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Russia in the world market of aircraft engines: Problems and prospects

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Abstract. The aviation industry is one of the economy's most knowledge-intensive and innovative sectors. For this reason, the main civil aviation manufacturers have a full production cycle for creating aircraft. A limited number of countries represent them. These are the USA, France, Germany, Great Britain and Spain, as well as Russia, Brazil, Canada, and China. Boeing and Airbus are the undisputed leaders in the international civil aviation market. Companies from the USA (General Electric, Pratt & Whitney) and Europe (Rolls-Royce, Safran) are also leading in the aircraft engine market. After a protracted recession, the aircraft industry in Russia began to integrate into the global aviation industry successfully. But, the restrictions imposed in the spring of 2022 against Russian civil aviation have impacted the possibilities of its development within international production value chains, significantly changing plans for individual projects and the Russian aviation industry as a whole. The goal of the article is to determine the place and prospects of Russia in the world market of aircraft engines; identify the possibilities of domestic enterprises to quickly implement measures to transfer all aircraft systems and units to domestic analogues. The article gives a general description of the global civil aircraft industry, including the production of aircraft engines. Leading companies in the global aircraft manufacturing market are represented. The study results made it possible to determine the main trends in this market; identify factors and conditions that influence their formation. In this context, the role of import substitution in this area of activity, the problems of the Russian aviation industry and its ability to provide the domestic market with civilian airliners in the foreseeable future are analyzed.

Keywords: global civil aviation market, civil aircraft industry, aircraft engines, Russia, world production of aircraft engines

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Россия на мировом рынке авиадвигателей: проблемы и перспективы

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Аннотация. Авиационная промышленность является одной из наиболее наукоемких и инновационных отраслей экономики. По этой причине основные производители гражданской авиации, которые обладают полным производственным циклом по созданию самолетов, представлены ограниченным количеством стран. Это США, Франция, Германия, Великобритания и Испания, а также Россия, Бразилия, Канада, Китай. На международном рынке гражданской авиации безусловными лидерами выступают производители Boeing и Airbus. На рынке авиационных двигателей также лидируют компании из США (General Electric, Pratt & Whitney) и Европы (Rolls-Royce, Safran). Авиастроение в России после затяжного спада начало успешно интегрироваться в мировую авиационную промышленность. Но ограничения, введенные весной 2022 г. против российской гражданской авиации, оказали влияние на возможности ее развития в рамках международных производственных цепочек стоимости, существенно изменили планы как по отдельным проектам, так и в целом по российской авиаотрасли. В работе поставлена цель — определить место и перспективы России на мировом рынке авиадвигателей; выявить возможности отечественных предприятий, в ускоренном порядке реализовывать мероприятия по переводу всех самолётных систем и агрегатов на отечественные аналоги. Дается общая характеристика мирового гражданского самолетостроения, включая производство авиадвигателей. Представлены ведущие компании на мировом рынке авиастроения. Результаты исследования позволили определить основные тренды на этом рынке; выявить факторы и условия, оказывающие влияние на их формирование. В этом контексте анализируются проблемы российского авиапрома, его возможности обеспечить гражданскими лайнерами внутренний рынок в обозримой перспективе.

Ключевые слова: мировой рынок гражданской авиации, гражданское авиастроение, авиадвигатели, Россия, мировое производство авиадвигателей

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Introduction

In order to create an (airliner) aircraft, it is necessary to have the appropriate potential: scientific, technological, and financial. That is why such a limited number of manufacturers operate in the world market in this area. American Boeing and European Airbus are leaders in the production of aircraft, followed by such companies as the Brazilian Embraer and the Canadian Bombardier (Table 1).

Deliveries of leading manufacturers of civil aircraft in 2013–2022 (PCs.)

Table 1

Leading manufacturers	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Airbus	626	629	635	688	718	800	863	566	611	661
Boeing	648	723	762	748	763	806	380	157	340	453
Embraer	90	92	101	108	101	90	89	130	141	52
Bombardier	26	59	44	53	43	33	33	-	-	-

Source: developed on the basis of based on official websites of Boeing, Airbus, Bombardier, and Embraer. Retrieved May 10, 2023, from <https://www.boeing.com/>, <https://www.airbus.com/en>, <https://bombardier.com/en>, <https://www.embraer.com>

About 90 % of all deliveries to the international market are made by Boeing and Airbus. These companies, in turn, compete with each other in the segment of large civil aircraft. Even though each company has its own structural features, design school and view of the needs of the civil aviation market, they generally produce aircraft of similar characteristics in the same market niches.

The sharp decline in Boeing deliveries since 2019 was caused by the suspension of deliveries following two Boeing 737 MAX crashes: one on March 10, 2018, in Ethiopia, killing 157 people, and the second — on October 29, 2018, in Indonesia, 189 people became victims of the disaster.

By now, deliveries have resumed. David Calhoun, CEO of The Boeing Company, stated, «We are focused on getting the Boeing 737 MAX back into service and restoring long-term passenger confidence in the Boeing brand».¹

¹ Boeing's new CEO faces tough tasks beyond 737 Max rescue in 2020. The national. 2019. Retrieved April 10, 2023, from <https://www.thenationalnews.com/business/aviation/boeing-s-new-ceo-faces-tough-tasks-beyond-737-max-rescue-in-2020-1.955535>

The Brazilian company Embraer and the Canadian company Bombardier occupy an essential niche in the segment of regional passenger aircraft. It should be noted that in 2020, Bombardier sold its share of Airbus in the commercial airliner program and focused exclusively on the business jet market, where already in 2022, it strengthened its leading position in the world, ahead of its main competitor in this segment, Gulfstream Aerospace Corp.

In 2021 Embraer delivered 48 commercial and 93 executive class aircraft to the international market, then in 2022, deliveries dropped sharply.² (Concepts — Embraer Commercial Aviation Sustainability, 2023) and the company is trying not to lower this level this year (2023).

The position in the market may change with the growing importance of the Chinese aviation industry. Commercial Aircraft Corporation of China, Ltd. (COMAC) is a leading Chinese company developing aircraft from regional jets to larger wide-body aircraft.

Despite pandemic restrictions, the company produced 35 aircraft of the “Chinese super jet” ARJ-21 in 2019. For the first time in 7 years of operation, one aircraft was delivered for export — the ARJ-21 aircraft went to Indonesia. An alternative to the market-dominating A320 and Boeing 737 narrow-body aircraft could be China’s COMAC C919 narrow-body aircraft.³

The plane was certified to comply with Chinese airworthiness regulations. COMAC plans to increase the annual production of C919 aircraft to 150 units in five years (from, 2022). The first flight with passengers is expected at the end of February 2023⁴.

Thus, despite modern challenges, the civil aircraft market is developing dynamically as the need for airliners for passenger transportation is growing. In addition, the infrastructure necessary for air transportation is improving qualitatively, and the legislation of countries and international legislation on air transportation is improving.

Boeing predicts that the global market is recovering, demand for domestic air travel is growing in several regions, and international travel is picking up as restrictions are eased due to the impact of the COVID-19 pandemic. By 2024, the market should return to pre-pandemic levels. By 2040, the global aviation fleet may increase by 80 % compared to 2019. The world fleet’s fuel efficiency and environmental friendliness are predicted to grow⁵.

² Concepts — Embraer Commercial Aviation Sustainability. Retrieved April 10, 2023, from <https://embraercommercialaviationsustainability.com/concepts/>

³ The Chinese competitor has significantly overtaken the Superjet 100 in terms of deliveries. Aeroo — aviation news portal. (In Russ.). Retrieved April 10, 2023, from <https://aeroo.ru/32029-kitaiyskiy-konkurent-sushestvenno-obognal-superjet-100-po-postavkam.html>.

⁴ A mainline jetliner developed by the People’s Republic of China has appeared on the Chinese market for the first time. TASS. 2022. (In Russ.). Retrieved April 10, 2023, from <https://tass.ru/novosti-partnerov/16570567>.

⁵ Commercial Market Outlook 2023–2042. Boeing. Retrieved April 10, 2023, from <https://www.boeing.com/commercial/market/commercial-market-outlook/index.page>.

Materials and methods

The article used a set of general scientific research methods: statistical analogies, grouping, generalization of information, as well as the method of expert assessments. These helped identify factors and trends, as well as determine their relationships. The scientific literature on civil aircraft engineering is quite extensive. The most important works on civil aircraft engineering belong to scientists and experts from the USA and the EU (Vasigh, Tacker, Fleming, 2018), in the monograph «Introduction to Air Transport Economics. From Theory to Applications 3rd Edition» paid attention to the theoretical foundations and practical approaches to the study of the economics of air transport. D. Roberts (Roberts, 2017), in his work “Entering the Civil Aircraft Industry: Business Realities at the Technological Frontier” considered the features of the civil aircraft industry, the importance of introducing the latest technologies into the aircraft industry. N. Clark (Clark, 2019) in his work «Airbus: The First 50 Years: The Story of a World-Leading Aviation Innovator» analyzed the history of the creation and rise of Airbus as the world’s leading innovator in the field of aviation. Rick Kennedy (Kennedy, 2019). In the research «GE1 “Building Block” Engine: Greatest GE Jet Engine Ever?» considered the production potential and prospects of the world’s largest manufacturer of aircraft engines GE Aviation. The article of Charles Alcock, (Alcock, 2022) is dedicated to the same company «New GE Aerospace Unit Laser-focused on Airline Recovery».

The state of the Russian civil aviation industry (Bazikova, 2018; Bogdanova, Prikhodchenko, 2017), the market of civil aircraft products, the competitiveness of the industry (Kuzmin, 2019), problems and prospects were considered in the works (Elentsova, 2009), of I.V. Bazikova, M.V. Bogdanova, M.K. Prikhodchenko, L.V. Kuzmin, M.A. Elentsova, F.A. Kuznetsova (Kuznetsova, 2021).

The problems associated with the departure of foreign partners, the role of import substitution of the most important components, including aircraft engines; the possibilities of their solution are reflected in the articles Borisov Yu. (Borisov, 2022), Ivashov N. (Ivashov, 2023).

Results

The post-pandemic recovery in passenger air travel, the growing demand for civil airliner deliveries, and the continued demand for aircraft replacements (due to their advanced age and the need to move to more fuel-efficient models with better and more cost-effective technical characteristics) create favorable prospects and for the production of aircraft engines.

CFM International (about 44 %) and General Electric (about 22 %) are the leaders in the aircraft engine market for the entire fleet of passenger aircraft (mainline narrow-body, mainline wide-body, regional) in operation. In the segment of engines for mainline narrow-body aircraft, CFM International (about 71 %, CFM56 turbofan family) and International Aero Engines (~ 19 %, V2500 turbofan family) companies. In the segment of engines for regional aircraft, General Electric (about 72 %, turbofan

CF34 family) and Rolls-Royce (about 17 %, TFE AE3007 family), and the segment of engines for long-haul wide-body aircraft, General Electric (about 51 %, families CF6, GE90 and GEnx turbofans) and Rolls-Royce (about 28 %, RB211 and Trent families) (Palkin, 2019).

The range of aircraft engines produced and developed by the above-listed manufacturers is wide. These companies can supply engines for major commercial and military aviation programs.

In 2020 and 2021, the aircraft engine market, like the entire aviation industry, experienced a downturn caused by the COVID-19 pandemic. In this regard, GE representatives state that the company «laser-focused» on helping its airline customers recover from the post-Covid shockwaves of poor fleet reliability and rising costs. That means improving production rates for aircraft engines and parts and making aftermarket support more responsive» (Alcock, 2022). In 2021 the global aircraft engine market was valued at 96,72 billion doll. The global aircraft engine market is projected to have a CAGR of over 4 % during the forecast period 2022–2027⁶.

Market growth is also driven by demand for next-generation, low-emission, lighter engines that improve aircraft fuel efficiency. Due to this trend, engine manufacturers are collaborating with aircraft manufacturers, investing in research and developing new engine models using the latest technology.

For example, Airbus signed a 50/50 partnership with CFM International in February 2022 to develop a hydrogen-powered aircraft engine to introduce zero-emission aircraft by 2035. Such plans are expected to contribute to the market's growth. Airbus and CFM International will be pioneers in hydrogen combustion technology. As Sabina Klauke, Airbus CTO, said, «This international partnership sends a clear signal that the industry is committed to making zero-emission flying a reality.»⁷ Thus, companies are currently focusing on improving the fuel efficiency of passenger aircraft while increasing their range as airlines seek to acquire such aircraft for their fleets.

And what about the Russian aviation industry? Currently, the aviation industry of the Russian Federation is characterized by an acute dependence both on foreign aircraft, on which flights are predominantly carried out, and on foreign components used in the production of Russian aircraft. However, the situation in this industry was not always like this — during the Soviet era, the domestic civil aviation industry was advanced and occupied a leading position in the world. The USSR was one of the few states (only 5–6 countries) with an entire cycle (macro technology) for creating aviation equipment, including the high technologies necessary for this. The Soviet Union accounted for about 40 per cent of the world's fleet, and all air transportation was carried out on domestically produced aircraft

⁶ Mordor Intelligence. Aircraft Engine Market Report. Size, share, growth and trends (2022–2027) (mordorintelligence.com) Retrieved April 10, 2023, from <https://www.mordorintelligence.com/en/industry-reports/aircraft-engines-market>

⁷ Airbus and CFM International to pioneer hydrogen combustion technology. Airbus. 2022. Retrieved April 10, 2023, from <https://www.airbus.com/en/newsroom/press-releases/2022-02-airbus-and-cfm-international-to-pioneer-hydrogen-combustion>

consisting of domestic parts and components. Aircraft were exported to many countries of the world and also made in some of them under license. The peak of the development of the Soviet aviation industry was the 1970–1980s. At the end of the 1980s, preparations began and mastering the serial production of a new generation of passenger aircraft with high fuel efficiency: Il-96-300, Tu-204 and Tu-214 for main air routes and Il-114 for domestic flights. After the collapse of the USSR (1991), the civil aviation industry was left without state support. There has been a rapid outflow of highly qualified personnel from the industry abroad. In the future, Russia, unable to adapt to a new scheme for creating aircraft, became increasingly dependent on foreign suppliers.

It should be noted that international experience in this field of activity shows that the fragmentation of value chains is generally typical for this industry. However, in the context of a strict sanctions policy, component suppliers have entirely severed relations with the Russian aviation industry. This was a massive problem for the Sukhoi Superjet 100 regional aircraft and the MC-21 medium-haul aircraft, which were preparing for serial production, which mainly consisted of foreign-made parts, including the engine for the Sukhoi Superjet 100 — Russian-French production, and for the MS-21 — the American engine of Pratt & Whitney PW1400G.

To this, we must add that the fleet of Russian air carriers has 1287 aircraft. Of these, 67% are imported. At the same time, 97% of the total passenger traffic belongs to foreign aircraft.

Under these conditions, it became necessary to quickly implement measures to transfer all aircraft systems and assemblies to domestic counterparts.

So, for example, the SSJ-New aircraft is being prepared to replace the “import-dependent” Superjet-100 (SSJ-100) (the project of which was developed in, 2019), which is planned to significantly increase the number of Russian parts, units and assemblies (up to 97%), including the Russian PD-8 engine. The aircraft is scheduled to be certified in 2024.

The head of Roscosmos, Yu. Borisov, said that dependence on the import of the Superjet 100 aircraft should be eliminated by the end of 2023. From 2024, the production of these machines should be at least 20 production aircraft per year. This is approximately the market demand for an aircraft that will soon be inside the country. A purely domestic aircraft will be called Superjet — New (Borisov, 2022).

The most important for air transportation are medium-haul narrow-body aircraft, such as the Airbus A320 and Boeing 737. In the Russian Federation, these aircraft should be replaced by the MS-21.

An all-Russian MS-21 with a Russian PD-14 engine is said to take to the skies in the spring of 2024. The first six aircraft will be handed over to Aeroflot. Then their annual release will double until it reaches 72 liners. In total, 270 MS-21s will be put into operation in 2030.

Aviation industry enterprises are currently forced to revise their production programs in the face of geopolitical and sanctions pressure on the development of the Russian economy in the direction of reducing the supply of MC-21 and SSJ-NEW aircraft in the short term (taking into account the need for accelerated import

substitution), as well as the deployment of programs to increase production of aircraft Tu-214, Il-114, “Baikal” (LMS-901) and TVRS-44 “Ladoga”.⁸

It should be noted that the Russian government has allocated more than 237 billion rubles to implement projects in the aircraft industry. During 2024–2025, another 32 billion rubles will be given for these purposes (Soyustov, 2020).

At an accelerated pace, the government developed and approved the Comprehensive Program for the Development of the Aviation Industry of the Russian Federation until 2030. According to the plan for the implementation of this program for 2022–2030, it is planned to supply 1036 aircraft for the needs of civil aviation, of which 142 units are SSJ-NEW, 270 units are MS-21-310, 70 units are Il-114-300, 70 units are Tu-214, 12 Il-96-300 units, 140 units.⁹ In this regard, the planned indicators for the production of engines for the presented range of civil aviation aircraft are indicated (Table 2).

Table 2

Plan for the production of aircraft engines until 2030

Engine's type	2023	2024	2025	2026	2027	2028	2029	2030	Total
PD-8	6	44	44	44	44	44	44	44	314
PD-14	—	14	26	52	80	108	152	152	584
PS-90	6	14	20	20	20	20	20	20	140

Source: Production schedules of domestic components by year. Government of Russia. Retrieved April 10, 2023, from <http://government.ru/docs/all/141773/?page=6>

As you can see, the load on aircraft manufacturing companies is increasing dramatically, including on the UEC, one of the leading enterprises in the country, which specializes in developing, serial production and maintenance of aircraft engines for civil and defense needs.

Conclusion

According to the latest research, the size of the global aircraft engine market looks promising and tends to grow in the next five years. The world's leading aircraft manufacturers are focusing on improving the fuel efficiency of passenger aircraft while increasing their range as airlines seek to acquire such aircraft for their fleets. The imposition of sanctions against Russia, aimed at reducing the fleet of aircraft by banning the operation of foreign airliners (their share is about 70%), has

⁸ Order of the Government of the Russian Federation No. 1693-r dated 25.06.2022. Government of Russia. (In Russ.). Retrieved April 10, 2023, from <http://government.ru/docs/all/141773/?page=2>.

⁹ Order of the Government of the Russian Federation No. 1693-r dated 25.06.2022. Government of Russia. (In Russ.). Retrieved April 10, 2023, from <http://government.ru/docs/all/141773/?page=2>.

threatened the very possibility of air travel and, with it, the transport connectivity of such a large country. The restrictions imposed in the spring of 2022 against Russian civil aviation have significantly changed plans for individual projects and the aviation industry. The cessation of supplies of foreign components, including engines, accelerated work on their import substitution. This is a severe challenge. But, it provides an opportunity for Russian industry, engineering, and research centres to use their modern technologies and products to fill the niches that have arisen after the departure of foreign suppliers. This is an opportunity for Russian companies to increase their presence in the domestic market significantly and lay the groundwork for entering foreign markets in the future.

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