lot of money while, in the opinion of the Soviet leadership, a main goal of Soviet cosmonautics should be the creation of a counterpart to the American "Space Shuttle" [Buran]. Gluschko tried until his last day to convince his bosses to finance this project, but without positive results.

After the LEK project other developed projects concerning lunar manned missions were not completed in Russia in connection with 'Perestroyka' and following economical difficulties.

What conceptual mistakes were made both in the attempted L-1/L-3 programs and in other proposed projects? One of them is quite clear if we compare the Soviet and American programs. It is the LK-1 project and L-1 program. As is pointed out in my paper at a previous IAF Congress,[1] the realization of the program L-1 for an overflight of the Moon had mostly a political purpose—to provide the first manned lunar spaceflight just before a celebration of the Soviet

Union's 50th anniversary. Giving a little in a technical regard, this program took a lot of effort and money from the main N-1/L-3 program.

I do not like to examine the organizational/technical mistakes of the N-1/L-3 program [my opinion in this regard was stated in the above-mentioned paper]. In any case, this program was, in general, similar to the American "Apollo" program and could be fulfilled in favorable circumstances. It is necessary to note only that both programs foresaw a very risky docking in circumlunar orbit, the danger of which nearly was confirmed by the "Apollo 13" mission.

A more interesting feature of all projects and even of the L-3 program [as well as the "Apollo" program] was the requirement of a new, increasingly heavier launch vehicle for each subsequent project. Indeed, the initial "Soyuz" project proposed the use of the modified "Vostok" launch vehicle [the future "Soyuz" launch vehicle], the LK-1 and L-1 required the re-design of the UR-500 super heavy launcher, the N-1 and UR-700 super heavy launch vehicles were necessary for the L-3 and LK-700 accordingly like the "Saturn V" for the "Apollo," the LM-3 project was concerned with aiding the N-1 launcher and, at least, the LEK project foresaw the development of the "Vulkan" super-heavy launch vehicle.

What was this—a mistake or necessity? Simultaneous solutions of two very difficult technical tasks—developments of manned lunar spacecraft and super-heavy launchers—required twice the effort and money in the same time period. Moreover, obstacles in one task's solution could lead to a failure of the whole program [which was "brilliantly" confirmed by the ill-fated experience of the N-1/L-3 program]. Was there any other way at that time?

Yes, such a way existed. This way was proposed in the initial "Soyuz" project, i.e. an assembling in LEO. True, in order to assemble a large manned complex for a landing on the Moon [instead of an overflight] a heavier launcher was required than the modified "Vostok" launch vehicle. But the fleet of Soviet launch vehicles just included the "Proton" heavy launcher after 1965! If only a part of the financing given for N-1 development would have been directed to the urgent upgrading of the "Proton" while another part was spent for an expansion of the "Soyuz" program on a docking and assembling procedure, I think the Soviet Union could have assembled the L-3 complex consisting of the Lunar Orbital Spacecraft (LOK), Lunar Module (LK) and two boosters [Block G and D] in LEO by four launches of the "Protons" in 1967-1968. It is possible to add that in this case the L-1 program would have been fulfilled more successfully because about one-third of its failure took place through the fault of the "Proton." Taking account that a major construction of on-ground infrastructures for the N-1 would not be necessary, I think also that after a successful lunar landing in this fashion in 1968 [perhaps before the Americans] enough money from expenditures for the N-1/L-3 program would have remained for a grandiose banquet in honor of this event.

There is a proverb: "I would like to be so clever as my wife after any event." However, such events like manned missions to the Moon and other planets are not only behind but also before us, I hope. When their time will come, interplanetary spacecraft should be assembled in LEO but not be launched from the Earth in an assembled form. Let us not repeat mistakes of our experience with past lunar programs and projects. Moreover, let us recognize that the existence of national and international space stations as well as a wide experience of EVA and cosmonaut/astronaut operations in 'open' space greatly simplified tasks for assembling spacecraft in-orbit.

If the above-mentioned conclusion of our former lunar program will be adopted in the realization of manned interplanetary missions, it would be a good confirmation of the sentence that mankind learns by mistakes nevertheless.

Appendix
A History and Brief Description of the UR-700 Project

The UR-700 foresaw the development of a launcher having a lift-off mass of about 4800 tons which could inject 150 tons of payload into LEO. It would have a module design which was like the Proton and Soyuz launchers simultaneously. A core [second] stage consisting of three modules in cluster was surrounded by three clusters of two modules which were joined as a first stage. Every module had a diameter of 4.1 m [a size limit from the point of view of railway transportation] and one RD-270 rocket engine.[2]

Modules of the second stage were somewhat longer than modules of the first stage and had, accordingly, a longer running period. Engines of the first and second stages began to run simultaneously from the ground, like the Vostok/Soyuz launcher. A third stage installed on top of the second stage was like the module of the first stage but had four modified [for higher altitude] RD-253 rocket engines [from the Proton's first stage]. A general view of the UR-700 is shown in Figure 3.

The preliminary development of the UR-700 project had been begun eventually in parallel with the Proton development, however the first official technical proposal was presented by Chelomey only in 1966 when the Proton had just made its maiden flight. Because of the existence of full-scale work on the N-1 at that time, permission and financing were given only for the design development of the project. After its completion, which concluded with the unsuccessful beginning of the N-1 flight tests, continued financing for the UR-700 was halted. However, Chelomey proposed a modified version of this project [the UR-700 M] intended for a manned flight to Mars. In this version the launcher featured a fourth stage equipped with a nuclear RD-410 rocket engine which also had been developed by Energomash and was in the process of being tested

at that time. Besides that, taking into account some troubles which had arisen during the RD-270 engine testing, it was proposed to replace these engines with a cluster of four RD-253s [from the Proton's first stage] in each module. The launcher could inject about 240 tons into LEO. Unfortunately, the Soviet leadership considered that the benefits from a manned flight to Mars would be disproportionate to the necessary expenditures.

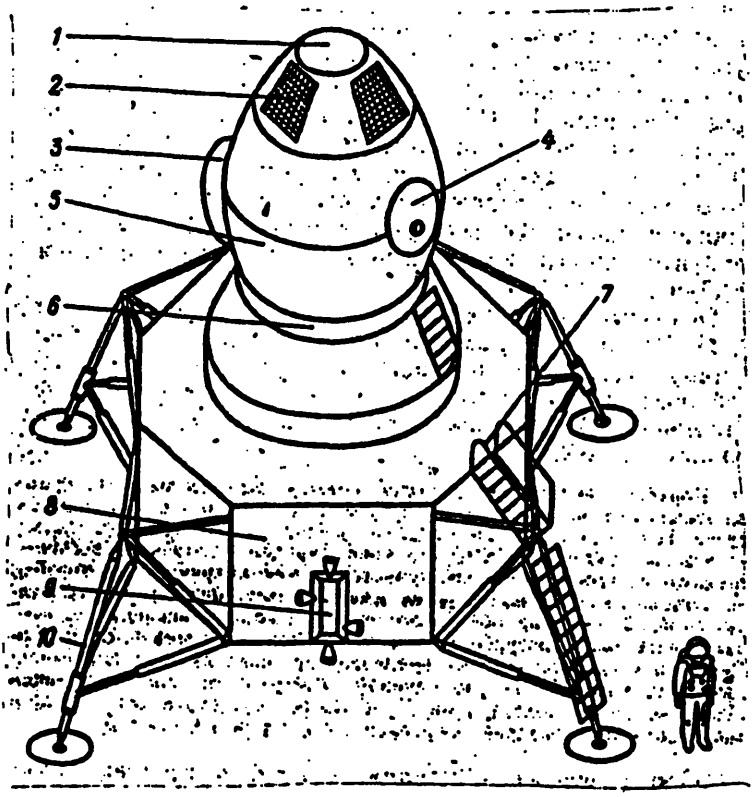

Figure 3 The LEK lunar spacecraft: (1) entry hatch; (2) radiator; (3) Moon rover; (4) operational hatch; (5) dwelling unit; (6) take-off stage; (7) ladder; (8) landing stage; (9) unit of attitude control thrusters; (10) landing support.

Reference Notes

[1]Oleg A. Sokolov, "The Race to the Moon: A Look Back From Baikonour," in *History of Rocketry and Astronautics*, Vol. 23, *AAS History Series*, 2001, pp. 459-466 (paper IAA-94-IAA.2.1.610, originally presented at the 45th IAF Congress, Jerusalem, Israel, 1994).

[2]This engine was developed by the Energomash Design Bureau. It had a thrust of more than 600 tons, used nitric tetroxyde and UDMH and in spite of the non-realization of the UR-700 project, sometime later it passed a test firing.