

DOI: 10.32703/2415-7422-2022-12-2-388-407

UDC 94(470+571)«1914/1917»:623.7:358.4

**Pavlo Tkachuk**

Hetman Petro Sahaydachny National Army Academy  
32, Heroiv Maidanu Street, Lviv, Ukraine, 79026  
E-mail: tkachukpp@ukr.net  
<https://orcid.org/0000-0002-7190-7887>

**Andrij Kharuk\***

Hetman Petro Sahaydachny National Army Academy  
32, Heroiv Maidanu Street, Lviv, Ukraine, 79026  
E-mail: andrij.kharuk@gmail.com  
<https://orcid.org/0000-0003-3459-1657>

**Ihor Soliar**

Ivan Krypiakevych Institute of Ukrainian Studies of the National Academy of Sciences of Ukraine  
4, Kozelnytska Street, Lviv, Ukraine, 79026  
E-mail: isoliar@ukr.net  
<https://orcid.org/0000-0003-0439-6957>

**Lilia Skorych**

Hetman Petro Sahaydachny National Army Academy  
32, Heroiv Maidanu Street, Lviv, Ukraine, 79026  
E-mail: liliscory4@gmail.com  
<https://orcid.org/0000-0003-3162-517X>

\*(correspondent-author)

**Russian aviation industry and First World War challenges**

***Abstract.** The purpose of this study is to highlight the peculiarities of the development of the Russian aviation industry during the First World War. The focus is on analyzing production programs and matching their quantitative and qualitative parameters to war requirements. The main methods used in our work are problem-chronological, used to describe the state of the Russian aviation industry, and comparative, used to compare the level of development of the Russian aviation industry with other countries that participated in the First World War. General scientific methods have also found their application – primarily, analysis and synthesis. The*



*research resulted in the following conclusions: First World War became a challenge for Russian industry that was in the developing stage, including aviation industry. Needs of the front demanded for increase in plane productions that was a complex task for Russia, taking into account its economic backwardness. Aviation industry, being represented by several big (in the scope of Russia) enterprises, demonstrated a dynamic of growth. For the war period the plane production capacity had increased only in 3 times while in Germany – in 10 times and in France and Great Britain the growth was much bigger. Leading enterprises of aviation industry, such as factory of Duks, Liebiédiev, Anatra, Shchetinin – mainly copied foreign samples (French, and sometimes German). Efforts to establish the production of original samples were a complete failure. The most known example is fighter “Illia Muromets” that was a leading one in 1914 but became old-fashioned till 1917. Aviation engine production was also narrow and was far beyond plane production. Enormous investments made in the development existed and building of new enterprises of planes and aviation engines production in 1916–1917 did not show any results, none of the enterprises started the production. We have analyzed some of these failures – building of Anatra factory in Simferopol and Matias factory in Berdiansk, and aero-motors factories Anatra in Simferopol and Deka in Aleksandrovsk. State police on controlling aviation industry based on providing subsidies and preferential loan, turned to be ineffective – it was vanished by basic purchasing prices that did not count on inflation. That is why Russian aviation industry appeared to be unable to face and respond to war challenges. Production plans of leading Russian aviation factories as well as qualitative and quantitative parameters of products have been analyzed in the article.*

**Keywords:** *aviation industry; aviation plant; military aviation; military aircraft; Russian Empire; First World War*

### **Introduction.**

War that commenced in August 1914 that was marked in the history as First World War became the first war of engines. The very modern inventions, among which were plane, were used during the war in great scale and scope. At the beginning very primitive planes, able to conduct recce flights, they became one of the main means of combat action conduct. Not only recce planes but also bombardment aircrafts and fighter planes became widespread. The field that was represented by almost small industrial enterprises prior to the war, turned into highly developed industry which utilize leading achievements in technology.

In 1914 France occupied the leading role in development of aviation material. Germany and Great Britain was just beyond France. The Russian Empire as Austro Hungary and Italy related to the “third class” of aviation countries. We did not take into account quantity of planes in military aviation (Russia was a leading country in the quantity of planes), but qualitative characteristics of aviation-industrial complex: its capabilities to produce modern planes of own projects and the quantity of planes` production should meet forces` needs.

The moment the Russian Empire entered the war led to the growth in production of armament and military materials and planes as well. One of the crucial factors that led to the growth in production was that delivery from abroad became difficult – Russian had to substitute foreign samples by own ones at least partially. Planes utilization in the field led to their accelerated run-out. The period of plane utilization to overhaul was two/three months and the overall lifecycle was not more than nine months. All these and combat losses demanded for increase in planes delivery.

Russian aviation enterprises received big contacts that exceeded the amount of orders that were prior to the war in almost 10 times. This pushed enterprises owners to develop the industrial base of existed factories and to establish new enterprises. Gradually a tendency appeared that marked the transition from licensed production of foreign samples to plane production based on own projects. We will do a comparative analysis of development strategies of main Russian enterprises of aviation production based on the published works and archive sources. We will answer some core questions: 1) To what extent Russian aviation industry was ready to the war? 2) Was it able to meet the needs of military aviation in its quantitative side? 3) Did the planes quality of Russian production meet the time requirements?

### **Research methods.**

In the Soviet historiography, the development of the aviation industry during the First World War has been fragmented. In the general context of aviation development, P. Duz' considered this problem (Duz, 1989). In his fundamental research on the development of aircraft, V. Shavrov also briefly addressed the state of the aviation industry (Shavrov, 1978). In post-Soviet Russian historiography, there are two groups of research relevant to our work. The first of these are publications on the general development of the Russian aviation and aviation industry (Soboliev, 2011; Kulikov, 2014). The second group consists of works on the specific types and classes of aircraft that were manufactured in the Russian Empire during the First World War (Khairulin, 2010; Maslov, 2021; Aleksandrov, 1998; Petrov, 2000). Ukrainian historiography is rather modest work on the subject of our research – the works of V. Savin and A. Kharuk, which discusses the development of the aviation industry in Ukraine (Savin, 1995; Kharuk, 2010; Kharuk, 2020). The source of our work was the materials of the F.s of the Russian State Military History Archive.

The achievement of the set goal was facilitated by the use of problem-chronological and comparative methods. Their combination made it possible not only to reveal the state of the aviation industry of the Russian Empire during the First World War, to show the problems of its development, but also to compare it with the state of the aviation industry of other leading countries.

### **Industrial Giants – Duks and RBCF (Russian Baltics Carriage Factory).**

Analyzing the process of Russian aviation industry formation, we can identify two options: development of planes production on existed machinery-building enterprises

and establishment of new specialized enterprises. The most typical example of the first option is Duks factory in Moscow which was previously responsible for bicycles and motorbikes production. Mr. Yulii Meller, Baltis German, was the owner who changed his last name into a Slavic Briezhniev after the beginning of the war.

In autumn 1910 Duks factory produced airship “Yastreb” but there was no further development of this airships production. Instead the owner began more forward-looking production – plane production. Particularly most Russian researchers did not pay much attention to this factory. Meanwhile during the First World War Duks occupied the first position in Russian based on the amount of production. From July 1914 till January 1917 this factory produced 1569 planes that made almost 1/3 of general Russian products (Kulikov, 2014. p. 266). What is the reason of such concealment? In our perspective the thing is that Meller-Briezhniev only duplicated French models not even trying to pursue own projects. Soviet historiography and most of modern Russian historians proved that such a position of the businessman showed a lack of trust to domestic designers and that is why deserves only a negative grade. But from business perspective this strategy is transparent. It is possible to duplicate ready-made samples without involvement of highly paid specialists. There were only 6–7 engineers in the technical branch of Duks factory (2300 personnel worked in the factory in 1917) (Kulikov, 2014. p. 267). More over duplication was often made with the license being purchased – but through reverse engineering. Putting aside law aspects it should be said that it allowed to substantially reduce base cost of products. From consumers` point of view – Military Ministry – an approach the Duks factory stuck to, had some advantages. Duplication of tested models allowed to avoid the testing period of own product which sometimes could last very long. This accelerated the process of providing aviation units with materials (vehicles) that were of great importance in war condition.

What planes did Duks factory produce? Till mid 1916 a two-seat scout airplanes Morane L were its main products (known also as Morane Parasol; approximately 400 samples were produced), Morane G (75 samples) and Nieuport IV (more than 140). Simultaneously in August 1915 airplanes Voisin started to be produced. 150 samples of such an airplane were produced by a factory in Moscow. Starting from summer 1916 recce airplane Farman XXVII (50 samples) and Farman XXX (250) had been introduced. Production of the latest ones stopped only in January 1918. In the end, in spring of 1916, fighter aircrafts Nieuport appeared in production. Till December 1917 Duks had produced more than 460 of such fighter aircrafts of models X, XI, XVII and XXI. In such a way this factory became one of the biggest producer of fighter aircrafts in Russian. At the end of 1917 a production of modern planes of such class started to be produced, namely SPAD VII. They managed to produce only 17 such fighters till January 1918.

Duks factory was able to start large scale plane production (based on Russian parameters) due to putting efforts in duplication of French models. In comparison the other machinery building factory failed to do it, namely RBCF (Russian Baltics

Carriage Factory). This association, tighter with passenger, cargo and tram carriages, produced also farming vehicles, cars and other products. In spring of 1910 two engineers were sent to France to get acquainted with aviation achievement due to the initiative Head of Supervisory Board Mykhail Shydlovsky. After their coming back a RBCF aviation department was established in Ryga. Till autumn 1912 10 planes had been produced here, two out of them were experimental of Yakov Hakkel, one of Aleksandr Kudashev and seven – based on French sample Sommer (Shavrov, 1978, p. 140).

In 1912 Aviation department of RBCF was moved to St. Petersburg and Mr. Ihor Sikorsky, being invited from Kyiv, occupied the position of chief designer. This young engineer of 23 years was credible in aviation communities. In St. Petersburg he constructed experimental planes № 6B, № 7, № 8 (Mikheev & Katyshev, 2003, pp. 95–96). But there were no orders for such planes. Instead RBCF produced planes Bleriot, Nieuport and Farman on order from Military Ministry (in total more than 100 samples) (Mikheev & Katyshev, 2003, p. 147). Being forward-looking the Aviation Department focused on production of heavy four-engine plane “Illia Muromets”. The prototype of this plane began testing in December 1913. On May, 12 1914 Military Ministry signed an agreement on supplying 10 such planes. The first serial sample was produced in August 1914 (Khairulin, 2010, p. 30). Based on different sources, from 79 to 83 samples of planes “Illia Muromets” were produced, the latest of which were produced after Bolsheviky revolution.

RBCF produced several variants of “Illia Muromets” which differed in glider construction details, types of engines and armament. First serial variant, known as type B, was produced in 5 samples. One of them got engine Argus, others – Salmson. The crew consisted of 5 people but weight of bombs load reached 240 kg. First sample of type B was produced in December 1914. This variant was different in reduced length of fuselage and smaller wingspan. Armament comprised to machine guns Maxim or Madsen that were on the platform in the middle of upper wing. Bomb load reached 400 kilograms. 18 planes of type B were produced to 1916, nine out of them got Sanbeam engines, and others – other types of engines. The most numerable was type “G” (40 samples) which was different in increased upper wing chord. Those planes got different types of engines – Sanbeam, Argus, Renault, RBCF.6 and others. Some of them could change several types of engines during exploitation. Fighter aircrafts of type “G” were equipped with machine guns Maxim, Madsen and Lewis (from three to five). Bomb load was 400 kilograms. Production of type “G” started in March 1916. Bomber aircrafts of type “D” and “E” were also produced but in smaller set (Kharuk, 2014, pp. 162–163).

“Illia Muromets” was the first four-engine bomber in the world. The moment it appeared it was, without exaggerating, a unique aircraft. But “Illia Muromets” has serious defects in construction, mainly in aerodynamics. Moreover, it had problems with engines. All changes done during First World War were very shallow and did not lead to radical improvement in fighter aircraft parameters. In 1917 “Illia Muromets”

became completely old-fashioned. The intensity of these planes' exploitations is hard to name as a high: in total, one fighter which took part in combat actions, done only 7.5 combat flights. Besides, this quantity varied in broad bounds: if "successful" samples could have dozens of combat flights, others – only one-two flights (Kharuk, 2014, p. 166).

During First World War the Aviation Department of RBCF was booked with production and maintenance of bombers "Illia Mutomets". The thing is that the Squadron of Aircrafts – units where these planes were on service – was under command of M. Shydlovsky. It is transparent that under such circumstances Aviation department of RBCF had to respond to the needs of aircrafts squadron. Production of other samples of planes almost stopped though I. Sikorsky continued to construct new experimental samples. Prior to the war, RBCF produced a small set (13 samples) of one-engine aircraft Sikorsky № 13. In October 1914 Sikorsky produced a model №16. In this case a role model for him was an English plane Sopwith Tabloid. Conceptually, model № 16 was cavalry plane – not big speed scout (Mikheev, 1994, p. 8). In such a role Sikorsky № 16 (known as S-16) was not in use. In 1915 18 samples of S-16 were produced, forwarded to aircraft squadron to be used in training purposes. Later some of them were equipped with machine guns and were used as improvised fighters (Stamper, 2000, pp. 77–78). The second set of S-16 (15 samples) remained unfinished up to the times of Bolshevik revolution.

In this case, production capacity of Aviation department of RBCF during the First World War was booked with production of prestigious but ineffective heavy bombers. Light planes were not produced though there was a need of them in the front. But according to M. O'Neil, production of "Illia Mutomets" and S-16 demonstrated that Russia not entirely dependent of foreigners for innovative aircraft design and production (O'Neil, 2002, p. 154).

### **Factories of Shchetinin and Lebediev.**

A range of aviation enterprises in Russia were established by aviation enthusiastic people. Not all of them achieved success: some of them went bankrupt having produced one or several experimental planes, another functioned as workshops being able to produce dozens of planes, and only some of them became real factories. Among them there are factories of Shchetinina and Lebedieva in St. Petersburg.

In 1909 Sergey Shchetinin, a lawyer and a businessman, established "First Russian Aeronautics Association" (FRAA) – first commercial enterprise in Russia which primary task was production of planes. In July, 11 1910 FRAA got an official permission from Ministry of Trade and Industry in Russia to open aviation factory (Soboliev, 2011, p. 18). Its first products were aircrafts *Rossia A* and monoplanes *Rossia B* (duplicate consequently *Farman III* та *Bleriot XI*). The factory produced 5 samples of each type. In 1912–1914 FRAA produced 57 planes *Nieuport* and 36 *Farman* of different types for Army Aviation (Aleksandrov, 1998a, p. 7). But the main factory production was seaplanes which were provided to Russian Naval Aviation.

From the period of creation up to 1917 the factory FRAA produced 1360 planes counting 1030 seaplanes (Kulikov, 2014, p. 231).

The key role in creation seaplanes in the factory FRAA played Dmitry Gryhorovych. This engineer, like Sikorsky, belonged to Kyiv Aircraft Construction School and later moved to St. Petersburg. He gained his first experience in naval aviation in summer 1913 when factory of Shchetinin received an order to repair a damaged aircraft Donnet-Leveque (of French production). Based on the received information an aircraft M-1 was produced, testing of which began in June 1914 (Petrov, 2000, p. 18). This model, in its turn, became basic for other more improved aircrafts which duplicates a scheme of one-engine two-seats flying boat with engine place between upper and lower wings. First Gryhorovych's seaplane which being produced in great quantity was M-5 with engine Gnome Monosupape with capacity 100 hp. From June 1915 183 aircrafts of such type were produced, the latest of which were produced in 1923 (Aleksandrov, 1998b, p. 7). M-5 stopped to meet time requirement as a combat plane because of low flight data (max speed did not exceed 105 km/h). But it continued to be widely used in Naval Aviation Schools to train pilots.

From April 1916 a company FRAA produced aircrafts M-9. From the second half of 1916 this type became the main one in Russian Naval Aviation and remained so until Russia withdrew from First World War. In comparison to M-5 this aircraft was different in having bigger size and more powerful engine Salmson (150 hp). M-9 was equipped with one machine gun and was able to carry up to 100 kg of bombs. Factory of Shchetinin produced approximately 240 samples of M-9. Development of this model led to appearance of aircraft M-15 which had smaller size and engine Hispano-Suiza (140–150 hp). M-9 was able to speed up to 110 km/h but M-15 with the same armament was able to speed up to 125-130 km/h. In November 1916 Fleet ordered 80 seaplanes M-15 and then decreased this number to 60. In 1917 there was an opportunity to produce only 30 samples of seaplane M-15 (Aleksandrov, 1998a, pp. 66–67). The reason was lack of engines.

Activation of German aviation in the Baltics led to the necessity of creation specialized seaplane-fighter. In summer 1916 in the factory Shchetinin M-11 was created, an average one-seat aircraft with an engine Monosupape (100 hp) or Le Rhone (110 hp), equipped with machine gun Maxim or Vickers. Based on M-11 another type M-12 was created. Russian fleet got 61 seaplanes M-11 and M-12 till May 1917. Factory of Shchetinin got orders to deliver more fighters but from May 1917 fleet stopped to accept them because of low flight characteristics. In July 1917 there were approximately 100 samples of partially constructed seaplanes M-11 and M-12 but they had been never finished.

Specific conditions of the Baltic Sea, significant part of which was covered with ice each winter, led to the appearance of another construction of Gryhorovych – “Winter M-16”. In comparison with previous seaplanes, M-16 was not a flying boat but a float plane. A flat floats let the plane take off either from sea, ice or snowy surface. This aircraft resembled French plane Farmana XXX. Seaplane M-16 had engine

Salmson (150 hp). Russian fleet ordered 40 samples of M-16 but the contract was not entirely completed: from December 1916 to June 1917 fleet accepted approximately 25 seaplanes M-16 (Aleksandrov, 1998a, pp. 72–73).

FRAA factory during the First World War was the main supplier of planes for Russian fleet. Its production covered the needs of Naval Aviation in quantitative figures but not in qualitative. Flight characteristics of Gryhorovych seaplanes were worse than their German opponent had.

There was also another aviation factory in St. Petersburg of Vladimir Lebediev named “Joint Stock Aeronautics Association”. In 1914–1917 this factory produced approximately 800 planes. Its early products were monoplanes Nieuport IV, Deperdussin TT and biplanes Farman of several models. In 1914–1915 the factory produced approximately 140 plane. Till 1917 reconnaissance biplanes Voisin started to be produced (215 samples). As Fleet ordered in 1914–1916 34 samples of FBA flying boats were produced based on French license. Planes Morane L and Morane G were produced as well but not in great amount (Kulikov, 2014, p. 244).

V. Lebediev paid attention to the development of his own constructions. Leopold Shkulnik, an engineer who worked in Germany in the AGO company before the war, was a chief of his designing office. It should be said that designing activities were displayed by the owner of the factory in ingenious way: he sold duplicated non-licensed samples of foreign planes or just repaired planes marked with his label tags. For example, in December 1914 two planes Lebed VII which were duplicated of Sopwith Tabloid were constructed. Lebediev sold the plane Lebed X to the Army. It was a trophy biplane LVG B.II being brought to the factory to be fixed but it did not prevent Lebediev from getting money as for a new one. Later he managed to sell nine more trophy planes-scouts of different types marked with Lebed XI tag (Kulikov, 2014, p. 246–247).

Maintenance of trophy German planes gave an opportunity to familiarize their construction. Based on this experience a new plane Lebed XII was constructed. It was an adaptation of two-seat plane-scout Albatros with engine Salmson. Testing of the prototype began in 1915. Testing results were almost satisfying and in February 1916 the factory received an order for production 225 samples of Lebed XII from Military Ministry. First set was forwarded to the Army at the end of September. In accordance with the contract all planes had to be delivered till July 1917 but the factory could not stick to the defined requirements: till the end of 1917 only 202 planes Lebed XII were produced (Maslov & Kulikov, 1998, pp. 10–12).

### **Anatra Factory.**

The third center of aviation industry in the Russian Empire (after St. Petersburg and Moscow) was Odesa. In March 1908 the second flying club in the Russian Empire was established here, which was run by Artur Anatra, a banker and a businessman who was of Italian origin. There was also an aviation school at the flying club and a workshop where samples of French plane were constructed only upon receiving private



orders. Till the end of 1912 18 planes were produced there (fourteen Farman, three Bleriot and one Nieuport).

Besides based on Vasilii Khioni project a two-seat monoplane with engine Gnome was constructed here. Plane Khioni № 1 participated in an annual competition of military aircrafts which was organized by Military Ministry, but was damaged and did not fully complete the competition programme.

Anatra understood clearly that civilian market of aviation materials in the Russian Empire is limited and the only way to develop the production is to receive orders from military organizations. In June 1913 he was able to get a contract for five planes Farman XVI and it was done in November that year (Russian State Military Historical Archive [RSMHA], F. 802, D. 4, C. 2337, S. 84).

In January 1914 Anatra got new order to produce 8 biplanes Farman XXIIbis which were delivered to Military Ministry in July-August 1914.

In July 1914, 95 people worked there. That time it was a workshop at Odesa Aviation School of Artur Anatra but in the second half of 1914 it became a joint stock corporation. To create a design office Anatra invited Elisée Alfred Descamps, a French engineer (In Russian he was named as Dekan). Project of plane P20 was a prerequisite for further work which Anatra bought before the outbreak of the war in a German company Aviatik (Aleksandov & Petrov, 1997, p. 31). It was not by chance that this project had been chosen – E. Dekan was working there from 1912 till 1913 (Hornat, 2005, pp. 32–33). But the implementation of this plane into production was going too slowly that is why the production of Anatra factory was focused on planes of French type. The businessman himself was satisfied with stable benefits so did not want to risk by implementing a completely new plane.

As many other Russian enterprises Anatra factory produced a variety of place based on French projects. Mainly 4 samples of biplanes Farman – IV, XVI, XX and XXII were produced there. The first was used in the training purposes, the other three were different in wing size and other small technical improvements, were used in front though were not as good as enemy planes.

From November 1914 till February 1917 Anatra, based on the archive sources, got an order to produce 278 Farman planes. Almost half of them – 138 samples – were the most primitive Farman IV (RSMHA, F. 802, D. 4, C. 2415, S. 2). Plane Farman XVI was produced in small quantity – 15 samples were ordered in November 1914 and delivered to the Army till March next year. Till February 1916 the factory also produced 30 Farman XXIIbis planes (RSMHA, F. 2008, D. 2, C. 428, S. 1–2). Finally in December 1916 and February 1917 Anatra got another order to produce 95 Farman XX planes (RSMHA, F. 493, D. 11, C. 305, S. 64). First planes of this type were ready only in July 1917. That time Farman XX could be used in training purposes only.

The second place in production biplanes of French design was Voisin. As Farman, Voisin was considered to be of a very archaic design. But in comparison with Farman, Voisin had more powerful engine Salmson (130-150 hp). Moreover, this type of engine

was the only one that was produced in the Russian Empire in a great amount. This made Voisin planes so popular in Russian Army Aviation (Kharuk, 2020, p. 85).

Anatra company got three order to produce 200 Voisin planes for the period March 1915-February 1916 (RSMHA, F. 493, D. 4, C. 9, S. 10). But its production was delayed because of some objective and subjective reasons. Till August 1916 the Army received only half of the ordered planes. The delay resulted in Voisin plane becoming old-fashioned. Aviators from combat units tried to improve Voisin flight characteristics. The most successful was Lieutenant Petr Ivanov. His plane named as Voisin Ivanova (VI) got new compact crew gondola. There were also some changes in the design of landing wheels and wings. Due to this the speed increased on 20 km/h though the engine remained the same (Shavrov, pp. 177–178). Having made the construction of the plane lighter he managed to improve flight characteristics but it decreased the toughness of the construction. But it was identified later during the service in the front. Meanwhile the plane Voisin Ivanova was successfully tested. In October 1916 a decision was made to exchange production of 100 of non-ready planes LAS for the same amount of VI with the deadline till the end of the year. But in reality this delivery prolonged up to July 1917 (Kharuk, 2020, p. 87). This contract can serve as an example for tracking peculiarities of finance calculations between the company and state. Military Ministry bought two-seats scout planes (without engine and armament) for the fixed price – 13500 rubles despite the type of the plane and the production factory. Anatra asked to increase the price for 1000 rubles for each plane because of the changes being made in the basic project. But Military Ministry insisted on preserving the initial price, though the Ministry admitted the factory's loss for 720 rubels on each modified plane (RSMHA, F. 493, D. 4, C. 119, S. 19–20).

Not only biplanes were produced in Odesa but also monoplane of French type – Nieuport IV and Moran G. These two-seat planes were equipped with engine with capacity of 70-80 hp. At the initial stage these planes were used in the front as scout planes or light fighters (in this purpose they were equipped with bomb holder of Shchetinina system). Later these planes were used in aviation schools. The amount of production was not big – based on the existed data Anatra factory produced approximately 100 planes Nieuport IV and Moran G (Kharuk, 2010, pp. 56–57).

In May 1916 Anatra factory started to produce Anade planes (Anatra D, or Anatra-Dekan) which was based on P20 project but with an engine Gnome Monosupap (100 hp) instead of German Oberursel. During 1916 Anatra got a huge order to produce this plane (from Russian perspective) – 5 contracts for 759 planes (Kharuk, 2010, p. 59). First this company did very fast job and forwarded to the Army 35 Anade planes in May-June 1916. But this rush caused in troubles concerning enduring appropriate quality of the product – part of the planes was returned to the factory to fix some defects. Than the tempo of production decreased. Till September 1917 148 Anade planes were produced and till the end of the year this amount reached 225 samples (Russian State Military Historical Archive. F. 493, D. 11, C. 305, S. 64a). In such case Anatra factory managed to produce less than 1/3 of ordered planes and was behind the

plan. It should be said that Anatra factory is the only guilty one. The main factor was “engine hunger” – permanent lack of aviation engines. Because of this 47 planes were accepted without testing – there were no engines. Other 24 planes out of 225 got powerful engines Clerget (110 or 130 hp). This sample was named Anakler (Maslov, 2021, pp. 22–23).

At the moment of accepting Anade plane in the Army it was old-fashioned, its speed was not enough and weight of bombs load did not exceed 30 kg. The modernization way was transparent – installation of more powerful engine. There were almost no choices as we mentioned before that the only engine available in Russia was Salmson (150 hp.). Anade variant adapted to this engine was named Anatra DS (Dekan-Salmson) or Anasal.

Installation of more powerful but heavier engine caused the need to make a lot of changes in the plane design. Its size became bigger, engine frame was reinforced, and fuselage was lined with flywood (tail part of Anade fuselage was lined with cloth). To preserve the right centering, the upper wing was moved forward (Maslov, 2021, pp. 25–27).

Anasal prototype began testing in July 1916 but fixing process of defects continued to December. Only at the end of 1916 the Army ordered 400 samples of such planes and in July 1917 300 samples more (RSMHA, F. 493, D. 11, C. 305, S. 880). All 700 planes were produced till the end of December 1917 but in reality only 46 samples were forwarded within the announced timeframe. It was too late for Anasal plane to take part in the IWW.

### **Capacity building of production base.**

Increasing need in combat planes in the front units caused the necessity of urgent expansion of production base of aviation industry as import of aviation materials was complicated because of war and available Russian enterprises could not meet the needs. That is why in 1916 Russian government initiated the support programme of domestic private entrepreneurs who considered the aviation industry as a chance to get profound benefits. Several aviation factories the building of which had already started or was about to start went beyond 15. We will consider some the most typical examples which illustrate three approaches of establishment aviation materials production: expansion of existed companies, creation of state enterprises and production of aviation materials of those enterprises which were not parts of that field before.

Expansion of the Anatra company became a typical example of first approach implementation. In March 1916 the owner of this company signed an agreement with military Ministry and in accordance with which he was obliged to build a factory in Simferopol during the following six months with the production capacity 20 planes per month. With this aim Main Military-Technical Department gave Anatra a grant for 300 000 rubles and interest-free loan – 340 000 rubles. The building of factory ended till the end of September 1916 (RSMHA, F. 493, D. 4, C. 119, S. 280). In October 1916 the Executive Committee at Military Ministry decided to order 150 Anade planes in

Simferopol factory. But in several days the decision was changed and from that moment the production of Anade planes was moved to Odesa. The factory in Simferopol received an instruction to get ready to the production of fighter planes Nieuport. The company received an order for 100 Nieuport XVII planes which had to be forwarded to the Army in April-May 1917 (RSMHA, F. 493, D. 11, C. 200, S. 5). According to the contract, the price for planes was 11000 rubles (without engine and armament) and it was a regular cost for one-seat fighter planes despite the type of it. But at the moment of contract signing there were some doubts concerning the deadline of its implementation. The reason was a well-known “engine hunger”. It was sending in the contract that only one out of five planes could be tested but Military Ministry was not able to provide even such a minimum of engines. That is why on October, 6 1917 Military Mentor at the Simferopol factory wrote out a card concerning receiving 50 Nieuport plane even without having them tested in the air – only by their appearance (RSMHA, F. 493, D. 11, C. 200, S. 47). It meant that the plane was officially forwarded to the Army and the company received its money but in reality planes were in the factory and there were no benefits for the Army.

An examination of Anatra factory in Simferopol done by state Committee in August 1917 revealed a very bad condition of it. There were 370 workers who worked at the factory. The factory facilities were ready to be used but only 60% of necessary equipment was installed. There was lack even in had machinery. The Committee admitted a low technical level, absence of effective management and bad road conditions. It was also revealed that highly qualified employees of aviation industry were involved to the production of furniture (RSMHA, F. 493, D. 11, C. 200, S. 67–68). So it is transparent that the state invested money into the factory but the Army did not receive any of the planes.

Matias factory can be an example of newcomer in aviation industry (Joint Stock Association “Matias widow and sons”) in Berdiansk near the Sea of Azov. This company was established in 1884 and dealt with agricultural vehicles and tools. Business was going smooth; in 1913 Matias occupied the eighth place out of 334 enterprises of agricultural machinery engineering in the Russian Empire based on the capital amount. That time there were approximately 500 employees. But the outbreak of the First World War caused the fall in payment demand for Matias products. It made the Council of Director think about the change of company specialty. They accepted P. Stefankevych proposal who was an engineer to initiate planes production. At the beginning of 1917 they started to repair working facilities and bought a land in the suburbs to build new workshops and creation of factory airfield. On June, 1 1917 Matias got an order for 100 scout planes Farman XXX with the deadline July-September 1917 (RSMHA, F. 493, D. 4, C. 561, S. 60–61). After completing this the company had to start the production of scout planes SPAD XIV. But the company failed: till 10 Dec 1917 Matias received 3,5 million rubles from the state to arrange plane production (debt exceeded the total cost of the factory), but did not produce any of the planes (RSMHA, F. 493, D. 9, C. 357, S. 351–352).

The situation with the Anatra factory in Simferopol and Matias factory in Berdiansk was typical for Russian; in 1916–1917 a range of enterprises received state subsidy and loans to expand plane production but there was a tiny effect. The possible course of action could be the establishment of State Aviation Factory. Another factor that made the Army do so was lack of interest of private entrepreneurs in implementation of improved planes samples. State factory had to make the implementation of new models playing the leading role in this field. The place for the factory had been chosen; it was Kherson in the South of Ukraine. The main reason of placing the factory there was good climate, mainly a lot of sunny days favorable for plane testing. On 31 March 1917 a final decision of building a State aviation factory in Kherson was made with the capacity of 200 planes per year with expense 3.35 million rubles; and an Aviation engine factory with capacity of 200 engines with total cost 3.4 million rubles (RSMHA, F. 493, D. 6, C. 11, S. 127). To control the building process a specialized Committee was established headed by Professor Aleksandr Van-Der-Flit. It was predicted in the plan that in July 1917 production of machine guns for planes will commence; at the end of 1917 – production of spare parts for planes and aviation engines, and till 1 July 1918 two factories will have been built. But building process was very slow and factories in Kherson were not in operation. Till January 1918 1.25 million rubles were given for the needs, 830 000 rubles out of which were spent to purchase building materials, tools, road building etc.) (RSMHA, F. 493, D. 6, C. 11, S. 171). Despite the expectation it turned out that the state was not a better and more effective manager of money than private owners. It is transparent that specifics of political situation should be taken into account – an effort to establish a center of aviation industry in Kherson coincided with revolutionary activities.

### **Production of aviation engines.**

We have already mentioned one of the most serious problems for Russian aviation during the First World War period – chronic “engine hunger”. There was total dependence on the import of aviation engines until September 1913 when first factory of aviation engine of a Joint Stock Association Le Rhone started to function in Moscow. Inventive rotary engines were produced there with capacity 80–120 hp. Average month capacity of the factory in 1915 was 25 engines but in 1917 it increased up to 40 samples. Inventive rotary engines were also produced by Motor factory in Riga which were evacuated to Moscow just after the war began (Kulikov, 2014, p. 228).

In July 1915 a factory of Joint Stock Association Salmson was opened in Moscow (with French investment). In November a stacking of engines using imported details began there. Later some spare parts were produced in Moscow but using imported half-finished items. In total during the war period this enterprise produced approximately 400 engines. Small amount of aviation motors also was produced by Russian Renault factory and FRAA.

Trying to solve the problem of lack of aviation engines, Russian government started the broad development campaign in 1916. A range of companies got subsidies and loans to build new factories. Among them there were “veterans” of aviation industry as well as newcomers

One of the newcomers in this field was electro technical company Diuflon and Konstantinovich from Petrograd, known as Deka company. Having received government support this company established an office of aviation engines which was run by an engineer Nikolai Brillig. Trophy German 4-cylinder engines Mercedes liquid cooling served as a role model of products. The company received an order to produce five engines with capacity 100 hp, 50–129 hp and 180–168 hp for total cost more than 5.3 million rubles (RSMHA, F. 493, D. 4, C. 384, S. 102–103). Production of first engines began in Petrograd. On October, 12 1916 it was announced that the engine with capacity 100 hp. successfully completed testing. For mass engine production the company Deka bought a factory of agricultural vehicles which belonged to brothers Moznaim in Aleksandrovsk (now Zaporizhzhia) (RSMHA, F. 493, D. 4, C. 352, S. 2). After modernization this factory became one of the best equipped enterprise of aviation industry in Russia. But mass engine production was not even started. As to 13 Sep 1917 Deka factory produced only one engine with capacity 100 hp (RSMHA, F. 493, D. 11, C. 305, S. 44). The enterprise was behind the plan as 135 ordered engines out of 235 had to be produced till the end of 1916. Finally, Deka factory could not start the production of aviation engines until Russia withdrew from the war.

Anatra also tried to start the production of aviation engines. In July 1916 he signed an agreement with Main Military Technical Department that implied building of aviation motors factory in Simferopol till April 1917 with capacity of 300 engines per year. To fulfill this plan Anatra was given a subsidized loan for 400 thousand rubles. First order comprised 200 Hispano-Suiza engines with capacity 200 hp. and 20 000 rubles cost per one engine. The contract implied the delivery of all engines during the period May-December 1917 (RSMHA, F. 493, D. 11, C. 193, S. 13). But these plans were disrupted. Machine tools ordered by Anatra in France at the beginning of 1917 were delayed by French government for their needs (RSMHA, F. 493, D. 11, C. 779, S. 1). Only in May 1917 all the tools were forwarded to a representative of Anatra company in Paris. Artur Anatra proposed to use these machine tools for establishment a design office in Paris from where sets of spare parts should be delivered to Simferopol. But this idea faced skepticism from military personnel who thought that the war in the sea would not allow us to guarantee regular delivery from France. Delivery of machine tools to Simferopol delayed. According to the latest report dates 13 February 1918 none of the machine tools arrived to Simferopol; they were in Arkhangelsk (RSMHA, F. 493, D. 11, C. 779, S. 101). Because of revolutionary activities transportation of equipment became impossible and a factory of aviation engines in Simferopol did not start to operate.

None of the efforts to expand the production of aviation engines in Russia in 1916–1917 showed desired results. “Engine hunger” remained a total nightmare for Russian aviation: it is even enough to say that in 1917 Military Ministry ordered 2290 planes but received (including import) only 525 aviation engines (Kulikov, 2014, p. 229).

### **General characteristic of aviation industry.**

During 1914–1917 3949 planes were produced in Russia. Is it many or a few? To compare let's admit that 36228 planes were produced in France, in Great Britain – 22747 plane, in Germany – 28185 (Soboliev, 2011, p. 18). Consequently, Russian aviation industry managed to produce fewer planes than any of the abovementioned country. More significant is the comparison of annual production. In 1914 Russian aviation industry produced 445 planes while German aviation industry produced 1348 planes, French – 541 planes, British – 245. In 1917 this number for Russia was 1432, for France – 23699, for Great Britain – 14421 (Soboliev, 2011, p. 30). It means that for the stated above period annual production in France increased in 44 times, in Germany – in 10,5 times, but in Russia – only in three times. Moreover, in 1917 plane production in Russia decreased in comparison with 1916, mainly 1386 planes in comparison with 1432. There are several reasons for that. First this was because of economic backwardness of the Russian Empire. In 1914 Russian was one the poorest country in Europe based on the GDP data (the situation was worse only in Portugal). Great Britain had bigger GDP, namely in 3.3 times, Germany – in 2.45 time, France – in 2.35 times. Besides, revolutionary activities in 1917 could not help industry to function in a sufficient manner. System of planes purchase based on standard costs, could not be flexible in the economic reality. From March to October 1917 purchase capability of rubles decreased in 4 times because of inflation, but purchase price for planes remained the same. As a result, for instance, Anatra complained about losing 6000 rubles per each Anasal plane production (Russian State Military Historical Archive. F. 493, D. 9, C. 56, S. 280). It is transparent that it could not attract companies to increase the amount of products.

Russian aviation industry characterized by its high concentration and by having a gap between big and small enterprises; there were no average companies. 90% of the production was provided by four big factories, namely Duks, Shchetinin, Anatra and Lebediev. Other 10% was divided between aviation office of FRAA (which produced mainly heavy planes but in small amount) and several small factories, or it is better to say workshops (Tereshchenko, Moska, Adamenko, Sliusarenko) (Soboliev, 2011, pp. 29–30).

Enterprises of Russian aviation industry differed greatly from European by low productivity and weak engineer cadres. Based on V. Savin's data, Anatra factory requires 30–40 employees to work during one month to construct one plane; meanwhile German and French factories required only 10 employees. There was one engineer per

50–100 employees in German factories, but in Russian factories, one engineer per 500–600 employees (Savin, 1995, p. 84).

Situation was critical at minor enterprises, for instance, there were no engineers at all at Adamenko factory. Consequently, such weakness of cadre potential had negative influence on the quality of products. Big enterprises such as Anatra and Matias could afford to compensate for the lack of domestic specialists inviting engineers from abroad. But for small enterprises it was not possible because of finance considerations – foreign specialists demanded for higher salary than Russians. Total quantity of workers in the Russian aviation factories increased from 1675 to 10800 people from 1914 to 1917 (Soboliev, 2011, p. 81). By this increase was followed by decrease of work productivity; as we mentioned before annual growth of planes production increased only in three times. “During the First World War, aircraft production was revived for obvious reasons, nevertheless, the domestic aircraft industry managed to meet only 9% of the demand for aircraft and 5% of the demand for engines generated by the Russian army in 1914–1917” (Mukhin, 2022, p. 60).

Being unable to provide the necessary quantity of planes led to great lack of planes in the front units. As to August, 2 1917 Corps Aviation squadrons` strength was only 42% (they lack 202 planes), Artillery Aviation squadrons` strength was 74%, Fighter Aviation squadrons` strength was 85%; and only Army Aviation squadrons almost met the plane requirements (Duz, 1989, pp. 195–196).

### **Conclusions.**

Chronic lack of planes in Russian aviation was even greater from perspective of their low combat capabilities. Biplanes Farman and Voisin were main planes in army aviation in 1917. Their speed slightly exceeded 100 km/h and it was not enough. Moreover, these planes had pushing propeller that made them too sensitive for enemy attacks from the back. But utilization of Farman and Voisin planes continued and industry continued to receive orders for these planes. Other scout planes such as Lebed XII and Anade did not meet time requirement in summer 1917 despite their more modern design (construction). Bomber “Illia Muromets” considered to be the most popular plane of Russian design, underwent only small improvements during the war period which could not enhance its parameters. In 1917 flight capabilities of “Illia Muromets” were too low. Only at the end of 1917 one started licensed production of modern French biplanes SPAD VII.

To sum up, Russian aviation industry appeared to be unable to supply military planes of efficient quality and in required amount during the war. Most of the planes duplicated foreign samples. Even those projects which had been mentioned earlier were based on foreign projects (Lebed XII and Anade/Anasal adapted German constructions and aircrafts D. Hryhorovych’s based on French models). Such duplication led to the situation when Russian aviation was sad been applied by old-fashioned planes. Almost one year passed in-between the appearance of a new plane in France till it was produced in Russia. In IWW conditions this plane became old-fashioned very soon. As a result,



Russian military aviation could not compete with German and Austro-Hungarian aviation. Russian opponent in eastern front retained few planes which were old-fashioned. But most of modern materials were concentrated in western and Italian fronts.

### **Funding.**

This research received no external funding.

### **Conflicts of interest.**

The authors declare no conflict of interest.

## **References**

- Aleksandrov, A. O. (1998a). *Apparaty Shchetinina i Grigorovicha [Apparats of Shchetinin and i Grigorovich]*. St Petersburg: B. S. K. [in Russian].
- Aleksandrov, A. O. (1998b). *Gidroaeroplany M-5 i M-20 [Seaplanes M-5 and M-20]*. St Petersburg: B. S. K. [in Russian].
- Aleksandrov, A. O. & Petrov, G. F. (1997). *Krylatyye plenniki Rossii [Winged captives of Russia]*. St Petersburg: B. S. K. [in Russian].
- Duz, P. D. (1989). *Istoria vozdukhoplavaniya i aviatsii v Rossii: Period piervoi mirovoi voiny (1914-1918) [History of aeronautics and aviation in Russia: The period of the First World War (1914–1918)]*. Moscow: Mashinostroenie [in Russian].
- Hornat, J. (2005). Descamps 27C.1. *Letectvi+kosmonautika – Aviation + Cosmonautics*, 11, 32–33 [in Czech].
- Khairulin, M. A. (2010). “*Illia Mutomets*”. *Gordost’ russkoyi aviatsii [“Illia Mutomets”. Pride of Russian aviation]*. Moscow: Yauza, Eksmo [in Russian].
- Kharuk, A. (2010) *Narys istorii aviatsiynoi promyslovosti Ukrainy (1910–1980-ti rr.) [Essay on the history of the aviation industry of Ukraine]*. Lviv: Lvivska Politehnika [in Ukrainian].
- Kharuk, A. I. (2014). *Bombardirowshchiki Piervoi mirovoi voiny [Bombers of First World War]*. Moscow: Yauza, Eksmo [in Russian].
- Kharuk, A. I. (2020). Litak “*Vuazen Ivanova*”: dokumentalna istoriia modernizatsii, vyrobnytstva i sluzhby [“*Voisin Ivanova*” aircraft: a documentary history of modernization, production and service]. *Doslidzhennia z istorii i filosofii nauky i tekhniky – Studies in History and Philosophy of Science and Technology*, 29(2), 84–89. <https://doi.org/10.15421/272024> [in Ukrainian].
- Kulikov, V. P. (2014). *Russkaya aviatsiya v Piervoi mirovoi voinie [Russian aviation in First World War]*. Moscow: Rusavia [in Russian].
- Maslov, M. (2021). *Russkie samolety Pervoj mirovoj: krylya Rossijskoj imperii [Russian aircraft of the First World War: wings of the Russian Empire]*. Moscow: Yauza, Eksmo [in Russian].

- Maslov, M., & Kulikov, V. (1998). “Lebed’ XII i drugiye Albatrosy V. A. Lebedeva [“Lebed’ XII and other Albatrosses of V. A. Lebedev]. *Aviatsiya i vriemia – Aviation and Time*, 3, 3–12 [in Russian].
- Mikheev, V. R., & Katyshev, G. I. (2003). *Sikorskiy [Sikorsky]*. St Petersburg: Polytechnika [in Russian].
- Mikheev, V. R. (1994). *Sikorskiy S-16. Russkiy skaut [Sikorsky S-16. Russian Scout]*. Moscow: Gonchar, Polygon [in Russian].
- Mukhin, M. Y. (2022, April). “Industrial Revolution” as an Element of the Soviet Project (Based on the Materials of the Soviet Aviation Industry). *Herald of the Russian Academy of Sciences*, 92(1), 60–69. <https://doi.org/10.1134/S1019331622070097>.
- O’Neil M. (2002). The Soviet Air Force, 1917–1991 In R. Higham & F. W. Kagan (Eds.), *The Military History of the Soviet Union* (pp. 153–168). New York, NY: Palgrave Macmillan. [https://doi.org/10.1057/9780230108219\\_10](https://doi.org/10.1057/9780230108219_10).
- Petrov, G. F. (2000). *Gidrosamoloty i ekranoplany Rossii [Seaplanes and ekranoplans of Russia]*. Moscow: Rusavia [in Russian].
- Rossiyskiy Gosudarstvennyy Voenno-Istoricheskiy Arkhiv – Russian State Military Historical Archive*. Fund 493: *Upravleniye voyennogo vozdušnogo flota. 1891–1919 gg.* [Directorate of the Military Air Fleet 1891–1919].
- Rossiyskiy Gosudarstvennyy Voenno-Istoricheskiy Arkhiv – Russian State Military Historical Archive*. Fund 802: *Glavnoye voyenno-tekhnicheskoye upravleniye 1891–1918 gg.* [Main Military Technical Directorate 1891–1918].
- Rossiyskiy Gosudarstvennyy Voenno-Istoricheskiy Arkhiv – Russian State Military Historical Archive*. Fund 2008: *Polevoye upravleniye aviatsii i vozdukhoplavaniya. 1914–1918 gg.* [Field Directorate of Aviation and Aeronautics 1914–1918].
- Savin, V. S. (1995). *Aviatsiya v Ukraine. Ocherki istorii [Aviation in Ukraine. History essays]*. Kharkiv: Osnova [in Russian].
- Shavrov, V. B. (1978). *Istoriya konstruytsyi samoliotov v SSSR do 1938 g. [The history of aircraft designs in the USSR until 1938]*. Moscow: Mashinostroenie [in Russian].
- Soboliev, D. A. (Ed.) (2011). *Istoriya otechestvennoy aviapromyshlennosti. Seriynoye samoletostroyeniye 1910–2010 [History of the domestic aviation industry. Serial aircraft building 1910–2010]*. Moscow: Rusavia [in Russian].
- Stamper, G. L. (2000, January). The Sikorsky S-16 and Russian Aviation during the Great War. *War in History*, 7(1), 65–81. <https://doi.org/10.1177/096834450000700104>.

## Павло Ткачук

Національна академія сухопутних військ імені гетьмана Петра Сагайдачного,  
Україна

## **Андрій Харук**

Національна академія сухопутних військ імені гетьмана Петра Сагайдачного,  
Україна

## **Ігор Соляр**

Інститут українознавства імені Івана Крип'якевича Національної академії наук  
України, Україна

## **Лілія Скорич**

Національна академія сухопутних військ імені гетьмана Петра Сагайдачного,  
Україна

### **Авіаційна промисловість Росії і виклики Першої світової війни**

***Анотація.** Мета дослідження полягає у висвітленні особливостей розвитку авіаційної промисловості Російської імперії в роки Першої світової війни. Основна увага зосереджена на аналізі виробничих програм та відповідності їх кількісних і якісних параметрів вимогам війни. Методологія дослідження побудована на засадах історизму, наукової об'єктивності, системного підходу та систематизації даних. Задля досягнення поставленої мети автори використали низку загальнонаукових методів (аналіз, синтез, класифікація) та специфічних історичних методів, як-от проблемно-хронологічний, порівняльно-історичний, ретроспективний, періодизації. Автори дійшли висновку, що Перша світова війна стала нелегким випробуванням для російської промисловості, у тому числі авіаційної галузі, яка перебувала ще у стадії становлення. Потреби фронту вимагали значного зростання виробництва літаків, що за умов загальної економічної відсталості Росії було складним завданням. Авіаційна промисловість, представлена кількома великими (як на масштаби Росії) підприємствами, продемонструвала слабку динаміку зростання. За час війни річний обсяг випуску літаків в Росії зріс лише утричі, тоді як в Німеччині – в 10 разів, а у Франції та Великобританії це зростання було ще більшим. Провідні підприємства авіаційної промисловості – заводи Дукс, Лебедева, Анатра, Щетініна – вдавались, головним чином, до копіювання закордонних взірців (французьких, а іноді – німецьких). Спроби налагодити випуск оригінальних конструкцій виявились не надто вдалими. Найвідоміший приклад – бомбардувальник “Ілля Муромець”, який був передовим у 1914 р., але застарів до 1917 р. Вузьким місцем було і виробництво авіаційних двигунів, яке суттєво відставало від випуску літаків. Величезні інвестиції, зроблені у 1916–1917 рр. в розвиток існуючих і будівництво нових підприємств з випуску літаків та авіаційних двигунів, не дали результату: жоден з цих заводів так і не розпочав випуск продукції. Ми проаналізували деякі з цих невдалих спроб – будівництво авіаційних заводів Анатра в Сімферополі та Матіас в Бердянську,*

*а також авіамоторних заводів Анатра в Сімферополі та Дека в Александровську. Державна політика регулювання авіаційної промисловості, яка полягала в наданні пільгових кредитів та субсидій, виявилась неефективною – її нівелювали стандартні закупівельні ціни, які не враховували чинник інфляції. Таким чином, російська авіаційна промисловість виявилась нездатною відповісти на виклики війни. У даній статті проаналізовано, як розвивались виробничі програми провідних російських авіаційних заводів, якими були кількісні та якісні параметри їхньої продукції.*

**Ключові слова:** *авіаційна промисловість; авіаційний завод; військова авіація; військові літаки; Російська імперія; Перша світова війна*

*Received 27.10.2022*

*Received in revised form 30.11.2022*

*Accepted 05.12.2022*