

MI-2 HELICOPTER IN M.L. MIL'S DIARY NOTES AND SKETCHES

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Abstract

The Mi-2 second generation helicopter developed by the Mil Design Bureau replaced the Mi-1 helicopter and is still in actual service. Its licenced production started at the PZL Swidnik Plant in Poland as far back as 1965. This long life of the helicopter can be attributed to a successful combination of the structure robustness and reliability, as well as to the production quality. M.L. Mil's sketches showing the helicopter layout and proposed design changes, prospects for replacing the engines by more powerful ones are presented. Visits made by M.L. Mil to Poland to arrange the Mi-2 production there are described.

The Mi-2 is one of the most numerous helicopters in its class (more than 5,500 aircraft have been produced). It was developed in 1962 and its licence production at the PZL Swidnik Plant started in 1965, and since 1974 it was produced by Poland bearing full responsibility for the product quality. The Mil Moscow Helicopter Plant in cooperation with the PZL Swidnik Plant is working at further improvement of the helicopter aimed at the extension of its life cycle.

During many years the Mi-2 has been successfully used to support geological exploration, oil and gas enterprises, and to do agricultural jobs. In 1996 the Russian sportsmen flying the Mi-2 won the World Helicopter Championship.

MI-2 Leading Particulars

Maximum take-off weight, kgf	3,550
Passengers	up to 8
Hovering ceiling, m	1,000
Range, km	600

The helicopter ordered by the Ministry of Civil Aviation should be a multipurpose transport aircraft. M.L. Mil personally did tremendous work to show its applicability in the national economy in general, and to prove its high profitability in agricultural application in different regions of the Soviet Union in particular. That cleared the road for its wide application and in those days of planned economy in our country that ensured large orders for this helicopter for our national economy and offered export possibilities

MI-2 General Arrangement

The notes and sketches made by M.L. Mil in his diaries show the way followed by him in designing this helicopter (des-

ignated the V-2). At the time, the helicopter designation started with the letter V (the letter V is the first letter in the Russian word "vertolyot" meaning "helicopter") according to the decision made by N.S. Khrushchev, CPSU General Secretary. And only when they were put into mass production their designation was changed to Mi. It was M.L. Mil's opinion, the decision was wrong. Later on, when his new helicopters got the Mi-2 and Mi-8 designations, he wrote in his 1964 diary:

"When you start thinking whether the helicopter is worthy of the designer's name, memories come flooding back: you have endured so much to make the helicopter come into being and then live... So many personal moments."

The helicopter was powered by two Isotov GTD-350 turbine engines. The weight of both engines developing total 800 horsepower was less than that of the Mi-1 reciprocating engine developing 575 horsepower. This difference in weight only allowed to almost treble the passengers to be taken aboard and to carry 8 instead of 3 passengers. And it was necessary to use the advantage provided by the additional power available. The engines were installed in front of the main rotor so that the cargo cabin centre of gravity could lie on the main rotor centreline.

The general arrangement of the helicopter and its passenger cabin are presented in Fig. 1 taken from the 1964 diary. He arranged two three-seat benches back-to-back with the seventh seat placed side by side with the pilot seat, and the eighth seat, at the rear wall. The container accommodating a flexible fuel tank was under the seats. This layout allowed the centre-of-gravity position to remain practically the same during the entire flight: from take-off to landing. The sentence on the figure reads: "The centre-of-gravity position with three passengers accommodated in the rear is acceptable".

Fig. 2 is a comparison of the V-2 and Bell Iroquois. M.L. Mil intended to work further to reduce the airframe and main rotor drag and fuel consumption. "We have to pay by range, airspeed and fuel." The same page contains the program schedule for the B-2 and B-8, the latter being developed in parallel. Both helicopters of the second generation with gas turbine engines were designed to replace the Mi-1 and Mi-4 piston-engined helicopters respectively. To reduce loads applied to the main rotor blade root end, a head incorporating spring dampers was designed. However, this

device was not implemented in the design of this helicopter, but it was used later on in the Mi-26 and Mi-28 designs.

Aircraft Engines

M.L. Mil studied carefully the problems involved in the effectiveness of helicopter applications. Our engines available then were much inferior to their foreign counterparts in terms of weight-to-power ratio, or, as they would say, they were "superheavy". The weight efficiency, i.e. payload-to-take-off weight ratio, was an essential parameter for helicopter profitability. M.L. Mil derived theoretically the relationship existing between the weight efficiency and the weight of major components (engines, rotor drive system, fuselage, landing gear), fuel and the main rotor diameter. The way it was derived is shown in Fig. 1 (on the right). He emotionally exclaims: "Theory has a great power! What you feel or are empirically aware of gives you an impulse or force to start, but an explicit theoretical conclusion gives you an invincible strength and a clear understanding of the future. The fundamental theory is a weapon, an instrument used to convince and win a victory over any opponents."

Analysing the relationship, M.L. Mil writes (Ref. 1): "The helicopter main rotor thrust depends equally both on its diameter and engine power. The engine weight and rotor drive system weight are in direct proportion to the engine power. But the rotor thrust increases with power only to the $2/3$ power. And although the power increase results in a lift growth, the weight empty increases to a greater extent. As a result, the aircraft weight efficiency becomes lower". He comes to a very important conclusion (Ref. 2): "Further development of aviation, both quantitative (in terms of payload capacity) and qualitative, in terms of the weight efficiency, is impossible without further improvement of engines in terms of the weight-to-power ratio and fuel efficiency". The diary of 1964 contains a draft letter to be sent to the Government in which reasons to improve the engine weight-to-power ratio were given.

M.L. Mil tried to upgrade the V-2 by installing more powerful engines. Fig. 3 presents sketches of this version. "To speak about the prospects for increasing power to 450-500 h.p. In case 500 h.p. is available, the entrance can be remade, and the tank can be arranged externally."

After the XXVI Paris Air Show held in Le Bourget in 1965 M.L. Mil visited aircraft plants in France. Oleg Antonov, another aircraft designer, and he tried to obtain a licence to produce Astazou XIV and Oredon XX small low-powered engines. Discussions were held with Mr. Schidkowski, Turbomeca representative. However, these plans were never realized. Fig. 4 shows a page from his diary with notes where his plans to replace the existing engines by their foreign counterparts were shown. It should be noted here, that these notes were made in 1966, and the helicopter itself was designed in 1961. He tried to start broad international cooperation within the helicopter community, but it was impossible to do that in those times.

How MI-2 Found Its Way Into Life

In 1960-1965 the Mil Design Bureau worked at the design of the Mi-2 and Mi-8 twin-turbine helicopters which are well known all over the world.

It was really very difficult not only to design a viable structure, but to launch its production, and prove its applicability. M.L. Mil, being a designer, managed not only to design, but he was always looking for new areas of their application and was energetically striving to use them in the national economy. In 1961 the helicopter was first shown to the Soviet leaders. (Fig. 5). Flights of the V-2 from Moscow to Kiev and other cities were arranged. Once when the helicopter was flying to Smolensk with A.I. Mikoyan, a member of the government, and V.A. Kuznetsov, the V-2 designer, one engine failed. The pilot calmly went on flying with one engine running, chose a suitable site and landed on a football field. The rest of the trip to Smolensk where the V-2 prototypes were built then was made by car. Thus, quite suddenly the possibility of the V-2 to make a safe landing with one engine inoperative was shown, although M.L. Mil himself considered this incident "a disgrace" (Diary of 1965).

In those times the necessity of using helicopters in the national economy was not made evident yet. M.L. Mil popularised helicopters in the press. He published some articles, such as "The Helicopter is Required Everywhere", "The Mi-2 is a Utility Helicopter" (Ref. 1), "Aircraft Effectiveness" (Ref. 2), etc. To demonstrate the capabilities of the new helicopter, record-breaking flights were arranged. And Tatyana Russiyan, a woman pilot-engineer flying the V-2 established new world records in speed and range for this category of the helicopter.

"The problem of wide application of helicopters in the national economy," - wrote M.L. Mil, - "is, mainly, a problem of their profitability, i.e. what profit is gained from doing work with their help. Are they so expensive in operation as it is often stated, where and in what areas should they be used? How many of them as compared to airplanes should be ordered?" To show the possibility of the helicopter to be used in agriculture and thus to provide a stable demand for the V-2 within the country, M.L. Mil made arrangements with some farms in the Non-Black Earth Zone for the helicopter to be used in treating crops with pesticides and then fertilizers. The operations were performed by the V-2 prototypes flown by the Mil Design Bureau test-pilots in spring-autumn in 1964-1965. In this case, the results of the agricultural operations that took into account the helicopter direct operating costs, fuel costs, chemicals costs, the profit gained from the harvest increase showed the profitability of using the helicopter in comparison with the airplane. The helicopter, as M.L. Mil believed, could be used more effectively than the airplane because it was insensitive to any seasonal slush on the roads and crosswind, could treat fields occupying rough terrain. Besides, spraying performed by the he-

helicopter flying at cruise airspeed was more effective due to its downwash. And M.L. Mil proved that the helicopter used by large farms having 12,000-20,000 hectares of land could pay for itself in a year.

The scope of work done by the Design Bureau in 1966 by using the Mi-2 helicopters produced in Poland was impressive: more than 5,000 hectares were treated! The profit gained due to the helicopter application was virtually equal to the helicopter cost. Thus M.L. Mil was always trying to prove that deliveries of this helicopter for the agricultural application should be increased. He went to see the Minister of agriculture several times trying to obtain an order for 2,000-3,000 Mi-2 agricultural helicopters.

According to the Decision made by the USSR Government and Council for Mutual Economic Assistance, the Mi-2 production should be launched at the PZL Swidnik plant in the People's Republic of Poland where the Mi-1 was produced under a licence. The production licence for the Mi-2 helicopter was granted to Poland free of charge, or, as they used to say in those times, "as a token of mutual economic assistance". The helicopters manufactured there were sold to the Soviet Union at negotiated prices. In 1965 that price was 200,000 roubles. All the drawings were handed over, and further development of manufacturing processes was successfully done at the plants in Zheshov and Swidnik. There the General Designer's representation office was set up to render quick and everyday assistance in solving any production problems. This design and manufacturing support was provided up to 1980s. All the necessary design changes suggested by the Polish engineers were approved by the Design Bureau. M.L. Mil visited the People's Republic of Poland several times: once in 1956 before launching the Mi-1 production, and twice in 1965 during the mastering of the Mi-2 production. He visited the engine manufacturing plant in Zheshov, and the helicopter manufacturing plant in Swidnik, as well as plants producing vendor items. The mutual understanding between him and the Polish engineers and workers was so deep that after a short while they could communicate without any interpreter.

The first General Designer's representative in 1965 was Mr. Nikolai Otdelentsev. That is what he wrote to the General Designer concerning the mastering of the Mi-2 production: "As for the general situation at the plants, the production of the Mi-2 and vendor items for it is mainly set with the exception of the plant in Zheshov. The last difficulties have been overcome by Swidnik, i.e. the mastering of the main and tail rotor blade production... The quality of the blades is good, and it will be better as soon as the autoclave is commissioned."

M.L. Mil tried to obtain the decision of the Soviet government on the production of the Mi-2 in the Soviet Union, and he paid numerous visits to the big brass to this purpose, his diaries contain many notes on the matter. However, the decision was never made, and the Mi-2 helicop-

ters successfully flying in Russia and other countries even now were produced by plants in Poland. The formation of the helicopter industry in Poland occurred due to the successful mastering of the Mi-2 production. And this means scores of plants, as well as thousands of working places.

The cooperation between the Mil Moscow Helicopter Plant and PZL Swidnik Plant was renewed in designing the W-3 helicopter.

At present work aimed at upgrading the Mi-2 fleet is under way. Since 1995 these helicopters have been overhauled and upgraded by Rostov-Mil company in Russia. According to M.L. Mil's prediction, the Mi-2, due to its sound structure, good aerodynamic qualities and quality production has lived a long life, it is still alive and will be able to work in the future.

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Тн В-2 → рассмотреть возможность
 иши двигателя от 450 и 500 л.с.

В случае 500 л.с. — можно увидеть
 фюз — сделать фюзеляж, бак бензина
 фюзеляж

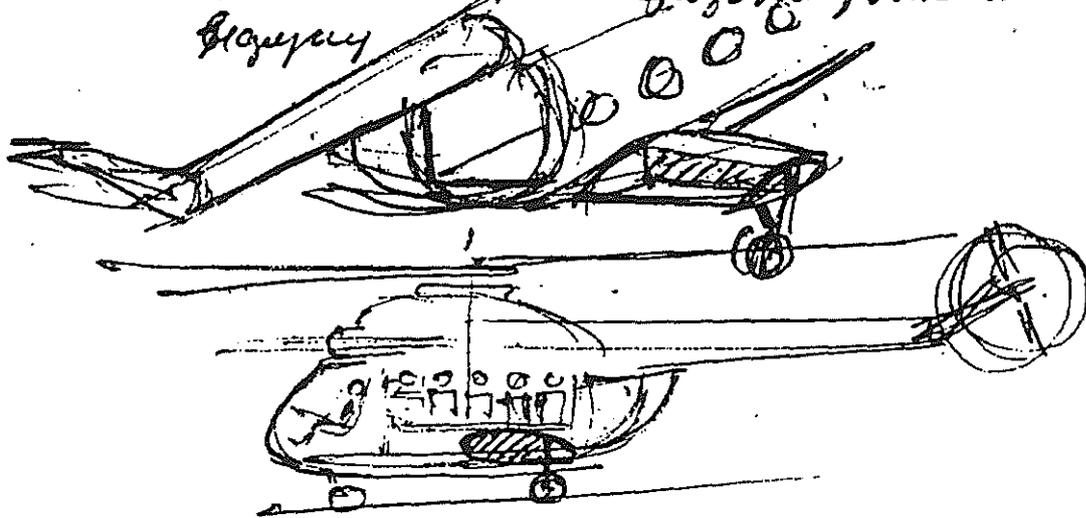


Fig. 3. Possible fuselage changes in case more powerful engine are installed, 1965.

Необходимо в зависимости от типа.

	1	2	3	4	5	6
3'ем	800	800	800	800	11-1000	25-1000
НО	Четырех	невозмож	возмож	возмож	возмож	возмож
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дл	короткий	средний	средний	средний	средний	средний
Двиг	400 л.с.	200 л.с.	100 л.с.	200 л.с.	200 л.с.	400 л.с.
	400 л.с.	200 л.с.				
	Мур2	Мур2	Мур4	Мур8	Мур16	Мур12

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двигатель 1/2 двигателя XII. Купил бы двигатель XII
 и в зависимости от мощности двигателя

Fig. 4. Plans for replacing the existing engines by their foreign counterparts, 1966.



Fig. 5. Demonstration of the V-2 to the Soviet leaders, 1961.



Fig. 6. V-2 agricultural version of 1965.