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## Chapter 30

# M. K. Yangel: The Unknown Pages of Biography\*

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### Introduction

The authors attempt to trace creative development (1954-1971) of Michael K. Yangel, the Chief Designer of space-rocket systems. His name is closely connected with the history of the formation of the Yuzhnoye Design Office that has been named after Yangel. At the same time, this is the history of the development of space rocketry in the Ukraine.

A high rate of development and perfection of the developed systems are characteristic of the activity of the Chief Designer M. K. Yangel, and the design office headed by him. Within the unprecedented term in propulsion history, not only the creative collective with its style of work was formed, but also the new principal trend was chosen in designing rocket complexes which use storable propellants and the independent inertial control system. Questions such as how and why this became possible, and what the role of the Chief Designer was, and other questions connected with Yangel's activity are analyzed by the authors.

The paper highlights the main stages of development of the space-rocket complexes, from SS-4 to SS-9, and traces continuity and updating of further projects up to SS-18. Attention is given to the development of launch-vehicles

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and spacecraft of the Cosmos, Intercosmos and Meteor series. The authors also analyze the development of load-bearing structural arrangements, the use of new materials, and the improvement of technological processes.

With this background, the authors attempt to find the key to explain the phenomenon of Yangel as an ideologist, organizer and the manager of large-scale technical projects from the viewpoint of philosophy and pioneer decision-making, and the role of engineering intuition and prediction in rocketry trends.

### **M. K. Yangel: The Unknown Pages of Biography**

Michael Kuzmich Yangel is one of the most significant figures in the history of rocket production development in the Soviet Union. The facets of talent determining the phenomena of character of the General Designer are impossible to put into a procrustean bed of standard characteristics.

He, like no one else, had a keen sense of new things, a vision of the technical perspective to realize the idea, a method for sensing the time needed for bringing it to realization, civic courage and fearlessness, and tenacity and self-control in critical situations.

The grounds for this enviable position, clearly determined and successfully realized, were honesty and adherence to principles shown during personal contacts at all levels (harmoniously confirmed by an ability to establish contact with people) and an ability to find, according to circumstances, those sole moves which would make those contacts into like-minded persons. Everybody who had the occasion to associate with him was stricken invariably, and was captivated, by his administrative wisdom and how his personal charm was brought to a level of artistry. His secret remains unsolved: was it an innate virtue, or something akin to the skill of a very talented artist?

When a decision had been made, the General was purposeful, and nothing or nobody could press him. He was able to subordinate himself completely to an achievement of purpose and to achieve his object neither by imposing work nor by an order, but by a conviction based on impeccable argumentation, by an ability to carry and inspire the collective with an interesting problem, and by the offer to direct them to a resolution of the problem presented.

As a leader he was an ordinary person, accessible and humane. People were disposed to Kuzmich, so he was often charged behind his back with piety by people trying to emphasize the non-formal character of the mutual relations of a "head and subordinate." He enjoyed great authority, attaining honors not only in his native collective but in numerous cooperating organizations and in ministerial corridors as well. He was invariably attentive to colleagues, able to listen as an interlocutor, and not indifferent to what he heard. He could disclose his ideas, "uncovering himself" before any person he was talking to, irrespective

of who this person was—an ordinary engineer, his private chauffeur, or somebody else. It was so in the office and outside the walls of the office premises.

At the same time, M. K. Yangel was no Messiah, no altruist, and all the more no Puritan, no ascetic. As for anyone else, nothing human was strange to him: affections, weaknesses, enthusiasms. During his rest hours he was an inveterate fisherman. He loved to be in a circle of fellow employees; he was merry, simple, sociable, and nobody felt the presence of a famous guest. He sang with emotion the cordial popular folk songs, especially the songs of his distant Siberian native land. As grounds for all that generous human nature, a great and not always easy course of life had been led.

He was an indisputably charismatic leader. But when the interests of a cause required him to be, he became harsh and uncompromising, and in a case of need he showed an enviable drive to forge ahead. The Chief Designer could resolutely break with any of his deputies if their interests were contrary to those of the common cause, and he achieved this by relieving the manager of the cooperative enterprise from his duties because of his ideological opposition to a new orientation in an engineering development. At complicated moments involving unavoidable conflicts, the negative streaks of his character could show, as with any mortal person. However, these features were not decisive, and did not define the fundamental worth of the Chief Designer, Administrator, and Person that was M. K. Yangel.

“De mortuis aut bene, aut nihil.” This worldly epigram came to us as a Latin maxim. By his activity he confirmed another well-known Russian proverb: “There is no rule without exclusion.” His biography does not require bonds.

The creative method of M. K. Yangel as the Chief Designer of rocket-space systems began in 1954 when, under a resolution of the government, he was appointed the Head and Chief Designer of the special design office organized on the base of a humble serial department, existing at a rocket plant based in 1951 in Dniepropetrovsk.

As to this walk of life his upward flight was very swift. During an unprecedentedly short period of time he succeeded not only to set up and unite a collective of like-minded persons capable of functioning (the basis of which were young specialists, yesterday’s graduating students of institutes of higher learning), but also to achieve large-scale progress in the creation of strategic missiles.

These powerful P-12, P-14, and P-16 missiles were designed and tested during seven years, which affirmed the prestige, and provided the recognition, for the design office as a leading center, one that possessed an excellent engineering and scientific staff. During these years the foundation of the future achievements of the Yuzhnoye Design Office was laid, namely the priority choosing tendencies, the formation of an office structure and brain center, the development of individual systems, and the creation of the basis for a principally new structure—the Council of Chief Designers—and in the establishment

of contacts with serial manufacturers. When M. K. Yangel was at this creative organization he worked out two extremely important problems, which determined the organization's destiny.

At the moment of the design office's formation, the collective of enthusiasts under the leadership of V. S. Budnik (who became the First Deputy Chief Designer), conducted design research for a feasibility study of a storable propellant rocket. The new and courageous proposal was at variance with the official doctrine of the time. It was thought that this proposal would have a tendency to lose liquid-propellant rocket engine specific thrust impulse by 10-12%. S. P. Korolev was of just this opinion; the achievements of Korolev spoke for themselves at that point in time.

The future showed the correctness and prescience of M. K. Yangel's decision, not only for missiles for which the possibility of long-term stationing in a fueled state gave the decisive advantage, but also for space launchers. Simultaneously the system for autonomous control was adopted. Both of these decisions provided for increased readiness for launch and simplicity of usage, while the latter allowed for the exclusion of a further cumbersome flight control system.

Within a short period of time he succeeded in solving another significant problem by creating a new young collective. In this significant period of design office formation, the talents for organization of M. K. Yangel were shown in all his power. He was engaged in offering work, using for this purpose all possible channels. The searches were carried on in other organizations and institutes of higher education. He promised invariably interesting work with specified salaries, and did not betray anyone's trust. He talked personally with each young specialist arriving at work. The first meeting with the Chief Designer was remembered by many for their whole life. As the years passed, many of them became prominent leaders themselves, but they always remembered with invariable warmth the atmosphere of care and attention, the frank simplicity of his personal contacts, and the friendly wishes that accompanied their first acquaintance with the Chief. The fact that the conversation did not have the character of edification, emphasized traditionally in such cases, invariably struck all present, and always remained in their memory.

It was extremely significant that in the initial stage, in the first years, the design office consisted of intellectual specialists, nearly 75% of which were not yet thirty years of age. The collective gained strength rapidly, every hour, every day as they say.

The search for new and innovative ideas ran intensely, and many decisions had to be made. Before the Chief Designer the complicated problem arose: to determine priorities so as to maintain the principal tendency of a priority associated with the development of intercontinental ballistic missiles, while at the same time giving the opportunity for the creative initiative of the younger generation seeking to affirm their worth before the designers.

In the second half of the 1950s interesting prospective investigations along the theme of subwater missile launches from a submarine were conducted. The contracts with allied offices were made, and as a result, principally new decisions were made to find new missile-transportation facility interfaces. Understanding that this way was a very independent trend, and well realizing that no collective could work successfully in two such complicated areas, M. K. Yangel had the courage to make a decision: to transfer the whole theme and all related to its elaboration to another design office. Time has shown that great progress was achieved just in this way while this design office became the leading collective in the country regarding the sea theme. The formative sources of modern conversion go back to the late 1950s.

In connection with that, missiles became obsolete; quickly the question arose about their destiny. M. K. Yangel invented a further usage of the launchers involving space exploration. Based on the P-12 missile (providing the first stage), the launchers for the Cosmos and Intercosmos satellites were designed. And for satellite design structural reorganizations were accomplished; the special design office for developing small satellites was established, and it still works successfully in our time.

Decommissioning the P-14 missiles came next, and the design of a new launcher capable of injecting powerful satellites into orbit came into existence. But M. K. Yangel realized all too well that the tendency of effort scattering was happening on a dangerous scale. In spite of the determined opposition of certain persons in his organization, who did not wish to share a "gold lode" which would provide guaranteed inexhaustible orders for years to come, he transferred all technical drawing documentation to a new design center that was being organized in far-off Siberia. In this manner the first "bricks" were laid in the foundation of an organization now known as the Scientific Production Association for Applied Mechanics.

An engineering activity of M. K. Yangel does not reside in the traditional bounds of a Chief Designer's image of one who confines himself at Kuhlman, drafting some inventive problems connected with load-carrying schemes or the interface of separate units and assemblies. On any proposed design, his interactions in discussions and making of decisions was always extraordinary, and his questions and remarks were always thorough, indicating an outstanding understanding of the mechanical matters of design, not found through formal knowledge, but with talent and flair. It is such a rare quality that people consider it a "God spark." As the Chief Designer to whom the last word is supposed to belong, M. K. Yangel possessed an unusual ability: the ability to choose from a number of offered, sometimes contradictory, versions the only one that was most fully in conformity with the raised problem. It had to solve the original optimization problem every time, discussing a new design based not on a formal mechanical apparatus to help search for a new method which at that time was only being created, but based on experience, knowledge, and ability, to foresee

the results. All that, along with mere technical factors, related in the first instance to manufacturing methods. Using promising materials, service conditions, economic factors, and the abilities of serial production, it was necessary to take into account moral-psychological consequences of the decisions made—but for all that, the executors were human beings.

M. K. Yangel was a master of this art, as no one else had been. And that was especially important: he always had an opinion of his own, and the decisions made did not carry a conjunctive character. Therefore, the designs of Yangel's missiles distinguish themselves through their high degree of engineering perfection.

The special theme is mutual relations with subordinates. They were a perfect model in many respects. In the Yangel administrative system the traditional distance between a manager and the executors did not exist. Simplicity and accessibility based on the mutual understanding of the community in solving problems were cemented with a magnified sense of obligation and responsibility on the part of all collaborators, from the Chief Designer down to an ordinary laboratory assistant. And one of the most significant features of M. K. Yangel was his ability to train a collective, unique in their level of professionalism, and an atmosphere of continuous engineering and scientific research reigned there. A legend has it that colleagues received a telephone call from the Chief Designer where he would say "Are you very busy now?" or "Do you have a meeting now?", after which he would say "If yes, after ending things come to see me."

In the early 1960s, in connection with the obvious progress made in the development of rocket engineering, the tendency towards gigantomania was evident. In key design offices intensive work on the creation of powerful launchers was begun.

M. K. Yangel came to a firm conclusion about the necessity to concentrate efforts in the design offices on individual trends and, basing his decisions on technical and economic grounds, he drew up a common scheme for the formation of rocket systems; and for the first time he proposed at an official level an all-around program of engineering development in which each collective should work on its own trend.

It was supposed that specialization would allow an improvement in quality and reduce the manufacturing terms of construction. With this proposal M. K. Yangel appealed to the Government. The fact of stating a problem at the state level was a courageous step. Before that, nobody was permitted to distribute roles, as was the case for S. P. Korolev, V. N. Chelomey, and M. K. Yangel. Everybody knew only that it was necessary for him personally. It was an act of high civic courage. The report taken to the Kremlin was approved and the proposal was considered very interesting and ... it was not adopted because of the fact that great means had already been invested in other projects, in particular, the lunar project of S. P. Korolev, named M-1. M. K. Yangel suffered keenly from this, but courage did not leave him in this situation.



In spite of the fact that M. K. Yangel and S. P. Korolev represented diametrically contrary trends in rocket engineering and the relations between them were complicated, the latter proposed to M. K. Yangel that he participate in the creation of the M-1 lunar project.

Not without pressure from above, S. P. Korolev made efforts to attain his goal, and it was entrusted to the Yuzhnoye Design Office to design a unit to be operated by two cosmonauts, with the code name "E Unit," for visiting the Moon. The spacecraft was made by the assigned date, and it distinguished itself by the high reliability of the system, and it was tried out in full measure in full-scale tests in orbit in an Earth satellite mode. But its travel odyssey was already complete, because after two unsuccessful launches of the launcher, the work on the M-1 lunar project was terminated. Taking into account the situation which formed at that time, the project was considered unpromising.

M. K. Yangel could not live without a future, without a dream. He possessed the pronounced ability to see the universal applications in a new idea, to discern the essence, and to substantiate the advantages and influence of it on the ways and perspectives of rocket engineering development. This quality of the Chief Designer was shown in its best measure in engineering a principally new trend: the pop-up start.

At the moment when a decision was in the process of being made concerning the development of a new trend, the launching of missiles was being done from tube launching guides. This was in a silo that was actually a bulky underground building with many service sites. A silo resembled an underground fungus. But the first P-12 missile left a silo under a free gas-dynamic scheme. For the first time, it was also a courageous decision of the Chief Designer. However, in studying the next project, it turned out that the start of a more powerful missile from a silo on the guides resulted in vast technical difficulties. In particular, it was necessary to create special gas flues, and as a result, instead of one silo, three had to be built. For reliable protection from any external actions the necessity arose to design a special roof. But there was a problem involved with moving the roof into position. And these difficulties were far from the only ones involved.

In our time, when everything new has already been discovered, sometimes not the appearance of a new idea, but the determination of an existing one, is of great importance. The idea itself about the possibility of throwing the missile out of a special device-container was in fact already known.

M. K. Yangel's contribution lay in the point that he saw an interconnecting idea relating the pop-up start to many ideas already formed at that time, and he estimated all the advantages. More important, he understood the moment of realization for a new silo.

Some more decisive circumstances should be noted as evidence of the correctness of his moment of realization: in the design office a certain experience regarding a missile going out of a silo resulted in the design of the hybrid PT-

20P missile (with a first stage using a solid propellant, and the second stage utilizing a liquid propellant). This missile was started from a container mounted on a tank. The missile flew successfully in tests and this was demonstrated during a parade on May Day in Red Square. But because of unrelated circumstances, work was discontinued on it. Meanwhile, to make a decision about a pop-up start was not as simple a step for the Chief Designer as it could have seemed. It was necessary to have a certain courage. It is extremely significant, that at the moment of making a decision, he had practically no like-minded colleagues. The idea of the Chief was not shared by the main customer in the person of the Defense Ministry, nor the main allied organization which should accept the starting position.

It is an incredible but well known fact that in spite of the immense prestige of Yangel, no one in his design office believed in the possibility of a pop-up start, while Yangel trusted in it and remained true to it to the end of his days.

What did the Chief Designer see in it? He saw the perspective of using the existing silos for the P-12, P-14, and P-16 missiles, recognizing the possibility of increasing their seismic protection for the new starting scheme without a fundamental conversion, increasing the production industrialization of the launching complex at the expense of container assembly in the plants, increasing the power capabilities at the expense of the throwing out process, and it would simplify the launch complexes and their maintenance.

It is important to recognize that M. K. Yangel was the first Chief Designer to realize the necessity of a principal reconsideration of military rocket production from the point of the technical and engineering ties of a missile to a silo. Before that, the opinion predominated that a launching complex was developed solely for a missile. The time had now come to see that the launching complex and a missile were a whole entity. It was necessary to design a missile in accordance with the launching complex, and also the reverse. Thus, the decision was made. But the following events had unexpected results: M. K. Yangel soon found himself in a hospital bed. It was a heart attack, the third in succession.

The opponents of the pop-up start took this occasion to make the project into an old variant—with the missile going out on guides. When the project was delivered to Moscow for approval by the Chief who was under treatment, his reaction was strict and uncompromising. The project should be done over again, as there is no alternative to the pop-up start. So the new way was opened as a trend in rocket engineering.

The pop-up start required the solution of a whole number of principally significant questions. Here are only some of them:

1. The development of a piston system for throwing a missile out of a container;
2. The refinement of a system precluding explosion at the expense of air residual burning in the lentiform volume under the piston at the launch moment of the solid-reactant gas generators;

3. The production of amortization in the system missile-container, ensuring high protection against seismic events, the driving of the piston aside, the launching of missile engines in a weightless state, and some other problems.

To solve these problems special tests were conducted and named “throw-out tests,” and these tests were carried out with scale models of different dimensions. It was a new word in the ground refinement of structure preceding flight tests. Such experiments were unknown both in the scale of the process and in the procedure. “Throw-out tests” and following flight tests confirmed the validity of all adopted schemes and design approaches.

In addition, it should be noted that the pop-up start was designed for the new intercontinental P-36M missile.

However, the Chief Designer was not fated to be a witness to the triumph of his idea. On October 25, 1971 he finished his mundane way during a solemn celebration in honor of his sixtieth birthday. He left this life filled with new ideas and intentions, and the pop-up start became his swan song, his last will to the collective of his native design office.

Experience following the design work showed that the pop-up start was fraught with more possibilities. The last point in its history was dotted by the development and realization of the P-36M2 missile, which became a classic in military rocket production. It went by the name Santa, and the designation of SS-18, in the West.

The more famous and outstanding a person is, the more distinctive is his talent as seen by his contemporaries, and it is more difficult sometimes to see the worthy estimation of his valuable contribution to societal development, and to all the distinctions of his talent noted profoundly and comprehensively. In the words of the great Russian poet S. Esenin,

Face to face

The face is not seen.

The Great is seen at distance only.

It is difficult to say these words about Chief Designer M. K. Yangel. People who saw his activities “face-to-face” always admired him. But the truth is that these activities look more majestic when they are tested by the Great Examiner—Time.

The present paper has a fragmentary nature, and is the first attempt of the authors to analyze and comprehend the fact that this extraordinary person bequeathed us his work, and left a deep mark on engineering development, and in the hearts of all without exclusion who had the occasion to associate with him.