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## Chapter 3

# **O. M. Makarov, the Outstanding Organizer of Manufacture of Soviet Rockets in Dnipropetrovsk: For 35 Years 100 Ballistic Missiles per Year<sup>\*</sup>**

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### **Introduction**

The name of the director of the Southern Machine-Building Plant (Yuzhmach—or YuMZ), O. M. Makarov (1906–1999)—an outstanding organizer of the manufacture of most parts of the Soviet ballistic missiles—is poorly known, on the one hand, owing to his extreme privacy and, on the other hand, because of incomprehension by the Western world as to the significance of this post owing to the essential difference of conditions of fabrication of rockets in the East and in the West. The world knows the outstanding designers of the Soviet rockets, that is, S. Korolev, M. Yangel, and V. Utkin, but very few people know that their successes, the realization of the conceived projects in the shortest terms, depended on a plant where these rockets were manufactured. It was at the

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present world-famous Yuzhmach plant where Oleksandr Maksimovich Makarov worked for almost 40 years: in the beginning as the production manager, then—since 1954—as the chief engineer, and for 25 years—since 1961—as its director.

The number of stars of the hero or laureate's medals on a chest was determining the best quality of a person in the Soviet Union. Among a thousand directors of engineering plants only O. M. Makarov was twice "Hero of Socialist Work" and the "Laureate of Lenin" and state awards. But the title "Hero of Socialist Work" for the Western world certainly means very little. O. M. Makarov undoubtedly should be judged by world standards, as his activity has imposed certain prints on a course of world history. Usually people are speaking mainly about politicians, sometimes about scientists, but it is rare in the case of managers of manufacture. Yuzhmach was responsible to the ministry for a large number of accessory manufacturers, by volume and by importance of released production, which was providing work for hundreds of the enterprises in the Soviet Union—from Leningrad to Siberia. Yuzhmach was providing parity of armed forces in the world. Therefore the activity of a director of Yuzhmach was influencing the geopolitics of the Soviet Union strongly.

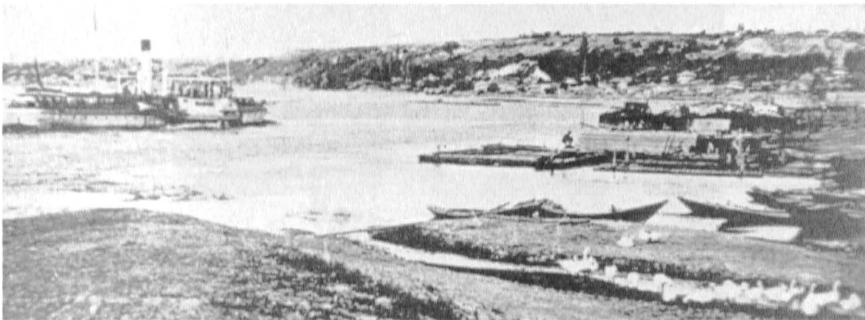
O. M. Makarov's destiny is unique as to the time of his life, which completely exceeded the period of existence of the Soviet Union, moreover with a certain time of life in imperial Russia (up to the age of 11 years—from 1906) and 9 years of life in the Ukraine, which received independence after the disintegration of the Soviet Union. The life and destiny of O. M. Makarov are bright reflections of a life of the Soviet Union and are a copy of the destinies of its engineering intelligence. O. M. Makarov was the exclusive organizer of manufacture even in comparison with an army of the production workers who have appeared in the Soviet Union on a crest of "great building projects."

The success of development of rocket technologies, of practical astronautics in the Soviet Union in particular and in the world in general was in many respects depending on such people as O. M. Makarov, which are realizing any one idea of designers. The rocket technology was a stroke of luck in the Soviet Union in the sense that for a director of the largest engineering plant O. M. Makarov could make everything possible. The appreciation of "class" of manager of an engineering plant is in O. M. Makarov's case determined first of all by rockets, by satellites, by the space vehicles made at the plant and are the answers to questions like: What has been made? How it has been made? Which contribution has been brought into global technology? Who are his pupils? What breadth of solved problems and universality of his circle of duties?

## The Beginning

### The Childhood and Youth—In Tsarism and After-Revolutionary Russia (1906–1922)

Non-accidentally the person as a mirror of life of the Soviet Union was born in the beginning of the 20th century (6 September 1906) in the center of Russia, in the village of Zimlianskaya, in the Cossack territory on the Don, which arose from escaped peasants in 16 centuries (Figure 3–1). His parents were Maxim Iljich Makarov (1880–1945) and Elizaveta Grigorjevna (1880–1933) (Figure 3–2). The father came from a family of old immigrants. He worked as the mechanic at a steam mill at first, and then he was the turner of the Rostov plant “Red fleet.” His mother was earning money as a seamstress additionally to support the family. The family was big—Oleksandr Maksimovich had three sisters. The beginning of life of Sacha Makarov falls basically within the period of World War I and the civil war. They were his first “universities” of life. The October revolution woke a wide thirst of knowledge and enabled the chance to study.



**Figure 3–1:** Village Zimlianskaya, in the Cossack territory on the Don, early 20th century.



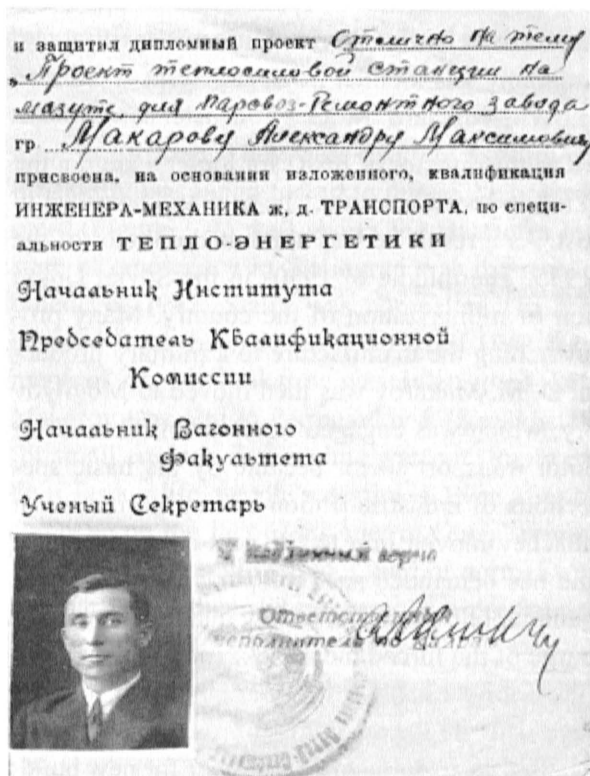
**Figure 3–2:** O. M. Makarov’s parents were Maxim Iljich Makarov (1880–1945) and Elizaveta Grigorjevna (1880–1933).

## Education

On leaving uniform labor school after nine years in his native village, Oleksandr Makarov was working as the mechanic at the Don-Kuban river shipping company from 1922 on (Figure 3–3). Then he entered the Rostov seaworthy school and after graduation from this school he was sailing to Italy and Turkey. On his mother's insistence he started to study at the Rostov Mechanical Institute of Railway Engineers on a profession line of heat-and-power engineering in 1929 (Figure 3–4). After successful defense of his graduation work (under the head of professor Vinokurov) in 1933 he was appointed deputy director of Rostov Scientific Research Institute (RSRI) and in two months he became its director (Figures 3–5 and 3–6) [1, 2]. This time did coincide with the slogan of the young Soviet state to industrialize the country, which caused the need for a new technical intelligence. As may be seen, young engineer O. M. Makarov appeared on a time to solve the problems in the Soviet Union. "Time has demanded such people" was the way O. M. Makarov used to explain the frequent personnel rearrangements.



**Figure 3–3:** Olexandre Makarov working as the mechanic of the Don-Kuban river shipping company staniza Vechenskaya in 1922.



**Figure 3-4:** Makarov student identification card from Rostov Mechanical Institute of Railway Engineers, profession line of heat-and-power engineering, in 1929.



**Figure 3-5:** Makarov as deputy director of Rostov Scientific Institute in 1933.



**Figure 3-6:** Makarov as director of Rostov Scientific Research Institute in 1933 (front row, second from left).

## **The Builder of Socialism in the Soviet Union**

### **Motor Transport**

O. M. Makarov did not work as the director of RSRI for long. "I am not the room scientist. I am missing working in special clothes," he said and he asked to be relieved from the director's post. As a result he was appointed director of the Autorepair station in Rostov in 1935. The middle of 1930s in the Soviet Union was characterized by amplification of militarization of the country. Many projects assumed an opportunity of switching the manufacture to a military production or a dual-purpose production. O. M. Makarov was then moved to Mogilyov (Belarus) to the Autorepair factory, which was engaged in repair of all kinds of motor transport vehicles. The motor transport sector became by his basic specialization as one of the key directions of industrialization and militarization of the country. In 1937 Minister Lihachev moved him to the post as director of a plant "Red Etna" in Gorky. "Time has demanded such people." This plant was producing a fastener for Gorky's automobile plant, but of low quality. Poor quality of finished products was a scourge of the forced industrialization in the Soviet Union. In 1940 the decree about the criminal liability for poor quality of finished products was issued. Administrative struggle for quality of finished products began: the confinement in prison was used as a source of cheap labor for new buildings in Siberia, in the north of Russia. Cases against heads of plants as responsible for release of poor-quality finished products began. O. M. Makarov could not avoid this sad fate either. In 1940 the wheel of an automobile came off because of a breakdown of a bolt made on "Red Etna." O. M. Makarov was cited to Moscow, and he was warned, that an additional complaint would be the road to prison. The complaint from the newspaper that there was no answer from the plant on an article in the newspaper about failure of the automobile had appeared even before his returning from Moscow to Gorky. This fact appeared sufficient so as the plant's manager was sentenced to eight years. O. M. Makarov arrived in the "river of Soviet time." This river was passing in the North, in Siberia, in a Gulag. And his destiny again became typical for millions of inhabitants of the Soviet Union.

### **Gulag**

From 3 August 1940 until 30 April 1942 O. M. Makarov was serving a sentence for 20 months above the polar circle in the settlement Avez in Pechersk Gulag. Together with him in this camp were another 1,400 directors of various enterprises, and as O. M. Makarov testified, they were the most capable, uncommon heads. The work on the construction of the railway was a felling and killed



many prisoners. People in charge of O. M. Makarov were basically thieves and bandits. A meal was poor, without any vitamins. All teeth were lost at once. The malaria was tormenting. O. M. Makarov saved his life by using crude birds from a forest for food. They were exerting psychological pressure on O. M. Makarov: his family was being forced to refuse the prisoner [9]. A photo from his confinement (Figure 3–7) well shows the state of a human being after the Gulag. The state of emergency in Stalingrad was the rescue for O. M. Makarov, and many others, in 1942. Stalin was compelled “to recall” many before the war condemned from the camps. On 30 April 1942 the term of the 20-month’s confinement of O. M. Makarov was interrupted on Stalin’s personal order. O. M. Makarov was sent to Petropavlovsk (Kazakhstan) on a post as the plant manager for small engines. The regime was not simply exploiting convicts, but also broke their further life, people’s destinies. Even after release it was forbidden to inform someone on the fact of his stay in Gulag, representing it as a “special mission.” The person was returned to a kind of normal work, he was restored in a communist party, but they did not remove a previous conviction.\* They were kept “on short bridle-rein.”



**Figure 3–7:** Identification card at release from Avez Gulag in April 1942.

\* In result the rocket techniques in the Soviet Union was born by efforts of convicts—S. Korolev, V. Glushko, O. Makarov, and N. Shniakin.

## War Revival

### *Petropavlovsk—Engines for Projectors and Antiaircraft Guns*

Destiny subjected O. M. Makarov to the hardest test at once after the arrival to Petropavlovsk. The plant of small-displacement engines consisted of unloaded machine tools in a near railway station from three plants evacuated out of Moscow, Kharkov, and Kiev. Before him three directors were not able to restore even one plant from the parts of three. The small city Petropavlovsk had only one lorry and one automobile. O. M. Makarov found a way to move the machine tools on a platform to the plant. He asked for a few big metal sheets, put machine tools on them, and dragged them to a building site by logway. Thus he personally worked as the barge hauler, moving machine tools. Walls of shelters were being built in Petropavlovsk from available cane, which was covered with clay. And the plant started production. In six months the plant had already released a production plan for the engines necessary at front for searchlight for anti-aircraft guns. Apparently, again O. M. Makarov's destiny and the destiny of the country are inextricably related.



**Figure 3–8:** O. M. Makarov moved in 1943 to a motorcycle plant in Irbit.

### *Irbit—10,000 Motorcycles*

The deeds of O. M. Makarov did not remain unnoticed. “Time has demanded such people.” Minister Akopov, understanding, that he deals with an outstanding organizer of manufacturing processes, moved O. M. Makarov in 1943 to a motorcycle plant in Irbit (Figure 3–8). And in a short wartime the plant

manufactured for the Red Army 10,000 motorcycles—with machine guns including carriages. Actually O. M. Makarov created a base for motorized forces. They could not break family life of Alexander Maksimovich either. His family was brought to Irbit from Rostov. He at last saw the daughter, who was born during his stay in the Gulag. She was naming him “uncle” for a long time and did not want to eat sugar, accepting it as salt.

## **Post-War Time (1948–1961)**

### ***Dnipropetrovsk: Car Plant for Output of Rockets***

The construction of the Dnipropetrovsk Automobile plant (DAP) started after the war. But the business was poor. Director K. Vlasov searched for those people, which could save the situation. The independent Plant of Auxiliaries (PA) was a key to successful work of an enterprise because its production determined both the construction at the car plant, and the release of automobiles. K. Vlasov knew O. M. Makarov from pre-war time, and he suggested him to take the post as director of PA in 1948. Again “Time has demanded such people.” Soon PA ceased to be a bottleneck in the production of automobiles, and DAP began making revenues: in 1949 the first lorry “Ukrainez” was produced. In 1950 Oleksandr Maksimovich moved to the post as the general director of DAP. By 1951 the plant produced the first motor vehicles.

The Dnipropetrovsk car plant occupied a huge area on the outskirts of a city with large possibilities. The city had a large number of high schools, metallurgical firms, and a system of railway stations linking the city with Donbass (coal); with Kiev (authority, intellect); with Harkov (science, personnel); and with Krivoy Rog (ore). The river of Dnieper opened broad transport capabilities [4].

But these opportunities of the plant also attracted the attention of others, the more powerful military department with L. P. Beriia and D. Ustinov as its head [4, 5]. The first introduction of ballistic missiles of S. Korolev’s design as a weapon documents the interest of military in a new kind of arms, but simultaneously also raised the question about their series production, because the test plant in Podlipki lacked the production capability. Therefore the all-powerful L. P. Beriia, known as a sponsor of a rocket and nuclear industry, gave to D. F. Ustinov, head of the Military-Industrial Commission (MIC), the task to define that firm, which one was necessary for handling the series production of rockets. D. Ustinov took advantage of a situation allowing him to reorganize any existing plant for series production of rockets. This plant was DAP. On 9 May 1951 the Council of Ministers of Soviet Union accepted the resolution about transfer of

DAP to the Ministry of Armament of the Soviet Union with the designation Plant No.586 (P.B. 186).\*

From 6 July 1951 V. S. Budnik was assigned as the Chief Designer of plant No.586, which was reoriented to series production of long-range ballistic missiles and anti-aircraft missiles [8]. The plant became completely secret, and the general director of DAP, O. M. Makarov, raised the question before the minister as to if it was opportune to work for him as having a previous conviction. The answer was unequivocal: "We know, you can work." And the production of rockets was put on the solid basis. The design, manufacturing of a prototype, its testing, the manufacturing of an experimental batch of missiles, and the flight tests only initiate the vast work of a serial production. It required both improvement of working drawings, maintenance of the manufacturing process of each of many tens of thousands of parts<sup>†</sup> and decreasing of their cost, and intermediate tests of each part, each aggregates and, on a sampling basis, of all rocket as a whole. And in June 1952 the first serial rocket R-1 produced at Yuzhmach was shipped. Its successful launching was made in November 1952 [8]. Then the rockets R-2 and R-5M (first operational strategic rocket from the design bureau of Korolev) followed. The creation in Dnipropetrovsk of this advanced production not only in the Soviet Union, but also in the world, allowed N. Khrushchev to state to the entire world a little bit later that Dnipropetrovsk produces rockets "as sausages."

These successes allowed the plant's own design bureau to elaborate the preliminary design of a new ballistic missile with a range twice superior that of the Korolev R-5M in 1953. In 1954, on the basis of the design bureau (DB Yu) headed by V. Budnik, an independent special design bureau with M. Yangel as chief and V. Budnik as his chief deputy was created [4, 5]. In the same year O. M. Makarov had been appointed as the chief engineer of the Southern Machine-Building Plant (Figure 3–9).

### *"Time has demanded such people."*

The design improvements of rockets in Dnipropetrovsk were determined in many respects by the main designers V. Budnik, M. Yangel, and V. Utkin. Their manufacture had a constant continuity in the person of O. M. Makarov as a key figure. Oleksandr Maksimovich possessed a unique ability; he knew WHAT TO

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\* I. Stalin said ostensibly: "There will be rockets—there will also be automobiles, there will be no rockets—there will also be no automobiles." In the Soviet Union the military "companies" were known as Plant No. to the administration, but only as Postal Box No. to the general population (no company names or locations were used).

<sup>†</sup> For example, a rocket R-1 had some 30,000 parts [13].

MAKE and HOW TO MAKE [11]. In 1961 director YuMZ L. V. Smirnov became chair of MIC, and O. M. Makarov was appointed new director of YuMZ (Figure 3–10). It can be said that a unification of the miscellaneous advantages of Yangel and the directors of YuMZ (in the beginning of L. Smirnov and then of O. M. Makarov) resulted in a fast transformation of the complex DBYu + YuMZ into the first rocket enterprise in the world. The next 25 years with O. M. Makarov in the rank of director of YuMZ (always finding the consent with the main designers—in the beginning with M. Yangel, and then with V. Utkin) created a unique rocket company on a global level.



**Figure 3–9:** In 1954 O. M. Makarov had been appointed as the chief engineer of the Southern Machine-building plant.



**Figure 3–10 (right):** In 1961 L. V. Smirnov became Chairman of MIC (centre), and O. M. Makarov (left) is appointed new director of YuMZ. To the right General Designer V. Utkin.



**Figure 3–11:** O. M. Makarov (right) with N. Khrushchev (centre) and M. Yangel (left).

### **The Pensioner—In Independent Ukraine**

Analyzing everything that has been performed under O. M. Makarov's participation as directors of the various enterprises for 50 years, one gets an idea of destiny not being under personal control: to pass through a Gulag, to comprehend disappointments, and to reach in it a state between life and death, again to rise, and finally to find oneself in the rank of director of Yuzhmach. To work for all the years of the patriotic war on a limit of the human force, to produce rockets after a "hot" war in conditions of a "cold" war under L. Beriia's personal control, then that of D. Ustinov, of S. Afanasjev, of N. Khrushchev, of L. Brezhnev and of V. Shcherbitskiy during 40 years (Figure 3–11). To amaze in his age of 75 years by over activity, by mobility of mind, by freshness and productivity of accepted decisions, by the responsibility for the decisions, to work more effectively than the young assistants, to live then after "sending on the deserved rest" for 13 more years in conditions of not being able to transfer his invaluable management information saved over 50 years. To live 10 more years, receiving a beggarly pension, to see the disintegration of the Soviet Union for which blessing he worked all his life using all his physical and intellectual forces (Figure 3–12). To pass worthily through the unique life in three completely different political systems—in imperial Russia ("with a wooden plough" according to W. Churchill), in the Soviet Union (with Gulag and a missile "Satan") and in the young state of

Ukraine (with a small pension), \*—to receive many awards and to deserve the love of all 50,000 workers of the Yuzhmach plant, of the colleagues in Ukraine and Russia, of city dwellers of Dnipropetrovsk, of children and relatives, and to finish it, feeling the uselessness of the created weapon and the senselessness of people of such rank “leaving on the deserved rest” but with an unclaimed enormous intelligence.<sup>†</sup>



**Figure 3–12:** O. M. Makarov (second from right) with M. Gorbachov (centre) and V. Scherbitzkiy (second from left) during perestroika.

### **O. M. Makarov—Thousands of Ballistic Missiles from YuMZ**

#### **The Conveyor to Produce the Missiles**

On the average YuMZ was producing two to three rockets per week. Therefore, for in the industrial life at Yuzhmach, O. M. Makarov directly participated in the production of about 4,000 long-range ballistic missiles (LRBM). If to take into account, only the strongest one in the world, the rocket “Satan”<sup>‡</sup> with

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\* Such pension was paid during first time. In the last years of his life the financial situation was taken under the personal control of President L. Kuchma [2].

<sup>†</sup> Reckless unreasonable waste of the human capital, in our opinion, is one of the reasons of an intellectual crisis in Ukraine.

<sup>‡</sup> ICBM NATO Code SS-18 Satan; Soviet Union Code R-36M.

the 10 nuclear warheads, which was capable to paralyze the whole terrestrial continent it is clear, that these missiles have changed many accents of global geopolitics.

But there was also the special internal reason for a fast practical realization of the design projects. A direct communication on the YuMZ engineering level started in the project simultaneously with DBYu. Already from the very beginning of the activities Makarov saw the necessity of a replacement of the usual three-step system: “DB—pilot production—series production,” to a two-step one: “DBYu—pilot/ series production (YuMZ).” This essentially reduced the development of a rocket by two to three years, because manufacturing of a preproduction model of a new rocket was combined with the manufacturing of the actual serial ones, and already at a stage of operational development of a rocket system all technical documentation and equipment was being prepared. Based on the proposition of the director Yuzhmach, O. M. Makarov, such restructuring was carried out. Certainly, this reorganization was carried out because of a deep understanding and excellent personal relation between the director of Yuzhmach and the main designer. Here both M. Yangel and V. Utkin were very fortunate, that the outstanding organizer of the production, Oleksandr Maksimovich Makarov, was the director of Yuzhmach. He spoke about it in such a way: “We have organized work so, that all experimental units, assemblies, details were made directly in the production plant, instead of a manufacture by the main designer. In result when design work came to the end, the plant was ready to start at the next day almost a batch production” [11]. In consequence of such actions a new rocket was being produced every two years without a special pressure and without rush of work. Several thousand LRBMs were being produced during the life of O. M. Makarov. V. Andreev has also positively described it:

Relations of the first heads were turning out uneasy. Not simply truth was being born in struggle for terms, but a level of quality. But in disputes the state approach, the greatest responsibility, was always on the part of each of them. And the truth was triumphing. Their adherence to principles was installing belief and optimism in consciousness of hundreds and thousand experts of DB and a plant, was creating conditions for the courageous, creative initiative. Work won from it” [7, page 272].

### **O. M. Makarov’s Contribution to the World Progress of Rocket Technology**

The process of the realization of a rocket taking place in the Soviet Union was represented by a synthesis of creative activities of hundreds and thousands of engineers, scientists, managers, and workers. The determination of maturity for manufacture of a new missile, its adaptability to manufacturing, and the quality



of created arms from the point of view of reliability was being fulfilled at a plant with direct participation of and with the last word of O. M. Makarov. Behind such decisions there was a multifactor analysis in total: from facilities and available specialists to ensuring materials and the equipment by adjacent organizations. It can seem that such decisions were not scientific. Really, they were not compared because such science (or sciences) did not exist then because of complexity and impossibility to formalize versatile sciences. But experiences of such outstanding managers as O. M. Makarov, the practical school of life were raising them to the highest scientific level otherwise not accessible for understanding many of problems to be solved.

The main contribution of O. M. Makarov was to be found in the continuation of manufacture of four generations of rocket complexes—from rockets with liquid storable propellant, for “mortar” launching, up to rockets for railway launching, up to the most powerful rocket “Satan” and to a rocket “Zenith” as a symbol of entry of humankind in the 21st century.\*

The first generation of Soviet ground-based rockets (in according to the classification of V. F. Utkin and Yu. A. Mozzhorin [12]) was characterized by open launching, by use of a high explosive warhead, by growth of operational range, and by battle readiness. The second generation of rockets was characterized by increase of operational range and by the creation of intercontinental ballistic missiles (ICBMs), with the use of a nuclear warhead, with transition from low-boiling propellants to high-boiling ones. In the Soviet Union the problem of increase of readiness of rockets was solved by creation of storable liquid propellant rockets. The main problem of that time was the readiness of a rocket for launch, that is, maintenance for a reliable functioning of the rockets after several years of storage in a state of combat readiness under filled condition by aggressive propellant components. Therefore, to fulfill this requirement, the basic emphasis was on the qualitative aspects of manufacture of rockets, that is, on a production plant, and thus on O. M. Makarov. The rockets of the third generation had the silo launcher, capable to sustain a nuclear attack of the opponent. Seven out of ten basic rockets, which were in service in the Soviet Union in 1963–1972, were rockets from the Dnipropetrovsk Design Bureau, which was nicknamed “factory of fear” in the West. The fourth generation of rockets was designed to realize the necessity to provide launching and reliable flight of the rockets on exposure to vulnerable factors of a nuclear explosion. The reliability of these rockets was checked against an opportunity for them to resist to the Strategic Defensive Initiative (SDI) of the United States. For the realization of rockets of the

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\* Figuratively speaking, humankind was driven in the 19th century by a steamship, in the 20th century by a train, and in the 21st century on a rocket [6].

fourth generation in the Soviet Union the main role belonged to DBYu (V. F. Utkin) and YuMZ (O. M. Makarov).

### **Achievements of Rocket Technologies at YuMZ**

Many scientific and technical problems were being solved directly under O. M. Makarov's participation (Figure 3–13). Many innovations were known only within YuMZ because of required security there. Issued in 1990 the list of 100 unclassified large technological innovations for scientific and technical problems shows the scale of achievements. Below are named some innovations from YuMZ according to the classification of the former chief engineer at YuMZ V. A. Andreev [3, 7]:

- Development and introduction of manufacturing methods of missile with storable propellants, in particular with maximum pressure-tight fuel tanks;
- Creation of a unique storage building and technology of moving rockets with the container;
- Development of the scheme of final assembly of rocket complexes at the customer place (on testing ground);
- Design of transport containers usable for rocket launching;
- The “know-how” of carbon fiber cases for rocket engines;
- Ways of machining of large-sized parts from titanium alloys;
- The organization of a large-scale production of rocket complexes;
- Production of rockets with the increased resistance to electromagnetic radiation after nuclear explosion;
- Production process of non-polluting and fully automated launch of a rocket “Zenith.”

It is also possible to select the individual technical know-how introduced into the manufacturing process of YuMZ with active participation of O. M. Makarov:

- Explosive forming of spherical shells in liquid;
- A control system for alignment of a vertical jig during welding;
- Development and introduction of unique in the world welding machines for butt-welding and also explosive forming;
- The soldering of corrugating spacers for the cooling circuit of liquid rocket propulsion;
- Development of test beds for rocket engines with system for measurement of thrust in vacuum.



**Figure 3–13:** O. M. Makarov in the daily work of problem solving at YuMZ.

### **Ensuring of Qualitative Manufacture of Rockets**

This action is difficult to understand for the Western experts, as it is not characteristic for market economy. During the war, and some time afterward, the industrial discipline in the Soviet Union was relying on patriotism and on terror of the responsible for the military production, L. Beriia. In the 1970s and 1980s a particular spirit of fanatical devotion to the enterprise was created in DBYu. The youth of the Yuzhmach's team, the quality of the organization of manufacture, creation and introduction of the newest technologies, breakthroughs in the realization of projects—also of fantastic and ostensibly unreal projects of the designers of DBYu—were supporting the improvements too. The level of production of rockets on YuMZ corresponded to the highest requirements of the western manufacture. Actually, O. M. Makarov has shown that socialism is, with appropriate financing, capable of performing a manufacture at a level of capitalism. The fact that O. M. Makarov put quality of production by the organization of manufacture in first place is certainly possible to explain from a lesson received from life in the form of such an unfair and severe punishment as the confinement in prison for low quality of production of a plant. Wide introduction of automation, the highest standard of the manufacture, creation by O. M. Makarov of a system of the daily control of manufacture, daily official reports of the basic technical services of a plant (behind which there were 50,000 workers), has resulted in extremely reliable systems of the rocket techniques, which forced the

Western world to name YuMZ as “plant of fear,” and provided opportunities for other enterprises in the organization of work.

## **Conversion of Military Rockets**

High quality of the manufactured rockets but insufficiency of financial resources concerning the poor country of the Soviet Union demanded a search of ways of economical means. And such statesmen as M. Yangel and O. M. Makarov came to a conclusion that the country could not afford to destroy rockets after their guaranteed term of service, as it is made in the United States. They proposed the conversion of military rockets when uncovering the big problem. So the rocket “Kosmos” (as modification of missile R-12), the Dnipropetrovsk satellites (DS) and V. M. Kovtunenکو’s space DB (inside DBYu) have appeared. Then there was a conversion of rocket R-14 into “Kosmos 2,” R-36—into “Cyclone,” use of recognizance satellites for the economic purposes: “Interkosmos,” “Zelina,” “Yantar,” “Tiphun,” “Weather”—in all 70 names of the space equipment for scientific, defensive, and economic purpose. A company developed the technology of a universal space platform based on V. Kovtunenکو’s idea. This platform had various payloads depending on the change of its purpose. These directions of conversion and the carrier rocket “Zenith” promote maintenance of the financing of the Ukrainian space programs and YuMZ-DBYu in new conditions of an independent Ukraine.

## **1.5 Million Tractors of O. M. Makarov**

No doubt that the non-military production in the heart of a defense industry became an achievement of YuMZ. All experts know YuMZ as the largest plant for production of rockets. But not many know that at the same time YuMZ manufactured 1.5 million tractors (per 60,000 one year), which for the first time in the Soviet Union received the quality symbol as it has brought the engine life of tractors until 12,000 hours (that is not achieved even in the United States). These tractors work in 40 countries of the world.

## **The Teacher**

YuMZ was the school for many outstanding organizers, politicians, and scientists in the Soviet Union. At YuMZ their skill was improved to work with people and to feel novelty. O. M. Makarov was the teacher of all of them. He was able to reveal and help talented people. Being an unusual person, he supported the promotion of other talented heads. The list speaks for itself: G. F. Tumanov

(main industrial engineer, chief engineer of the ministry); N. D. Hohlov (main industrial engineer, deputy minister); V. N. Konovalov (deputy minister); V. A. Andreev (chief engineer, chief of central administrative board of the ministry, general director MKK “Kosmotranse”); V. M. Shkurenko (director of Pavlograd plant); the heads of services of a plant—G. G. Komanov, V. M. Kulchev, V. V. Borodin, B. Komissarov, Golovin, V. I. Sichevoj, and V. D. Kruchkov. It is not well known that O. M. Makarov was professor of the faculty of the manufacturing engineering of rockets at the Dnipropetrovsk state university. He had no opportunity to lecture to students, but he was helping in promoting of professors. His visiting of the faculty was rare, but effective. Here his scholar professors A. Kvasha and O. Chernjavskaia created a unique technological laboratory and developed new fundamental directions with essential help of Oleksandr Maksimovich. For a long time he was a member of the special council on defense dissertations at the university. His presence at the sessions of the council was a school for many young scientists.

### **The Servant of People**

At the YuMZ, O. M. Makarov has developed a complex of “manufacturing (the plant)—a way of life (a rest house, sanatoria, hospitals, polyclinics, sport centers, kindergartens, and home)—and a subsidiary agriculture.”

Living in Dnipropetrovsk and having enormous financial opportunities the Makarov plant has created in Dnipropetrovsk a special infrastructure of 1/3 of the city. It has constructed a whole complex of apartment buildings, a cinema, a pool, an ice palace, and created a soccer team “Dnepr.” Without O. M. Makarov’s intervention Dnipropetrovsk would hardly have an opera and a ballet theatre, an airport, a stadium “Meteor,” and many monumental sculptures [8].

O. M. Makarov really was the outstanding citizen, the servant of people. And as this takes place, still he had a previous conviction for a long time: he was rehabilitated finally by L. Brezhnev [2].

### **What O. M. Makarov Left for YuMZ**

The best monument over Makarov is YuMZ, which is the whole state. Its spaces for production are stretched over 740 hectares,\* and the area of buildings is equal 100 hectares. The Makarov plant YuMZ is a plant and garden, a plant

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\* For comparison the area of the state of Monaco is four times less and its number of people two times less.

with creative techniques, which have not found an analogue in the world. The plant is actually a city of space specialists with everything that is necessary for the life of its workers [11].

Unfortunately, during 14 years of independence, the plant is losing the positions won during the time when O. M. Makarov was director.

### **O. M. Makarov—The Person**

The long industrial life of the outstanding organizer of rocket manufacturing, of O. M. Makarov, who left the post as the plant manager at the age of 80 years, is a unique phenomenon not only in the rocket and space technology. It is necessary to also stress his remarkable human qualities. His distinguished modesty of a big state person, exclusive diligence, the internal discipline, an enormous technical outlook, boldness, purposefulness, skill to listen, and utter devotion to the interests of one thing, his native country.

His main feature is the talent as an organizer. He started in the rocket technology at the beginning of its industrial being, when a quality of manufacture of reliable long-range ballistic missiles was the key question. If accuracy of hits of usual small arms was being provided by quantity of shots (a vivid example to that is the Kalashnikov submachine gun), this requirement for rockets was the opposite because of cost—that is, the maximal accuracy of a shot. The fact is that the person who came to the rocket engineering was feeling from his own fate that the quality of the production was the call of time: “Time has demanded such people.”

Makarov was not the intellectual in Nth generation; he was not the hereditary engineer. One hundred years ago the engineer was as uncommon as we now meet with the doctor of sciences. He was the son of a person servicing machines. Therefore, the clever, talented son of a mechanic of a mill has gone the way of the father, but already with opportunities to receive a higher education, which his father did not have. Work in a working-class environment has taught him deep respect for people of the working class, their ability to suffer heavy physical work, and skill to not lose fitness to work under any conditions.

At the same time this work has imparted to him a not normative lexicon. It is not surprising, but during the Soviet time the foul language at the best was held back. We write about it, because the memory of O. M. Makarov does not demand being embellished. Yes, in a working-class environment, he did not always have intelligent treatment, but without spite, without unforgiveness. The Gulag taught him very much for all life, in particular, today a person can be at the top of life, the authority, and tomorrow one can be a nobody. Always he remained the accessible and modest person. All his life he helped people, he loved people, and

he always felt an obligation for them both as the deputy and as the plant's manager. He did not take offense if people were visiting him at home with their questions.

But he was not overly cautious in the decision making when it came to the interests of the people working with him. When during the war the Irbit's women were in need of stockings or wadded jackets, he ordered to confiscate the truck with these goods, and this despite the fact that only a year had passed since his exit from the Gulag. He had the authoritativeness, the command attitude in distribution of labor for the achievement of the industrial purpose (probably it was by influence of Gulag). But he always tried to observe a measure in the reshaping of human destinies. The human life for him was the main criterion of world value. As the manager at a plant, he listened to other opinions, and then he made the decision. He was, most likely not the generator of ideas, but a very talented manager, the executor of others ideas. But in course of time he rejected objections more and more, and he became more categorical. Probably, it was an instinctive reaction on realizing that mistakes could be seen as suggestibility to the opinion of others.

There was a good ambition in him, he had a high feeling of the debt, honor, he liked to execute "perfectly well" a task, he did not love defeats, though in a life there were enough failures, (that for the plant manager is not surprisingly), but he found forces and courage to rise from ashes. Though, probably, he could not avoid the transactions with conscience. Despite his ambitions, he did not love celebrations especially, but he was suffering laudatory speeches. He was recollecting his teachers with gratitude—Professor Vinokurov was the head of the graduation work in the institute, of director DAP Vlasov and of M. Yangel. K. Vlasov has imparted feeling of the owner of the plant, who was solving all problems—from social up to industrial ones.

### **Makarov's Family**

In January 1934 O. M. Makarov married Alla Dmitrievna Chebotareva, with whom he lived for 50 years (Figure 3–14). Oleksandr Maksimovich had found eternal mutual love in the person of Alla Dmitrievna. The success of activity of O. M. Makarov was defined by a reliable "domestic rear" in many respects. Son Alexander was born in 1935, and daughter Elena in 1941 when he was in the Gulag (Figure 3–15). He found out about it only after an exit from prison. In his family very obligatory attitudes were established. He had almost full indifference and neglect to attires, to the various material goods. The simple meal, clean clothes, not ostentatious care was satisfying him. Home rest was frequently re-

duced to fishing and to quietness. Psychologists should find out still, why there is an unloading of the memory and of the nervous system of a person during the process of fishing. But it is the fact that it used by many outstanding figures of space technology—M. Yangel, V. Utkin, O. M. Makarov, and V. Budnik.



**Figure 3–14:** In January 1934, O. M. Makarov married Alla Dmitrievna Chebotareva.



**Figure 3–15:** Olexandre and Alla Makarov with son Alexander and daughter Elena.



The children of Oleksandr Maksimovich became worthy of their father. The feeling of novelty distinguishing O. M. Makarov from many others was undoubtedly transferred also to the children. Elena Aleksandrovna has given all her life to the development and introduction of high technologies to rocket technology—she started to use the holography when it first became known. With her active participation a university laboratory of holography was created for the first time in the Soviet Union, which “has developed techniques of diagnostics of quality of large-sized composite cases and pressurized metal tanks on the basis of holographic interferometry” [10]. These techniques provided an estimation of the influence of working conditions—deformed conditions, detection of zones of the lowered durability. The designer and engineers received the information about characteristics of stiffness in any point of an environment [10]. Alexander Aleksandrovich, as expert of liquid propulsion engines, began a labor life in the design office of DBY/4, which investigated LPREB. With time he took up other work as the deputy main designer of SPRM in DBY/5 and main designer of DB “Orbit.”

### **O. M. Makarov in Our Memory**

“Great is being seen on a distance.” These words of the poet in connection with O. M. Makarov’s figure make more and more distinct sense. The strange property of this person is that he does not appreciate the present, and only in due course, when big contours appear all more distinctly, he starts to understand the greatness of his person, starts to estimate in another way his actions, by the witness and eyewitness he was. People are remembering the activity of O. M. Makarov, vital credo—never to lose presence of mind, natural inquisitiveness. And his decency and fidelity to family can be an example for our youth and present time. Dnipropetrovsk, his second native land, does not forget the outstanding fellow countryman. In Dnipropetrovsk a monument is set up, the bronze bust is put up, and the memorial board is opened. O. M. Makarov’s name is given to YuMZ and at the square near the plant O. M. Makarov’s commemorative medal is founded (Figure 3–16).

Very little is written about Oleksandr Maksimovich Makarov because by Soviet tradition “cults” of the main designers of rockets and the cosmonauts were not publicly known. But the world elite of space and rocket technology should know all those to whom this technique is obliged. We hope that the present work will make the person of O. M. Makarov known to the world scientific community as the organizer of rocket manufacture on a global level.



**Figure 3–16:** In Dnipropetrovsk a monument is set up in the honour of O. M. Makarov.

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