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2 December 1995

Fuzzy Conejo, Major, USAF
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Dear Major Conejo

Enclosed are an unbound copy of my thesis and an abstract with bibliography.

Happy holidays.

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GEORGE LEE STAMPER, JR., Capt., USAF
The Sikorsky S-16 and Russian Aviation During the Great War, 1995, 88 pages
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(Under the direction of JOHN MORROW)

The history of aviation before and during World War I seldom includes Russia. In the few instances where the Russian aviation experience is examined, historians resort to the "backward" generalization and minimize Russian contributions to aviation history. Typically, Russia is portrayed as a nation of non-flyers, hopelessly unable to master flight or raise a modern air force. The story of the Sikorsky S-16 fighter, in conjunction with the evolution of the Squadron of Flying Ships and the Imperial Russian Air Force, reveals a sophistication that is not readily apparent. It demonstrates that Russia did possess the technical know-how to design state-of-the-art aircraft and the doctrinal savvy to employ them to great effect. But, it also illustrates the weakness of Russian aviation that has been evident to historians. Russia chose not to develop her technical-industrial infrastructure and, therefore, was unable to translate her engineering capability into a strong fleet of aircraft.

INDEX WORDS: Aviation, Russia, World War I, Igor Sikorsky, S-16, Ilya Muromets, Squadron of Flying Ships (EVK), Imperial Russian Air Force, Grand Duke Alexander Mikhailovich, Russo-Baltic Rolling Stock Factory, Aircraft Production, Aero-engine Production

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THE SIKORSKY S-16
AND
RUSSIAN AVIATION DURING THE GREAT WAR

by

GEORGE LEE STAMPER, JR.

B.S., United States Air Force Academy, 1988

A Thesis Submitted to the Graduate Faculty of the University of Georgia

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MASTER OF ARTS

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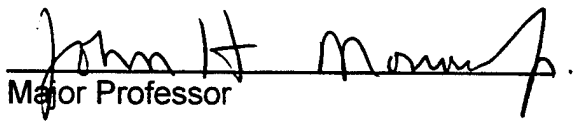

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To my wife, Anne-Marie Stamper, with love

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TABLE OF CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

Avia-Balt	Aeronautical Section, R-BVZ, Petrograd
CMTD	Central Military Technical Department of the War Ministry
EVK	Squadron of Flying Ships
IM	Ilya Muromets
IRAC	Imperial All-Russian Aero-Club
IRAF	Imperial Russian Air Force
IRN	Imperial Russian Navy
R-BVZ	Russo-Baltic Rolling Stock Factory, Riga
"S" aircraft	Prefix designator of Sikorsky built aeroplanes
Stavka	Russian High Command during World War I
TO's	Tables of Organization of Russian Army
TsGVIA	Central State Military History Archive, Moscow

ONE

INTRODUCTION

The history of aviation before and during World War I has focused on Western Europe. After all, the west was where the airplane was born and, for the most part, where it matured. France has long been considered the cradle of military flight, and rightly so. During the Great War, the airplane was utilized on an immense scale and to deadly effect on the Western Front. The great offensives combining air and ground forces, large air battles, and, especially, the daring dogfights that typify World War I aviation all occurred on the Western Front, as historians have dutifully chronicled.

Historians have not afforded the same amount of attention to the development of aviation in Eastern Europe. This is due, in part, to the lack of information. Also, the scale of aviation activity in the east was much smaller, and the air war on the Eastern Front was seemingly nonexistent when compared to the intense aerial activity in the west. In February 1917, for example, France, Britain, and Germany each mobilized air forces roughly three times as large as Russia's. The disparity in aircraft production was even greater. French, British, and German aircraft manufacture from 1914 to 1918 was 52,000, 43,000, and 48,000, respectively, handily surpassing Russia's total output of 4,600

machines.[1] The meager size of the Russian air force coupled with the vastness of terrain in the east--which meant that air units were thinly spread throughout the front--contributed to the belief that little of significance to aviation history occurred, and that "backward" Russia was incapable of raising a modern air force. Recent works that have examined the aviation activities in late Imperial Russia tend to resort to the "backward" characterization--portraying Russia as a nation of non-flyers, hopelessly unable to master the modern invention of aviation.[2]

Utilizing sources that have become more readily available, historians like Von Hardesty, Carl Bobrow, and Scott W. Palmer have taken a closer look at the development of aviation in Russia.[3] Hardesty and Bobrow have described the incredible achievements of Russian aircraft designer Igor I. Sikorsky and his

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[1]John H. Morrow, Jr., The Great War in the Air: Military Aviation from 1909 to 1921 (Washington and London: Smithsonian Institution Press, 1993) Morrow, 197-280, 371. J. Alexander, "The Russian Aces," Air Aces of the 1914-1918 War, ed. Bruce Robertson (Letchworth, Herts, England: The Garden City Press, Limited, 1959) 149.

[2]Lee Kennett's, The First Air War, Robert A. Kilmarx's, A History of Soviet Air Power, and studies by David R. Jones emphasize Russia's shortcomings and apparent ineptitude. Even John H. Morrow, Jr.'s, The Great War in the Air, a wonderful comparative analysis of the warring nation's air forces, cannot avoid the general characterization of "backwardness." See page 373. Robert Wohl's cultural history of aviation, A Passion for Wings, focuses almost exclusively on France. He does discuss two Russian artists, the Futurist poet and pilot, Vasily V. Kamensky, and the Suprematist painter, Kazimir S. Malevich. But the effect of these accounts is to minimize the awareness of aviation in Russia to a few, privileged, avant-garde radicals, which is misleading.

[3]See K. N. Finne, Igor Sikorsky: The Russian Years, eds. Carl Bobrow and Von Hardesty (Washington, D. C.: Smithsonian Institution Press, 1987). Dorothy Cochrane, Von Hardesty, and Russell Lee, The Aviation Careers of Igor Sikorsky, Seattle and London: Washington University Press, 1989. Carl Bobrow, "Early Aviation in Russia," W. W. I Aero 114 (April 1987): 18. Alexander Riaboff, Gatchina Days: Reminiscences of a Russian Pilot, ed. Von Hardesty (Washington, D. C.: Smithsonian Institution Press, 1986). Scott W. Palmer, "On Wings of Courage: Public "Air-mindedness" and National Identity in Late Imperial Russia," Russian Review 54 (April 1995): 209-226.

monumental machine, the huge, four-engine Ilya Muromets. As editor of Alexander Riaboff's memoir, Gatchina Days: Reminiscences of a Russian Pilot, Hardesty offers a glimpse of Russian military aviation during the tumultuous days of the civil war. Palmer's cultural study portrays Russia as a nation enraptured by flight and in love with her new aviator heroes. Their works reveal that Russia was not backward. In fact, Russian aviation progressed at a pace comparable to, and at times faster than, the west's.

France had her share of aviation pioneers: pilots like Louis Blériot and Roland Garros, and designers like the Voisin and Farman brothers. Russian pioneers included pilots like Lev Matsievich and A. A. Vasil'yev, and designers like Sikorsky, M. Lebedev, and D. P. Grigorovich. Germany's aviation establishment enjoyed the patronage of Prussia's Prince Heinrich, who headed the National Aviation Fund, founded in 1912. Three years prior, a member of Russia's Imperial family, Grand Duke Alexander Mikhailovich, established a similar trusteeship for the advancement of aviation in Russia. Britain had the Aerial League of the British Empire, France the Aéro-Club de France, and Russia, the Imperial All-Russian Aero Club. And, just as the famous air meets at Reims were a sign of France's aviation prowess, similar events at St. Petersburg and Moscow attested to Russia's.

As military aviation evolved in the west, it also evolved in the east. Early military proponents of aviation included Germany's Hermann von der Leith-Thomsen and France's Ferdinand Ferber. Similar pioneers existed in Russia. During the war, the development and employment of fighter aircraft with synchronized machine guns occurred nearly simultaneously. And, Germany's Oswald Boelcke was not alone in developing fighter tactics. I. A. Orlov and E. N. Kruten, two of Russia's leading aces, who are less well known than France's René Fonck or Germany's Manfred von Richthofen, were also distinguished

tacticians. Also, the great battles of 1916 on the Western Front, where aircraft became an essential element in the success of an army's operation, were mirrored by Russia's coordinated use of air and ground forces during the Brusilov offensive. Finally, the emergence of Russia's large, multi-engine bombers predated Germany's Gothas by two years. It is evident that aviation in Russia did not progress, as Lee Kennett suggests, more slowly than in the west.

The history of another great Sikorsky aircraft, the S-16 fighter, reinforces the progressive theme of Russian aviation. Its development, which was closely associated with the evolution of both the Squadron of Flying Ships, Russia's unit of Ilya Muromets bombers, and the Imperial Russian Air Force, demonstrates that Russia did possess the technical know-how to design sophisticated aircraft and the doctrinal savvy to employ them to great effect. But, the story of the S-16 also reveals the glaring weakness of Russian aviation that has been so evident to historians. It suggests that Russia was unable to translate her engineering capability into a strong fleet of aircraft. She could not mobilize a sufficient number of quality machines; not because of backwardness, but because she chose not to.

TWO

PROLOGUE:

1909-1913

"Air-mindedness"

On a warm, bright morning in late July 1909, Russian aviation awoke. As Grand Duke Alexander Mikhailovich, who was vacationing in France, enjoyed his morning tea and croissants, he noticed the headlines emblazoned across the front page of his Paris newspaper announcing Louis Blériot's epic flight across the English Channel. Immediately, he "understood that Blériot's achievement was ushering in not only a new means of transportation but an additional weapon of warfare as well," and he "decided to act at once and introduce the heavier-than-air flying machines in Russia."

As chairman of the Committee for the Strengthening of the Naval Fleet by Voluntary Contribution, which was organized at the end of the Russo-Japanese war for the construction of torpedo boats, he had at his disposal nearly two million rubles of public funds. He intended to use these funds for the creation of a Russian air fleet and wrote to the editors of several newspapers asking the contributors if they would approve of his spending their money on airplanes

instead of additional boats. Within a week he "received thousands of answers, containing unanimous approval" of the proposition.[1]

When Alexander returned to Russia to garner official support, however, he found less enthusiasm. The Minister of the Navy, whose torpedo boats were in jeopardy, naturally thought he was "crazy." Minister of War V. A. Sukhomlinov "shook with laughter" and Grand Duke Nicholas Nicholaevich, who would command Russia's armies at the start of the war, failed to see any utility in a fleet of aeroplanes, which he regarded only as toys. The Tsar, however, after Alexander's pleadings, grudgingly accepted his proposal for the creation of the National Subscription for the Establishment of a Russian Air-Fleet. He also authorized Alexander to send a select group of officers to France for pilot training under the tutelage of aviator-manufacturers Louis Blériot and Gabriel and Charles Voisin, arrange for the purchase of French aircraft, and establish Russia's second military flying school at Sevastopol. The War Ministry had already sponsored the preparation of the Gatchina aerodrome as an aviation branch of the St. Petersburg Aeronautics School.[2]

One year prior to Blériot's triumphant channel crossing, the Electric Service Section of the Russian War Ministry's Main Engineering Directorate, which was responsible for lighter-than-air dirigibles and balloons, recognized that aeroplanes might play an important military role in the future.[3] As yet, though, the government had devoted little effort to the promotion of military aviation. Grand Duke Alexander, as the royal patron, invigorated aviation activities in

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[1]Alexander, Grand Duke of Russia, Once a Grand Duke (New York: Farrah & Rinehart, Inc., 1932) 237.

[2]Ibid., 237-241. David R. Jones, "The Beginnings of Russian Air Power, 1907-1922," Soviet Aviation and Air Power: A Historical View, eds. Robin Higham and Jacob W. Kipp (Boulder, Colorado: Westview Press, 1977) 17.

[3]Jones, 17.

Russia. By virtue of his high position in official circles and as the trustee of the National Subscription, he was instrumental in organizing aviation exhibitions and War Ministry aircraft competitions. The first "Aviation Week," held in St. Petersburg from 15 April to 2 May 1910, attracted an audience of over 160,000 spectators, rivaling the popularity of French air meets at Reims and Issy-les-Moulineaux.[4]

The growing popularity of aviation among the Russian people was due, in no small part, to the work of Vasilii Korn, the founder of the Imperial All-Russian Aero-Club (IRAC). In a series of letters to the editors of numerous aeronautical journals, he argued "that Russia's aeronautical 'primitiveness' (pervobytnost') stemmed from the nation's failure to develop social organizations that would 'popularize the idea of aviation as a sport, and that might accommodate that sport to [Russian] society.'" He lamented the sorry state of aviation in Russia--civilian and military--and implored Russians to learn from the example of West European aviation enthusiasts. In 1908 he founded the IRAC in St. Petersburg based on the European model. This club, with branches in many of Russia's larger cities, sponsored aviation events, trained pilots, and contributed to the growth and popularity of aviation in Russia.[5]

Evidence of Russia's growing "air-mindedness" appears in the public's response to the First All-Russian Festival of Aeronautics, held in St. Petersburg in the autumn of 1910. During the festivities a young aviator, naval Captain Lev Makarovich Matsievich, who earlier had given P. A. Stolypin a flight that "hooked" the Prime Minister on aviation, plunged to his death when he fell from

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[4]Novoe Vremia, 8 October 1910, quoted in Palmer, 213.

[5]V. Korn, "Russkii aero-klub (Pis'mo v redaktsiiu)," Vozdukhoplavatel 12 (1907): 480 and "Organizatsiia i zadachi russkago aero-kluba (Pis'mo v redaktsiiu)," Vozdukhoplavatel 1 (1908): 39, quoted in Palmer, 218.

his Farman biplane while attempting to top the latest altitude record set by his companion and competitor B. V. Matyevich. The national celebration aroused by the feats of these airmen quickly changed into a collective outpouring of grief and sorrow upon word of Matsievich's death. It was a national disaster, as if the Tsar himself had passed. "Never before has St. Petersburg so honored its heroes," one newspaper asserted.[6]

Aviation had become a symbol of Russia's greatness and the loss of one of her aviators pulled the people together. "Matsievich's funeral had united 'all professions, groups, political camps and estates' in a common display of sincere sympathy. In short, 'there was neither Greek nor Jew at the graveside of the deceased aviator [as] Kadets, Octobrists, Black Hundreds and even Socialists were united in their estimation of the importance of such pioneers of aviation.' As if by some miracle, 'the dead pilot's body had filled the chasm separating Right and Left' in the Russian political arena and, as such, brought forth the possibility of national reconciliation and renewal."[7]

Again in 1911 the broad public appeal for aviation was evident when the Russian aviator A. A. Vasil'yev won the 400 mile long St. Petersburg to Moscow air race. All of Russia watched intently as aviators made the arduous flight over Russia's rugged northern forests. When Vasil'yev landed at Khodinskoye field in his Blériot aircraft, the only pilot to complete the course, it seemed that the entire city of Moscow rushed to greet him.[8] Even press reports of the event that criticized the IRAC for inadequate attention to safety measures after numerous

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[6]Novoe Vremia, 29 September 1910, quoted Palmer, 212-213.
[7]Novoe Vremia, 2 October 1910, quoted in Palmer, 224.
[8]Von Hardesty, "Introduction," in Riaboff, 16.

crashes and one fatality did not dampen the excitement of spectators and enthusiasts.[9]

An impressive series of developments in Russian aeronautical engineering accompanied the proliferation of aviation's popular appeal. For many years beginning in the late nineteenth century, Russian scientists and inventors produced some of the world's most advanced aeronautical technology and sophisticated aircraft designs. Nicholas Zhukovskiy, known as the "Father of Russian Aeronautics," built the first wind tunnel in 1902, which was designed with the help of Konstantin Tsiolkovskiy, the great Russian astrophysicist and aeronautical engineer. Two years later, Zhukovskiy founded the world's first Institute of Aerodynamics at Kuchino.[10]

Stephen Dzevetskiy accomplished important pioneering work with propellers, and in 1910, Luka Shkolin invented a gear mechanism to vary the pitch of propeller blades. One of Russia's prolific early designers, Joseph Hackel, constructed many successful aircraft and was first to fly a strut-braced monoplane. In 1912, I. I. Steglau pioneered the use of plywood instead of cloth for aircraft wings and fuselages and employed welded steel tubing to strengthen aircraft critical joints--techniques that became important to improve the ruggedness and survivability of military aircraft. Another designer, D. P. Grigorovich, became famous for his flying boats, and in 1917, E. I. Kasyanenko invented variable-incidence wings--another first in aviation.[11]

The Russian aeronautical industry also began relatively early. Although many of its factories--including the Moscow Duks aircraft works (established 1910) and the Moscow Gnome-Rhone engine assembly plant (established

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[9]Palmer, 217.
[10]Bobrow, 18.
[11]Ibid., 18-20.

1911)--were French firms, they nevertheless represented the growth of aviation in Russia. Native firms included the J. Möller Company in St. Petersburg and the Kalep engine company in Riga. As early as 1910 Russia produced its own aero-engines: the Kalep 25 horsepower and the Stephen Grizodubov 40 horsepower.[12]

Igor Ivanovich Sikorsky

The year 1912 proved to be an important one for Russian aviation. Grand Duke Alexander's aviators first participated in military maneuvers, "spreading air-consciousness among the moth-eaten bureaucrats of the War Office and earning the generous praise of the Czar." It is also the year that Igor Ivanovich Sikorsky assumed his role as the most creative Russian aircraft designer. Sikorsky, the son of a distinguished psychology professor and graduate of the Kiev Polytechnic Institute, had been interested in aviation for several years. He had studied in France and experimented with both fixed-wing and rotary-wing aircraft. Blessed with a sizable bank account and a generous sister, Olga Ivanovna, Sikorsky was able to finance the design and construction of several "S" series aircraft. In 1910 his second aircraft, the BIS No. 2, became the third aircraft of native design to fly in Russia. One year later he earned his Russian pilot license flying his own S-5 aircraft, powered by a German 50 horsepower Argus water-cooled, in-line engine. He also set four Russian records in the S-5, flying to an altitude of 500 meters (1,640 feet) at 125 kilometers per hour (77.5 miles per hour) for 85 kilometers (52.7 miles) during a 52 minute flight.[13]

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[12]Jones, 19. Bobrow, 20.
[13]Alexander, 241. Bobrow, 21. Finne, 33.

In 1912 Sikorsky's career took off with his most successful biplane yet, the S-6a, powered by an 100 horsepower Argus . In only three months he designed, conducted wind tunnel testing, and built the S-6. In March, the S-6a, a slightly modified version, set multiple world records including a flight carrying four passengers to a speed of 106 kilometers per hour (65.7 miles per hour). Sikorsky's achievements in his S-6a caught the attention of a prominent industrialist and air enthusiast, M. V. Shidlovskiy. Shidlovskiy, Chairman of the Russo-Baltic Rolling Stock Factory (R-BVZ) of Riga, hired Sikorsky to head the Aeronautics Section of the company located in St. Petersburg. The marriage of Shidlovskiy's powerful company with Sikorsky's creative genius proved to be very productive for Russian aviation. That same summer Sikorsky's S-6b, an improved S-6a with a cockpit starter and reinforced undercarriage, won first prize at the War Ministry's international aircraft competition.[14]

The following year, Sikorsky designs again dominated the competition. First place went to the S-10 biplane, a direct descendant of the S-6, flown by R-BVZ test-pilot G. V. Alechnovich. Second prize was awarded to the S-11 two-seat monoplane flown by G. V. Yankovskiy, another R-BVZ test-pilot who performed Nesterov's loop for the first time in a Russian designed aircraft. The S-11 was powered by an 100 horsepower Gnome-Monosoupape and established an altitude record of 3,860 meters (12,660 feet).[15] Despite the success of these native designs, the Russian government only ordered two Sikorsky machines of the S-6b type, preferring instead the French Blériot, Farman, Nieuport, and Voisin aeroplanes.[16]

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[14]Bobrow, 21.

[15]Ibid., 22. Finne, 33.

[16]Vadim Mikheyev, Sikorskiy S-16: Russkiy Skaut [Sikorsky S-16: Russian Scout] (Moscow: Gonshar, 1994) 6.

Perhaps the most significant achievement of Sikorsky and the R-BVZ occurred on 26 May 1913. During a cool, calm spring evening before a large, anxious crowd that had assembled on the grassy fields of the St. Petersburg's Korpusnoi Aerodrome, the world's first four-engine aircraft took flight, effortlessly circled the aerodrome several times, and landed smoothly near its hangar. Much to the pleasure of the supportive onlookers, Sikorsky had successfully piloted the giant, 4,200 kilogram (9,240 pound) "Russkiy vityaz" ("Russian Knight," also known simply as "Grand"), despite the predictions of "many aeronautical experts of that time [who] considered the proposed flight impossible. If the Grand actually took off, some cynically commented, the airplane would crash the moment one of its engines stopped." A majority of foreign aviation experts had abandoned the idea of building a large flying machine, considering it foolhardy and destined to fail. Sikorsky and Shidlovskiy, unlike most Russians who "accepted uncritically the opinion of foreigners on matters of aviation," believed it could be done. They succeeded, clearly demonstrating the sophistication of Russian aviation and aeronautical engineering.[17]

The Military

Amid this flurry of civilian aviation activity the Russian army struggled to accept aeroplanes for military use. As early as 1910-1912 a group of Russian officer-pilots, who served in the Officer Aeronautical School, produced "the fundamental works to define the possible uses of aircraft in war. They concluded that in future wars 'the first battle would be to seize command of the air,' and for this it would be necessary 'to have a whole series of machines,

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[17]Finne, 26-27. Bobrow, 22.

assigned not for reconnaissance use, but solely for battle in the air!'" They defined five types of aircraft that the army required: aircraft "for reconnaissance and bombardment [long-range, high-payload types like the Grand], for the destruction of aeronautical machines and the protection of aerodromes [fighters], for correcting artillery fire [observation], for joint operations with cavalry [attack aircraft] and for communications."[18] These references to fighter and attack aircraft were revolutionary, considering the general staffs of most countries, including their own, had little knowledge of aviation and no understanding of the potential military application of aeroplanes.

In a series of War Council bills from 1911 and 1912, the Russian army sowed the seeds of its air service, creating corps squadrons and fortress squadrons under the control of their respective army units. By 1913, the "Great Program to strengthen the army" called for 30 corps squadrons, 8 fortress squadrons, and an additional field squadron for service with a numbered army. While this does indicate a growing military "air-mindedness," the assignment of aircraft types to each unit reveals a poor understanding of aircraft application. Unlike the astute officers of the Aeronautical School, the War Ministry planned to use the squadrons only for reconnaissance and assigned aircraft without regard for their possible use or flight characteristics. Instead they were assigned according to the mobility of the army unit to which they were attached. For example, aircraft in fortress and field squadrons were larger, heavy biplanes, and aircraft in corps squadrons were the more "mobile" light, compact monoplanes.[19]

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[18] V. V. Ribalka, "Aircraft of Air Combat," Krilya Rodini: Sbornik [Wings of the Fatherland: A Collection], eds. V. V. Ribalka and L. M. Shishov (Moscow: DOSAAF, 1983) 36.

[19] N. Kozlow, A Study of the Military-Technical Supply of the Russian Army in the World War, Part I, From the Beginning of the War to the Middle of 1916, trans. Charles Berman (Moscow: Government Military Publications

Russia, like her West European neighbors, was also unsure of how to organize her fledgling air service. As early as 4 January 1912, the General Staff assumed control of aviation from the Chief Engineering Directorate to make aircraft a more integral part of the planning, raising, and training of the army. "The ultimate objective of the aviation service," the order said, "is to serve troops, to lighten the burden of the troops in combat by affording them better means of reconnaissance and the maintenance of communications." This action was approved by the War Ministry on 30 July 1912.[20]

Although the General Staff's attempt at integrating aviation into the army was well intentioned, it proved to be detrimental, for the General Staff was ill equipped to handle the technical demands of aviation. A year later, the administrative shuffling continued as the War Ministry searched to find a proper home for the air service in the army's vast bureaucracy. In a memorandum to the War Council on 4 September 1913, the War Ministry outlined its proposed change:

> it appears appropriate that the handling of clearly technical matters pertaining to the construction and make of various types of equipment and machinery be charged to the Chief Engineer Department, and that the organization of special technical troop units and establishments should come under the control of the General Staff. But the present organization and personnel of the Chief Engineer Department does not permit the transfer to its control of the matters referred to; nor can this be concentrated solely in the hands of the General Staff, which does not have available suitable specialists necessary for the various ramifications of the military technical undertaking. In view of this, it appears necessary to create, in place of the Chief Engineering Department, a separate Chief Military-Technical Department, the functions of which, in general, should be as follows: a. The erection of fortifications; b. The preparation and care of telegraph, mine, projector, motor, aviation, railway, sapper, and pontoon equipment; c. The supply of the army and

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Division, 1926) 86-90. Mikheyev, 6.

[20]Kozlow, 86-87.

> fortresses with all types of the equipment above referred to; d. To develop and to decide upon all technical matters connected with the responsibilities above remunerated.[21]

On 20 December 1913 the change was approved, making the General Staff responsible for the organization and training of aviation units and the Chief Military-Technical Department (CMTD) responsible for all technical matters, including the procurement of aircraft and the supply of engines and spare parts.[22]

Amid this administrative turmoil, the army had accomplished little practical work for the raising, training, and equipping of the air service. And with less than a year until the outbreak of hostilities, a newly formed bureaucracy assumed control of a new, complex, technical weapon. Historian N. Kozlow pointed out that the "CMTD had not yet realized in 1913 the great importance that aviation was destined to assume and which stood out so prominently during the war."[23] But neither had the other great powers at that time.

Conclusion

By the end of 1913, aviation in Russia was coming of age. Her progress, in most respects paralleled or even surpassed developments in the west. One contemporary observer, Charles C. Witmer, an engineer and pilot for the Curtiss Aeroplane Company of America, was quite impressed with Russian aviation. He visited Russia several times throughout 1912 to deliver Curtiss flying boats and train Russian pilots at the Sevastopol Aerodrome. "From what I observed at that time," Witmer wrote, "and estimating the advance since then, I have reasonable

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[21]Ibid., 89.
[22]Ibid.
[23]Ibid., 90.

foundation to make the statement that I believe Russia is second to none in the science of aviation." He was especially impressed with the size of the Sevastopol training center and with the quality of the Russian aviators, believing them "to be far in advance of either the French or German and I expect," he said, "to see [Russia] use the aeroplane to best advantage."[24] Witmer even asserted "that Russia stands first, even ahead of France . . . in numbers of machines and pilots."[25]

Without a doubt, Russia had joined the European flying club. Aviation's popular appeal was tremendous and the "air-mindedness" of the army was growing, albeit somewhat haltingly. Advances in aviation sciences and aeronautical engineering were especially impressive. Russia definitely possessed the technical know-how to design and produce sophisticated, state-of-the-art aircraft. But the astute Witmer noted other developments in Russia that would have to change for her to keep up with her western neighbors. He detected the "Russian backwardness in the construction of machines in her own country."[26] In other words, he realized that Russia, despite her domestic technical abilities, imported the majority of her aircraft, primarily from France, and that this reliance on foreign production impeded the growth of her own native aero-industry. Unless this dependence could be overcome, Russian aviation would be doomed, no matter how creative her designers and engineers.

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[24] Charles C. Witmer, "Russia's Pilots and Planes are Remarkable," Aero and Hydro 8, 19 (August 8, 1914): 235.

[25] Charles C. Witmer, "At Sevastopol with Russian Naval Flyers," Flying 2, 8 (September 1913): 7-9.

[26] Witmer, "Russia's Pilots and Planes are Remarkable."

THREE

1914

The ambiguous state of Russian aviation noted by Witmer in 1912 was unmistakably confirmed during 1914. The onset of the Great War exposed problems in Russia's aviation establishment that would continually hamper the army's ability to exploit the air weapon.

The Ilya Muromets

In 1914, Igor Sikorsky's engineering success continued. His S-12 monoplane, a streamlined version of the prize-winning S-11 modified to optimize its aerobatic performance, received rave reviews that spring. Piloted by the skilled Yankovskiy, it placed first in the aerobatic competition during the aviation week held at Kolomyazhskiy hippodrome, located not far from the IRAC's Komendanskiy aerodrome on the northern outskirts of St. Petersburg.

Of even greater significance, though, was Sikorsky's development of the "Ilya Muromets," an upgraded version of the world renowned Grand. In January construction was completed. The new giant, although larger than the Grand--weighing 5,100 kilograms (11,220 pounds)--and powered by the same 100 horsepower Argus engines, had improved performance because of refinements

to the high-aspect ratio wings, which were lengthened to a span of 32 meters (105 feet). The Ilya Muromets could fly at 95 kilometers per hour (59 miles per hour) at an altitude of 1,500 meters (5,000 feet) and boasted a comfortable, enclosed passenger cabin complete with engine-exhaust duct heating, electric lighting, a bedroom, and even a toilet.[1]

In June Sikorsky again astonished the world by successfully completing a 1,600 mile round-trip flight from St. Petersburg's Korpusnoi Aerodrome to Kiev's Kurenev Aerodrome, home of the Kiev Aeronautical Society. For this flight, the Ilya Muromets was fitted with more powerful Argus engines. The two inboard engines produced 140 horsepower each and the outboards 125 horsepower each. With the additional 130 horses and total weight trimmed to 4,650 kilograms (10,230 pounds), Sikorsky could pilot the Ilya Muromets to a speed of 100 kilometers per hour (62 miles per hour) at 3,000 meters (9,840 feet).[2]

During this epic flight, Sikorsky and his crew of three co-piloted by naval Lieutenant Georgi Ivanovich Lavrov, who would later be instrumental in the design and production of another successful R-BVZ aeroplane, the S-16 fighter, encountered many harrowing experiences. After departing from a refueling stop at the city of Orsha, the halfway point of the first leg of their journey, the left inboard engine caught fire, forcing the crew to make an emergency three-engine landing. Even more frightening was the fierce turbulence, caused by electrical storms and forest fires, that twice tossed the Ilya Muromets into spins that were controlled only after a considerable loss of altitude. Poor weather conditions

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[1]"High-aspect ratio" refers to a long, narrow wing which produces maximum lift with minimum drag. This feature was essential to the success of Sikorsky's large aircraft considering the low power of the engines that were available. Finne, 33, 40-41, 185-188.

[2]Igor I. Sikorsky, The Story of the Winged-S (New York: Dodd, Mead & Company, 1938) 106-117. Finne, 47-55, 187.

also required Sikorsky to fly "blind," using only his flight instruments to maintain directional and attitudinal control, through thick layers of clouds on numerous occasions--an amazing feat for the time. Despite these challenges, the Ilya Muromets and her crew survived. During the return trip from Kiev the aircraft set a world record for long-distance flight by remaining airborne for nearly 500 miles before landing for fuel. Sikorsky had clearly demonstrated the practicality of multi-engine aircraft.[3]

For this achievement Sikorsky was showered with praise. He received the Order of St. Vladimir, Fourth Degree, was exempted from the draft to allow him to continue his design work, and was promised a grant worth 100,000 rubles from the State Duma. During an Imperial military review at Krasnoye Selo in July, Tsar Nicholas II decorated and christened the Ilya Muromets, "Kievskiy." Also in attendance was French President Raymond Poincaré, who was so impressed with the four-engine giant that he scarcely noticed the squadrons of French-made machines lined up for review along the field.[4]

Yet even with this publicity, official recognition, and admiration from the French president, the R-BVZ did not receive the expected government order for serial production of Ilya Murometsy (IM's), the world's most impressive aircraft. Furthermore, Sikorsky's grant never materialized, providing yet another

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[3]The flight instruments on the Ilya Muromets were primitive. They included four tachometers--one per engine, a compass, a crude altimeter and airspeed indicator, two glass V-shaped tubes and a ball for bank indication, and a series of horizontal bars situated vertically on the nose of the fuselage for measuring climbs and descents. Later, a drift indicator was added to aid bombing. See Finne, 174. Reflecting on his "instrument flying" during the Kiev flight Sikorsky recognized the danger of his feat, given the crudeness of the instrumentation: "I might say that with the instruments we had then, I would not now fly blind, I would not even go up with them in bad weather." See Sikorsky, 109.

[4]Finne, 53-55.

indication that the government either could not, or would not support domestic aircraft production, no matter how sophisticated the design.

Preparation for war

As the drums of war echoed ever more ominously throughout Europe, Russian military aviation found itself in a paradoxical state. On one hand, Russia possessed the largest air force in the world, boasting some 250 machines at the start of the year.[5] On the other, her military commanders were still unsure of how to use, maintain, and supply the air weapon. Furthermore, many of these aircraft were quickly becoming obsolescent. The CMTD, in the wake of the previous years' bureaucratic melee, had yet to establish a definite procurement and technical supply policy to ensure the readiness of the air fleet. At the beginning of 1914, "no particular definite type of plane had been determined upon which would best meet the requirements of combat conditions [and] the question of armament of planes (i.e. questions of supplying airplanes with guns, machine-guns, bombs, etc.) had not been worked out."[6]

In March, CMTD held a conference to address the aircraft procurement question. Curiously, the General Staff did not send a representative to this important meeting. Why the organization which had a compelling interest in the types and numbers of aircraft its units would possess did not participate is not clear. Possibly, the CMTD did not extend an invitation or maybe the General

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[5] Robert A. Kilmarx, "The Russian Imperial Air Forces of World War I," Airpower Historian (July 1963): 90-05.

[6] Kozlow, 101.

Staff simply refused to attend. In any case, the apparent lack of interdepartmental coordination and latent hostility were deleterious developments.[7]

In the end, the technical conference did little more than make official what had already developed in military aviation. The army had received nearly two dozen different types of aircraft, primarily of French design. Now there would be an attempt to consolidate into individual squadrons aircraft of only one type to simplify maintenance and supply and to facilitate pilot proficiency.

The CMTD awarded new contracts to obtain more "modern" machines for the corps squadrons to R-BVZ for 43 Sikorsky S-11's, to the Deperdussin firm for 48 monoplanes, and to Morane for 42 Parasols. To equip the fortress and field squadrons it ordered an equal number of Voisin, Sikorsky, and Farman biplanes. Finally, it planned an additional order of Morane Saulniers for "special" squadrons and 2 Sopwiths, 2 "Lt. Kovanko" types, and 2 Rumpler Taubes "for the purpose of gaining practical experience."[8]

The selection of these aircraft was completely arbitrary. The conference had little knowledge of the military value of the aircraft and no knowledge of the desires of the General Staff. With regard to the monoplanes selected for the corps squadrons, the CMTD admitted that "the army aviation units have as yet no direct extensive experience with any of these three types of planes; consequently, there are no grounds which would justify the giving of preference to any particular one type of these planes."[9] Furthermore, "direct, extensive tests of the planes selected for equipping the corps aviation squadrons . . . had not been conducted by the aviation units of our army."[10] The Deperdussin's

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[7]Ibid., 102.
[8]Ibid., 102-105.
[9]Ibid., 103.
[10]Ibid., 145.

were ordered simply because they were "theoretically better constructed than the Sikorsky plane," and the Parasols were valued because they "were receiving much attention in France." The same was true for the Voisins, although the Saulniers were considered attractive for their flight characteristics and adaptability for military use.[11]

Meanwhile, the War Ministry, intending to take all measures to form a viable air force by 1 April 1917, expanded its "Great Program".[12] The law which took effect on 24 June 1914 provided for the increase of corps squadrons from 30 to 40 and field squadrons from one to 10. Fortresses would gain an additional squadron making the total nine, eight "special" squadrons would be raised for service with large bodies of troops, and the number maintenance companies would be expanded to 11, each capable of serving as a depot for three to seven squadrons.[13]

The army's tables of organization (TO's) established on 31 January 1914 required each corps and field squadron to be staffed with 7 pilots (5 officer, 2 enlisted) and each fortress squadron with 9 pilots (6 officer, 3 enlisted). If it is assumed the "special" squadrons would be staffed as a field squadron (requiring fewer pilots), the army would need a total of 487 pilots, not including reserves or pilots serving as instructors, by the outbreak of hostilities. Observers were not even included in the TO's until 8 May, when the Chief of the General Staff persuaded the War Council to include them and appropriate funds for their

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[11]Ibid., 105.

[12]"Bolshaya Programma po teknicheskim voiskam." V. Sekretno, sostavleno nachalnikom Generalnovo shtaba Smyslovskim, TsGVIA, f. 2000, op.3, d. 255, ll. 40-48, 55. Cited in P. D. Duz', Istoriya vozdukhoplavaniya i aviatsii v SSSR, 2-e izdaniye . [A history of aeronautics and aviation in the USSR, 2nd edition] (Moscow: Mashinostroyeniye, 1979) 240.

[13]Kozlow, 92.

training. Aircraft for these units, given the standard of six machines per squadron, would number more than 400, reserves not included. By 1917, these numbers conceivably could be obtained, but there would not be that much time.[14]

In June CMTD finally concluded a contract with R-BVZ for the construction of light aircraft. The agreement called for the delivery of 45 machines to the army by the end of the year: 14 S-10A's, 24 S-11A reconnaissance monoplanes, 2 S-12 training monoplanes, and 5 "training biplanes."[15] The number of S-11's had been reduced from 43 in favor of the "theoretically better" Deperdussin, which ultimately proved ill-suited for military use due to its slow speed (53 miles per hour) and mid-wing configuration which hindered observation.[16]

The Imperial Russian Navy (IRN) also turned to R-BVZ for new aircraft. Earlier Sikorsky models, the S-5 float biplane and the S-8 "Malyutka" biplane, had performed well as trainers, especially the more advanced S-8 which featured a unique side-by-side seating arrangement to facilitate student-instructor communication. The navy ordered additional Malyutka's as well as S-10 floatplanes, and the army considered the Malyutka to fulfill the "training biplane" requirement.

By the time the orders were placed, however, these aircraft were already obsolescent. The S-10 and S-11 designs were a year old and the S-5 and S-8 were of 1912 vintage. Thus, not only would construction take time but the aircraft produced, which were intended as "modern" replacements of dated machines, would be of questionable utility themselves. In light of this, Sikorsky

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[14]Ibid., 93-97.
[15]Mikheyev, 6. Kozlow, 103.
[16]Kozlow, 104-105.

and the R-BVZ contemplated designing a new biplane, but for now the Ilya Muromets project kept them busy.[17]

War

When Russia ordered her general mobilization for war against the Central Powers on 30 July, the "Great Program" had not had sufficient time to produce results. Only six new maintenance companies were mustered to join the previously existing 39 combat squadrons. The total numbers of aircraft and personnel comprising these units is not certain. Between 202 and 263 machines existed in the air service and about 289 aero-engines. Thirty of these aircraft were for training only and were located at the schools, but an additional reservoir of 42 aircraft existed at aeroclubs throughout the country. Most of the 263 aircraft were French Nieuport IV's along with Farman XVI's, Morane Parasols, and the ineffectual Deperdussins. Nearly all of them were old and decrepit, hardly capable of combat.[18] Shortly after hostilities commenced, President of the State Duma M. V. Rodzianko declared that "the materiel of many squadrons was completely worn out and the squadrons went into battle with aircraft that had been flown for two years."[19]

Pilots were in short supply as well. Training at Gatchina and Sevastopol had not progressed rapidly enough, producing only 147 students in the first half of the year. Only 133 received rank as military pilots[20] Observers, having been

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[17]Mikheyev, 6-7.

[18]N. N. Golovine, The Russian Army in the World War (New Haven: Yale University Press, 1931) 150. Duz', 241.

[19]TsGVIA, f. 2000, op. 3, d. 761, ll. 192-199. Quoted in Duz', 245.

[20]Duz', 242. Golovine lists 129 pilots at the start of the war, see page 150.

accounted for only since May, were not yet available for duty in an air service that considered its main function to be reconnaissance and observation.[21]

Furthermore, CMTD had not established necessary technical supply and production policies. The department, for example, failed to outline procurement specifications requiring higher grade gasoline for aero-engines. As a result, air units were supplied with low grade automobile fuel from the Nobel Company which led to several accidents and ineffectual sorties due to poor engine performance. This diminished further the already meager support the air service could provide to the army.[22]

Aircraft production was also woefully inadequate. Russian aircraft factories produced only 30 to 40 machines per month by August (compared with 100 per month in Germany). Duks in Moscow and the Lebedev factory in Petrograd each accounted for about 12 aircraft per month, primarily French designs manufactured under license. The remaining machines trickled in from Shchetinin in Petrograd, Anatra in Odessa, Slusarenko in Riga, and R-BVZ's Petrograd division. Aero-engine production, hardly noticeable, was a feeble five to ten per month at the Gnome works in Moscow with a few additional Kaleps arriving from Riga's Motor Works.[23]

With supplies cut off from Germany (notably the dependable Argus engines) and French shipments threatened by the needs of her own air force, the continued supply of Russia's air units seemed hopeless. High attrition rates, averaging 37 percent, meant that Russian manufacturers would need to deliver more than twice their production capacity of aircraft and six times their monthly

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[21]Kozlow, 93. Golovine lists 100 observers at the start of the war, see page 150.

[22]Kozlow, 129-140.

[23]Duz', 242.

output of aero-engines just to maintain minimum combat strength. The situation became so dire that Nieuports manufactured at the Shchetinin plant were knowingly sent to the front with defective wings, resulting in a number of accidents and fatalities.[24] By "5 October 1914, after only three months of war, the aviation squadrons attached to the III, IV, V, VIII, and IX Armies, had lost 91 out of 99 aircraft."[25] And there was little hope of replacing them any time soon.

Not surprisingly, the air service was of little value to the hapless Russian generals in East Prussia. The 42 machines in Samsonov's II Army, for example, were all but useless, most of them grounded with innumerable defects.[26] Many observers believed that a better equipped and properly exploited air force might have saved the Russian armies at Tannenberg and Masurian Lakes. The Governors of the Aero Club of America, who were closely following the fortunes of the belligerents' air forces in an effort to promote military aviation in the United States, commented "that Russia has committed the same mistake that Germany committed in the early part of the Belgian campaign, and that the Russian defeats are the result of a lack of aeroplanes on the Russian side for reconnoitering, controlling artillery fire, and preventing the German air scouts from mapping the Russian possessions."[27] Indeed, had Rennenkampf and Samsonov utilized their scouts as effectively as Hindenburg and Ludendorff did, they might have discovered that their armies were becoming perilously separated and that Samsonov's II Army was being encircled by German troops

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[24]Kozlow, 112. Golovine, 150.

[25]TsGVIA, f. 6280, d. 2067, l. 83, g. Doklad glavnokomanduyushchemu armiyami Yugo-Zapadnovo fronta. Quoted in Duz', 245.

[26]Norman Stone, The Eastern Front: 1914-1917 (New York: Charles Scribner's Sons, 1975) 51.

[27] [Henry Woodhouse], "Russian Defeats Due to Lack of Aeroplanes," Aerial Age Weekly I, 21 (August 9, 1915): 493-494.

"retreating" from Rennenkampf's I Army. Historian and IRAF flight surgeon K. N. Finne believed "that the reversals suffered by the Russian army during the opening days of World War I might have been avoided if there had been more enthusiasm for building the Ilya Muromets," which would later become an invaluable long-range reconnaissance and bomber aircraft.[28]

On 14 August 1914, the General Staff (Stavka) created the Imperial Russian Air Force (IRAF) and gave it "control of the organization of the aviation service of the active army." Grand Duke Alexander was appointed commander of the southwest front air forces, and General Kaulbars was given command of the northwest front air forces. But this late attempt at improving the status and organizational independence of aviation did little good. The internecine rivalries in the army were merely extended to the new IRAF, leaving it to fend for itself in the midst of the chaos and confusion caused by the ensuing disasters on the battlefield. Alexander, who later assumed control of all fronts on 5 Jan 1915[29], describes the meeting when he was offered command and reveals the less than desirable relationship between himself and his commander (and cousin), Chief of Staff Grand Duke Nicholas Nicholaevich, and the poor state of the IRAF:

> Our mutual antipathy increased our politeness toward each other. We made desperate efforts to be friendly. He suggested my taking command of the air forces of the front and gave me carte blanche. I took this appointment in the spirit it was proposed, as a flattering though somewhat belated compliment to my pioneering aviation work. We both knew that no one else in the army could have fitted the post. A salon car, to serve as my temporary headquarters, was provided by the Stavka; the rest, including airplanes, machine guns, repeating rifles, flyers, observers, technical staff, motor cars, even the typewriters, had to be gotten through my own ingenuity. As a sinecure the post of commander-in-chief of the Imperial Russian Air Forces fared rather moderately. I did not complain, how-

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[28]Finne, 57.
[29]Kozlow, 100.

> ever, because everything else pertaining to warfare had to be improvised by our commanders.[30]

Nevertheless, Alexander endeavored to shore-up his feeble command with a series of organizational changes.

In an effort to consolidate what was left of the air units, he organized the aviation squadrons into groups and assigned them directly to the numbered armies. This had an adverse effect on reconnaissance at the corps level but facilitated the concentration of air strength for more practical use. The trend continued with order No. 78 on 27 September. This directive created an additional command level, the division, to coordinate aviation activities between armies, and organized special squadrons for massed flights with specific objectives (bombing installations, troop concentrations, etc.). Fortress squadrons were reorganized into corps squadrons raising their number by 13, a new squadron was created at Odessa, the Tsar's residence received its own air defense squadron, and the All-Russian Aero-Club volunteer corps squadron was officially mustered. The order also specified that each unit possess at least four observers and the maintenance companies be expanded with two forward technical sections each to expedite repair work.[31] These reforms were an improvement, but without an adequate number of machines of sufficient quality they were mainly cosmetic.

Sikorsky to the rescue

In September, CMTD turned to Sikorsky and the R-BVZ to ameliorate the IRAF's dearth of aircraft by placing an order for the immediate delivery of 10

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[30]Alexander, 267.
[31]Kozlow, 94-96.

IM's. Two models were available at the factory and were dispatched to the front at once. Unfortunately, these initial IM's did not perform well. A combination of poor weather, engine troubles, and their hasty departure with aircrews who were unprepared to handle heavy aircraft led to disappointing results. The commander of IM-1 became so disgruntled that he reported to Stavka that "the flying ship could not maintain the required operational altitude. There were," he continued, "difficulties as well with the reliability of the power plants. The aero engines for the Murometsy were regularly serviced and, with each of the many breakdowns, given a thorough inspection, but to no avail."[32]

This pilot, however, was not skilled at flying heavy airplanes and his attitude reflected the general belief that the IM's were "abnormal" machines, inherently inferior to light aircraft of French make. "It could be argued," writes K. N. Finne, "that if the commander of the IM-1 had been more sympathetic to Russian-built aeroplanes than to so-called 'regular' types--that is, French-designed flying machines--those shortcomings of the IM-1 that he pointed out in his telegram certainly could have been eliminated." Ironically, the poor engine performance could be attributed, in part, to the French Salmson radial engines that were used in lieu of the German Arguses, which were in short supply once the war began. The Salmsons, although of greater power, were temperamental and far less efficient, seldom produced their rated 200 horsepower, and were therefore detrimental to the IM's performance. Nevertheless, as a result of this critical telegram, Stavka issued a directive stating that "aeroplanes not suitable for military use should not be dispatched to the army and that no new aeroplanes

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[32]Finne, 65.

be ordered from the Russo-Baltic factory, and that existing orders be considered void."[33]

This directive posed a potentially crippling blow to R-BVZ and to the Russian war effort. If Stavka's order was obeyed, Russia's most prolific aircraft manufacturer would have been shut down, thereby eliminating a significant amount of production that the IRAF desperately needed. But Shidlovskiy, the R-BVZ's CEO, being a shrewd businessman and patriotic citizen, appealed directly to War Minister Sukhomlinov and, in turn, to Tsar Nicholas to revive the IM contract. He admitted that the failure of the initial IM's was due to their limited performance, but he also outlined the inexperience and unfamiliarity of the crews in handling heavy machines. Shidlovskiy went on to recommend that new IM's, then being redesigned by Sikorsky and his engineers, not be ordered until their military value was demonstrated, and that a separate unit, the "Squadron of Flying Ships" (Escadra Vozdushnykh Korablei, EVK) be organized under his command to ensure adequate training of crews and proper employment of the heavy machines.[34]

Sikorsky, although disheartened by the events, was not surprised, for he knew that the dispatched IM's might prove ill-suited for combat. "At that time," he wrote, "none of my ships had participated in military flights. I realized that the huge planes with roomy cabins, but with slow speed and limited altitude, would not be successful for actual war purposes."[35] Upon gaining Shidlovskiy's approval, he set out to develop the Ilya Muromets, type V (Veh), the world's first aircraft designed expressly for long-range reconnaissance and bombardment. It was essentially a modified version of the Ilya Muromets Kievskiy, "not as large

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[33]Ibid., 57, 67-68.
[34]Sikorsky, 125-126.
[35]Ibid., 119.

and lighter, and it had a much smaller fuselage, and one single cabin properly arranged for bombs and military equipment."[36]

The new bombers were built at a frenetic pace:

> With the factory operating twenty-four hours a day in three shifts, with the engineering department working indefinite hours, practically as long as men could efficiently stand it, the construction was pushed ahead at full speed. . . . The plane was designed, and several structural and aerodynamic tests were completed; then the ship was built, transported to the airport, assembled, checked and finally test flown. From the time I received the order to start the preparation of drawings to the day when the new 'Ilya Muromets V' made its first flight, exactly seven weeks went by.[37]

The new machines were capable of carrying 3,300 pounds of bombs, 20 miles per hour faster than the previous models, to an altitude of 11,480 feet, almost twice as high.[38]

That same October, Shidlovskiy had also directed Sikorsky to begin work on a new light reconnaissance plane to replace the dated S-10 and S-11. Because the unexpected redesign of the IM was Sikorsky's foremost concern, he delegated control of the project to G. I. Lavrov, a lifelong friend and courageous crewmate on the Kiev flight. A gifted inventor and skilled aviator, Lavrov would serve as chief of the design team and primary test pilot. The head of the Aeronautical Section's technical bureau, Anatoliy Anatolevich Serebrennikov, worked with Lavrov as chief engineering assistant. Serebrennikov and Sikorsky had been classmates at the Kiev Polytechnic Institute, members of the Kiev Association of Aeronautics, and had worked together to create Sikorsky's early

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[36]Ibid.
[37]Ibid., 122-123.
[38]Ibid. Finne, 188.

successful light aircraft, the S-6b and S-10. This talented team would create Russia's most capable light aircraft, the S-16 fighter.[39]

For the design, Sikorsky prepared only a sketch of the general views and the basic arrangement, estimated the weight distribution, and outlined some of the primary parts of the new machine. With this information, Lavrov's staff completed a detailed design study. The team was influenced by the recent success of the English Sopwith "Tabloid," which had won the "Schneider" Cup at Monaco and was used by the Royal Naval Air Service during a bombing raid on German airsheds in Cologne and Dusseldorf. Its speed was especially attractive, and the team no doubt thought that such an aircraft would have been useful against the Germans in East Prussia.[40]

The "classic" aircraft of the Tabloid type--a small, light, single-strut tractor biplane with two pilots seated tandem in a narrow cabin--influenced the design of aircraft in many countries for many years. The S-16 evolved from knowledge of this aircraft coupled with the team's experience designing the earlier "S" series light biplanes. In fact, the S-16 differed from the last modification of the S-10 primarily in size only and improved upon the Tabloid design by increasing the payload, restructuring the chassis to eliminate the drag-inducing skids, and employing ailerons instead of wing warping for lateral control. The S-16's Oregon spruce frame with steel pipe reinforcements at critical junctures also improved its ruggedness and an aluminum and Plexiglas cowling protected the pilot from castor oil that inevitably sprayed from the whirling rotary engine.[41]

The construction of three prototypes began as early as November, but the R-BVZ's Aeronautical Section soon encountered other, more serious problems.

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[39]Mikheyev, 6-8.
[40]Ibid.
[41]For a complete technical description of the S-16, see Mikheyev, 21-34.

The war interrupted shipments of the French Gnome-Monosoupape 100 horsepower engines, threatening production of the S-10's and S-11's on order for the army. Because 80 horsepower Gnomes were more readily available from the Moscow plant, R-BVZ decided to design the S-16 for use with this engine. During the interruption in production of S-10's and S-11's, they believed, the S-16 project could be completed and production begun, thereby eliminating the delay in the delivery of aircraft to the army and providing a more capable aircraft in the process. Despite the moratorium against new orders for R-BVZ aircraft, Shidlovskiy sent a proposal to CMTD suggesting that the previous order be amended to replace the S-10's and S-11's with a corresponding number of S-12's and S-16's equipped with Russian-made Gnomes. Given the magnitude of the emergency in the army, the change was likely to be approved.[42]

Meanwhile, R-BVZ learned that Tsar Nicholas had agreed to Shidlovskiy's earlier proposal to create the EVK, the world's first formation of strategic military aircraft. On Christmas Day, all available IM's were assembled at Yablonna airfield, just north of Warsaw, with Shidlovskiy, breveted a Major General, as commander and Colonel V. F. Naidenov, a professor from the Nicholas Military and Engineering Academy, as his deputy. Sikorsky also set out for Yablonna to assist with the goal of creating an effective combat unit and reclaiming the lost glory of the flying ships. R-BVZ-built light aircraft were collected from units throughout the IRAF, along with pilots who were to be trained for dual-qualification in both light and heavy machines.[43] The TO's allowed Shidlovskiy to assemble two pilots, an artillery officer, a flight sergeant-major, one junior

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[42]Mikheyev, 9.
[43]Ibid. Finne, 71-72.

mechanic, and 20 soldiers for each Muromets.[44] This diversion of resources from the already strapped IRAF encountered fierce opposition.

Grand Duke Alexander, now the Field Inspector General of Aviation, could not believe that precious pilots and planes were reassigned to support a squadron of "abnormal" heavy machines of no military value. Furthermore, the appointment of Shidlovskiy, a civilian and CEO of the firm that manufactured the aircraft under his command, raised suspicions of the EVK and created allegations of corruption.

Many of the pilots transferred to the unit simply refused to fly the Murometsy. They "had already accumulated experience flying small aeroplanes," K. N. Finne explains, and "considered themselves to be an elite in the world of Russian aviation and authoritative spokesmen on all matters related to aviation. . . . they were asked to undergo new training in the war emergency, to be transferred from positions as instructors at Gatchina to the status of cadet-trainees under the overall supervision of a civilian. All of these circumstances, as might be expected, bruised their egos." Moreover, they "doted on foreign aircraft and expressed disdain for indigenous flying machines. . . . Their continued preference for small aeroplanes led to their absence from training sessions at the 1st Aviation Company aerodrome, where the Murometsy hangars were located. Eventually these pilots completely withdrew, switching to single-engine aeroplanes."[45]

Thus, the EVK came into being under the most challenging of circumstances and without the support of the IRAF. Stavka, if supportive, could do little

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[44]Kozlow, 96-97.
[45]Finne, 61-62.

to help given the EVK's remote location and Stavka's preoccupation with a myriad of other military problems. The EVK was on its own.

Conclusion

During 1914 Russian aviation flew at grand heights with Sikorsky's triumphant St. Petersburg-Kiev flight, then abruptly crashed to the earth with the start of the Great War. What initially appeared as a potent force was quickly consumed by the ravages of battle. The unseen chinks in the armor of Russian aviation became gaping fissures that desperately needed to be filled. The General Staff and CMTD had not, indeed could not, prepare the air service for the needs of war because the technical complexities of military aviation were still unfamiliar. As a result, Russia's air service was ill-prepared for battle. Internecine rivalries hindered prewar planning and alienated the wartime IRAF from the General Staff. And, within the air force itself, a schism separating light and heavy aviation nearly aborted the birth of what would be Russia's most important military aviation unit, the EVK. It also became painfully obvious that domestic aviation production was insufficient to meet the needs of the IRAF.

War taught Russia, along with the other belligerents, that the airplane was essential to military operations as a reconnaissance and observation tool and that it might play an important role as an offensive weapon in the future. But, until Russia could produce sufficient numbers of quality aircraft at home, she would remain unable to exploit the air weapon. At the end of 1914, the IRAF, still dependent on French imports, needed to foster domestic production. The R-BVZ offered a solution with its Ilya Muromets and S-16 biplane, but the IRAF remained reluctant to take it.

FOUR

1915

In 1915 the fortunes of the IRAF declined. The army's defeats of 1914 coupled with the "Great Retreat" of 1915 left Grand Duke Alexander scrambling to rebuild his air force. Because no clear-cut procurement policy was in place during the first five months of war, a mere 300 aircraft had been haphazardly ordered in groups of one to 30, often at the initiative of individual units that desperately needed machines. To rectify the situation, Alexander presided over a series of conferences to coordinate aircraft production based on projected needs. As a result of the first three conferences, which met in Moscow on 22 February, in Kholm during July, and in Petrograd on 17 September, the IRAF requested and CMTD ordered 1,472 aircraft from Russian manufacturers.

At current rates of production, though, delivery could take up to three years. Manufacturers would need to greatly increase production levels and improve on current designs to ensure the viability of the IRAF. The Aeronautical Section of R-BVZ, renamed Avia-Balt in May, possessed advanced machines but deliveries were slow. The large, complex Ilya Muromets could not be built quickly until CMTD agreed to finance serial production. And the S-16, although of great potential, was still in its developmental stages. Deliveries were also delayed by interruptions in supply shipments from abroad and, of even greater

significance, by the paucity of aero-engines. Without engines, aircraft delivered to the IRAF as a result of Alexander's procurement conference would be of little value.[1]

The "motor famine"

Throughout the development and delivery of the S-16 Russia faced a crippling shortage of aero-engines. In January, the first experimental model, No. 154, was delivered without an engine to Reval (Tallinn), where Lavrov was stationed with the IRN. To conduct flight testing, he borrowed one of the navy's Rhone-80 rotary engines intended for use on a Malyutka trainer. The Rhone was considered a good substitute for the obsolescent Gnome, which was first produced in 1912. It was more reliable, consumed less fuel and oil, and its design provided a greater range of throttle control, eliminating the need to shut down the engine during flight and on the approach for landing. The Moscow Gnome plant was scheduled for conversion to manufacture the Rhone; but, at that time, they were still imported from France and were therefore scarce. Lavrov was pleased with the engine's performance, but February snows interrupted testing as the experimental S-16 was not equipped with skis.[2]

In March, as part of the EVK's consolidation effort, Lavrov and his S-16 were transferred to the airbase at Yablonna; the navy retained its valuable Rhone. Shidlovskiy ordered the next two experimental S-16's, Nos. 155 and 156, also be dispatched to EVK. They arrived on the sixth and nineteenth,

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[1]The procurement conferences are discussed in detail in Kozlow, 113-119.

[2]Mikheyev, 9, 29, 8.

respectively, along with additional IM's, S-10's, and S-12's. All of these machines were delivered without engines.[3]

Eventually, Shidlovskiy was able to acquire three aero-engines at the central warehouse, taken from supplies intended for Farman trainers. Two were Gnome-80's and were fitted to aircraft Nos. 154 and 155. The third was one of the first Russian Kalep 60 horsepower aero-engines, mounted on No. 156. Although durable and more reliable than the Gnome, the Kalep's lower power necessitated alterations to its S-16. During development, Sikorsky refined his efficient airfoil and modified the wings of Nos. 155 and 156. These did not possess the slightly arrowshaped backward slant of No. 154, but instead were straight with a distinct V-shape upward slant. To compensate for the Kalep's power deficiency, he further modified No. 156 by lengthening the span of the upper wing to over 10 meters (32.8 feet), resulting in a four and half square meter (48.4 square feet) increase in surface area. To improve maneuverability, Sikorsky removed the ailerons from No. 156's lower wing and enlarged them on the upper. These alterations became standard on subsequent S-16's and its characteristic "1½ plane," or sesquiplane, configuration made it distinct from pure biplanes.[4] This feature would later become famous with the success of the French Nieuport 27's and 28's.

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[3]Ibid., 9.

[4]Ibid., 9. TsGVIA, f. 369, op. 8, d. 72, ll. 13, 14, 18-22, 25; d. 54, ll. 4, 6; f. 493, op. 4, d. 414, ll. 304-305; f. 2003, op. 2, d. 623, ll. 38, 41, 121, 125; op. 3, d. 628, l. 169; f. 2008, op. 1, d. 47, l. 34. Kostkin I. M. Zapasnya knizhka 1917 g. (Nauchno-memorialnyy muzei N. Ye. Zhukovskovo). Cited in V. B. Shavrov, Istoriya konstruktsii samoletov SSSR do 1938. 3-e izdaniye. [a history of aircraft design in the USSR for the period before 1938. 3rd edition.] (Moscow: Mashinostroyeniye, 1969, 1978, 1985) 184.

Although the inadequate supply of aero-engines forced Sikorsky to make alterations that ultimately improved the S-16's performance, it also delayed delivery. If delays continued, the S-16's sophistication would be for naught. The pace of technological advancement in aviation was becoming so rapid that successful designs were often antiquated within a year.

The Ilya Muromets suffered from the lack of quality engines as well. Because Sikorsky could no longer obtain German Arguses, he resorted to French Salmsons and British Sunbeams, which were largely unsatisfactory.[5] The situation became so desperate that R-BVZ designed and produced its own 150 horsepower six-cylinder in-line aero-engine to ensure adequate performance and availability. Kireyev, the creator of the R-BVZ-6 engine, had worked as an engineer in Germany prior to the war and put this experience to good use at the R-BVZ's Riga plant. The R-BVZ-6 easily outclassed the Salmsons and Sunbeams and rivaled the performance of the favored Arguses. Four were installed on IM-2 in August and during flight testing the engines performed flawlessly, powering the flying ship to an altitude of 3,450 meters (11,316 feet) with a load of 820 kilograms (1,804 pounds). On another flight, IM-2 carried a huge 400 kilogram (880 pound) bomb during a ballistics and munitions test. Unfortunately, the German army advanced to within striking distance of Riga, forcing the evacuation of the factory, and only five motors were delivered to EVK as a result.[6] Nevertheless, by carefully husbanding the valuable Arguses, Sikorsky was able to prove the worth of the IM bombers.

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[5]One cause for the ineffectiveness of the Sunbeams was a lack of spare parts and mechanics trained to repair them. See note in Finne, 121.

[6]Finne, 103, 105, 120.

The EVK

On 27 February the first military Ilya Muromets type V, called IM-Kievskiy, flew the EVK's first combat mission under the command of Captain G. Gorshov and copiloted by Lieutenant I. S. Bashko. Throughout the spring, IM-Kievskiy and IM-3 flew many long-range reconnaissance and bombing sorties in East Prussia. On 9 and 10 March, IM-Kievskiy destroyed a railroad station, several aircraft hangars, and a group of horse-drawn carriages at Willenburg and photographed troop concentrations at Mlava. Raids on the 19th and 20th of April ruined the marshaling yards at Mlava and Sol'dau and destroyed the Sanniki aerodrome. Another successful mission on the 24th wrecked Neidenburg's railroad station.[7]

These, and other effective missions, quickly caught the attention of army commanders and the attitude toward Shidlovskiy's squadron abruptly changed. In the face of the army's disastrous defeats and the ensuing retreat, the success of the EVK was a welcome development and the services of the IM were greatly sought. The Headquarters Staff of the Russian First Army, especially satisfied with the destruction at Sol'dau, telegraphed the following to the Field Inspector-General of Aviation:

> The IM-Kievskiy made six flights, ordered by the staff of the First Army. These flights consisted not only of reconnaissance work, but also of the mission to destroy railroad stations. The resulting reconnaissance information was highly valued, owing to the convenience of observing and taking photographs of each targeted enemy area. According to our information received from secret agents, the bombing of the railroad stations was met with great success. It was the experience gained from the first flight that demonstrated that aeroplanes of this type could be efficient both in reconnaissance and in bombing operations. The flights were nor-

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[7]Ibid., 75-85.

> mally conducted at an altitude of 3,200 meters [10,500 feet] and took four and one half hours to complete. We surmise that aeroplanes of this type, regarding their flight characteristics, deserve encouragement and their future actions depend entirely on how well they are staffed with experienced pilots.[8]

The Northwestern Front commander too, after having refused to accept IM-2 on 27 March, requested that Stavka inform him "whether it would be feasible to assign an Ilya Muromets of the Kievskiy type to the Northwestern Front." Stavka, mindful of the tension between light and heavy aviation within the IRAF and desirous of having direct control over the EVK, removed the unit from the command of the Field Inspector General of Aviation and placed it directly under its own supervision. This, naturally, raised the ire of Grand Duke Alexander but ensured that the Ilya Muromets would be properly provided for and effectively employed.[9]

The German army responded to these raids as well. K. N. Finne reports that "useful military flights similar to [these] became more frequent resulting in much greater attention being paid by the adversary to our ships." Alarmed by the lethal attacks, the Germans reinforced their defenses at Willenburg, Mlava, Sol'dau, and other points in East Prussia. Places that at one time had no air defenses now bristled with anti-aircraft artillery. Hindenburg's air forces also conducted their own raids against the airbase at Yablonna and "more efforts were made by squadrons of German pursuit planes to bring down a 'Muromets.'"[10]

The bombers, though, were formidable opponents. They were rugged and well armed and, with the fire-retarding fuel tanks that Sikorsky developed in

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[8]Ibid., 80. Sikorsky, 129.
[9]Finne, 79-80.
[10]Ibid., 84.

response to the German pilots' use of incendiary bullets, proved almost impossible to shoot down.[11] Nevertheless, the two operational IM's could not be expected to survive for long, and they were too valuable to be frivolously thrown into perilous air battles or be destroyed in their hangars. The EVK needed a fighter to defend its airbase and to escort its bombers.

The S-16

Extensive flight testing of the three experimental S-16's progressed quickly, and their operational use as trainers began at the EVK's pilot school during the summer. Overall, the response was good. The "Sikorsky Jr.," as the EVK's pilots affectionately called the S-16, was easy to fly, very nimble, and fast. Its top speed, most likely attained on a special flight-test sortie with minimum payload, was an impressive 144 kilometers per hour (89.3 miles per hour). The official record lists the S-16 as capable of flying 125.5 kilometers per hour (77.87 miles per hour) and climbing 1,000 meters in four minutes (820 feet per minute).[12] By comparison the highly touted Nieuport 11 "Bebe," France's first fighter aircraft, flew at 115 kilometers per hour (72 miles per hour) and climbed only 664 meters in four minutes (544 feet per minute). Germany's Fokker Eindecker, the scourge of the western front, also suffered by comparison to the Sikorsky S-16.[13]

Many pilots from units throughout the IRAF examined the S-16 and were favorably impressed. Staff officers from Stavka, members of the Tsar's family, and numerous international delegations visited EVK to familiarize themselves

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[11]Sikorsky, 132.
[12]Mikheyev 9.
[13]Jane's Fighting Aircraft of World War I (New York: Military Press, 1990).

with Sikorsky's celebrated Murometsy and agile biplanes. During these visits, Shidlovskiy was questioned about the origin of his nimble aircraft and about the acquisition of additional machines for both the EVK and the IRAF. He could only answer that CMTD had not agreed to substitute the S-10 order with S-16's, but instead renegotiated for four Murometsy. The expected new contract for S-16's did not materialize. As a result, the three S-16's at EVK, which were the private property of Avia-Balt, were the only models in existence.[14] Yet, despite this inquiry and dismay at CMTD's demurral, Stavka did not take action to secure a contract.

Only after Shidlovskiy's repeated petitions did Stavka inquire at the War Council regarding the delayed order of S-16's. In a telegram dated 11 August, Stavka stated:

> In view of the necessity for small machines for the execution of some tasks and the training of EVK aircrews, to the table of organization is introduced 12 aeroplanes [light]. Part of these machines are actually available at EVK. However, they compose, it appears, the property of Wagonbaltic [Avia-Balt]. In view of the desire of the majority to have the Sikorsky machine S-16, about which the pilots petition, kindly instruct about the acquisition of wanted machines and the supply of others.[15]

The War Council sent a corresponding letter to CMTD. Shortly thereafter, on 21 August, Avia-Balt received a proposal from CMTD introducing the terms of a contract for the order of 18 S-16 aircraft--12 to fulfill the requirement of the EVK's new TO and six to "replenish normal loses." The Executive Commission of the Separate Conference for State Defense approved the terms and contract number 24130 became official on 24 October. Avia-Balt agreed to deliver eighteen S-16's along with parts kits for each aircraft plus three additional

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[14]Mikheyev, 9.
[15]Ibid., 9-10.

complete parts kits, which were essentially unassembled aircraft. On 4 October the three prototypes already at EVK made up the first three contracted machines and the remainder were to be delivered according to the following time-table: four aircraft and seven parts kits by 4 November, and the remaining 11 aircraft and 14 parts kits by 4 December. Avia-Balt was also required to pay all expenses for packaging, delivery, and possible repairs due to breakage during shipment. These were tough terms, but Avia-Balt was happy to have a contract.[16]

For its part, CMTD was responsible for supplying Rhone-80 or Gnome-Monosoupape-100 aero-engines and airscrews and agreed to pay Avia-Balt 9,500 rubles ($19,000) for each aircraft, 4,500 rubles ($9,000) for each parts kit, and 7,300 rubles ($14,600) for each complete parts kit. Avia-Balt received an advance of 25% of the contract cost to launch production and 25% more for the purchase of raw materials. In September, production began on S-16's numbered 201 through 215.[17]

Avia-Balt's order of 18 machines was small by comparison to orders received at other Russian aircraft manufacturers. Orders placed at Duks, Lebedev, and Shchetinin, for example, numbered in the hundreds as a result of requests made by Grand Duke Alexander's special conferences. These orders, of course, were for French models, primarily Voisins and Parasols, that were favored despite their obsolescence.[18]

During the Petrograd conference, the IRAF decided not to open new factories for fear of spreading technical personnel too thinly. Opening new factories, they feared,

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[16]Ibid., 10.
[17]Ibid.
[18]Kozlow, 114-119.

> would have the effect of diminishing production in the already well established factories, which would be occasioned by the change in the technical personnel of these by the transfer of this personnel to the newly established factories and which, with the shortage of skilled engineers and mechanicians, and in view of the general shortage of material, both in Russia and on the foreign market, would be likely to slow production of aviation equipment and to turn out planes of an inferior quality.[19]

Ironically, by limiting the expansion of the aero-industry, they believed, production could be increased. Given the IRAF's request for a new order of 900 aircraft, production would have to increase.

Current reports showed that the IRAF was still terribly under strength. Its 49 squadrons, for example, had 49 Voisins and 90 Moranes where there should have been a force of 189 Voisins and 117 Moranes--167 machines short. The conference also called for an additional 33 squadrons in 12 new divisions to match the army's planned expansion. Assuming 50% wastage, the conference estimated a shortage of 557 aircraft by 1 September 1916.[20] Meeting this great demand would require a tremendous amount of growth in industry. If new factories were not to be opened, existing factories would need to be utilized to their fullest and orders not limited to a few major producers as had been the case thus far. Smaller firms, like Avia-Balt, could no longer be neglected.

However, Avia-Balt found it difficult to deliver its meager order of 18 machines. Most of the factory's resources were allotted to production of Murometsy; and, because the light aircraft section had never benefited from capital investment that accompanied War Department orders, the assembly line was still little more than a workshop for building experimental aircraft. Coupled with this, Avia-Balt encountered great difficulty obtaining shipments of

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[19]Ibid., 122.
[20]Ibid., 123-124.

manufactured and semi-finished materials (steel and brass pipe, sheet metal, wheels, bolts, etc.), many of which were delivered from abroad, principally Sweden. To overcome this problem, Sikorsky and his assistants urgently adjusted production to manufacture these materials at Avia-Balt.[21]

Delays were aggravated even more by the diversion of aero-engine shipments to Archangel. The German autumn offensive into Serbia severed supply routes from Salonika, forcing the Allies to reroute their shipments to the north. An early freeze, though, required unloading at Alexandrovsk, on the Murmansk coast. Because the railroad had not been continued to this northern port, the shipments were placed in storage and for months, until spring thaws allowed delivery, valuable aero-engines sat in crates. This delay rippled through the IRAF's supply network, preventing CMTD from providing Gnomes to Avia-Balt on schedule.[22]

The same poor weather interrupted the delivery of the first S-16 to EVK. During a test flight of aircraft No. 206, the pilot was unable to land safely due to strong, gusting winds. During the crash landing, the aircraft and engine were severely damaged, requiring repairs that were not complete until March 1916. To complicate matters further, Lavrov was sent to the front, leaving the factory without a test pilot. According to the letter of the contract, Avia-Balt was obligated to conduct flight testing with its own pilots and at the factory's expense. Citing this rule, CMTD refused to provide test pilots to help during Lavrov's absence.[23] As a result, finished aircraft stood idle in a factory hangar at Petrograd, awaiting testing.

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[21]Mikheyev, 10-11.
[22]Golovine, 150.
[23]Mikheyev, 11.

Amid these difficulties Avia-Balt's director, M. F. Klimikseyev, made every effort to accelerate construction. During a temporary shutdown of the Muromets line for modifications, all of the primary workers were transferred to the assembly of S-16's. The factory worked overtime, on weekends, and during holidays, but to no avail. A succession of strikes negated these efforts and by the end of November, it became evident that only four of the fifteen ordered aircraft would be completed (Nos. 206 through 209). Klimikseyev was forced to request an extension from CMTD, which it granted, accompanied by the requisite forfeiture of payment.[24]

Russian fighters

During these delays, it became more apparent that EVK desperately needed fighter aircraft. On 19 July 1915, IM-Kievskiy was jumped by 3 Brandenburg two-seaters that relentlessly assaulted the flying ship. After repeated passes, the German gunners pierced the fuel tanks and knocked out both port-side engines. As IM-Kievskiy limped back across the front-line to safe territory, both starboard engines died from fuel starvation, leaving the huge aircraft without power. Despite severe wounds to the head and leg, Captain Bashko was able to perform an emergency, engine-out landing in a boggy pasture just outside Kholm.[25] The bomber and crew were saved, but this close call made it clear that the IM's needed fighter protection. The S-16 would no longer be used as a reconnaissance or training aircraft, but instead was

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[24]Ibid.
[25]Finne, 94-96.

designated as a fighter, "for the defense of flying ships against attacks by the enemy air force."[26]

One of the primary promoters of creating a fleet of fighter aircraft was IRN Lieutenant G. I. Lavrov. His experience with the IRN and the EVK had taught him that Russian military aviation needed to become more aggressive, both to defend its bombers and observation aircraft and to deny German planes the freedom to perform these tasks as well. Russia needed to secure command of the air. To this end, he submitted a series of proposals urging the formation of fighter squadrons. By the end of the year, the EVK received authorization to create its own fighter squadrons composed of four S-16 fighters, four scouts, and six trainers each, to be augmented by two or three additional aircraft, supplies permitting.[27]

Lavrov had also been busy in EVK's craftshop working on a project to arm the nimble S-16. To make it a true fighter, the S-16 needed a machine-gun that could fire forward, through the propeller arc. In 1913, 1st Lieutenant Poplavko, and in late 1914, Engineer Smyslov and Lieutenant-Commander Victor V. Dybovski had done earlier work to develop a synchronization gear. Dybovski later traveled to England and designed, along with Warrant Officer F. W. Scarff, a gear used on Sopwith 1½ strutters and a successful machine-gun ring mount. Lavrov's design of the fall of 1915, though, was the first Russian design to be successfully tested. His gear was adapted for use with the highly regarded English Vicker's 7.71 millimeter heavy machine gun, capable of firing 600 shots per minute. Testing was completed at the Pavlovski Military Academy shooting range in Petrograd, and on 1 December, the Ministry of Trade issued Avia-Balt a

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[26]Mikheyev, 11.
[27]Ibid.

patent for the device. Immediately, CMTD placed a large order for mass production and required that all S-16's be armed with the Lavrov synchronizer.[28]

Meanwhile, the IRAF, also aware of the need for fighter aviation, formed its own fighter squadrons. A "fighter detachment" had existed earlier that spring when a special squadron was quickly assembled for the defense of Warsaw. But this was more an act of desperation than a conscious effort to exploit the air weapon. However, by winter, two of the IRAF's most capable and airminded pilots, Ye. N. Kruten and I. A. Orlov, like Lavrov, were calling for the creation of fighter squadrons to gain air superiority. Their call was heeded; and, shortly after the new year, Grand Duke Alexander ordered that fighter aircraft be added to the ranks of each squadron.[29]

During the Smolensk conference of 21 and 22 November, the IRAF finally realized that the aircraft being supplied to squadrons were inadequate. Current models in use were hopelessly slow, unable to exceed 110 to 115 versts per hour (73 to 76 miles per hour).[30] The S-16, however, with its great speed and synchronized machine-gun, posed a serious threat to enemy airplanes and was, therefore, very attractive to the new, fighter-conscious air force. Unfortunately, none were ready for delivery, and the EVK claimed all of the few under production.

Moreover, the Smolensk conference refined the projected requirements determined at the Petrograd conference and called for an expansion to 77 squadrons with 600 airplanes by 1 April 1916. Figuring a lower, and historically correct, attrition rate of 37 percent, the IRAF anticipated a shortage of 629 planes by 12 June 1916. And, considering that shipping delays and material

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[28]Ibid., 11, 32-33. J. Alexander, 149.
[29]Jones, 24. Ribalka, 36.
[30]Kozlow, 108.

shortages might impede the actual delivery of more than 1,000 planes, it would be necessary to supply 2,000 machines to the front from 1 June 1916 to 1 June 1917.[31] Orders were placed accordingly, but it remained doubtful that they could be met, despite the deliberate calculations of the Grand Duke's conference.

Conclusion

The Russian air force survived 1915 surprisingly well. Despite the dire circumstances it regrouped and was better organized than the year before. Poised for expansion in 1916, it anticipated the arrival of more potent fighter units. In many respects, Russia's exploitation of the air weapon proceeded at a pace comparable to the west's. The EVK's success as a strategic bombing and reconnaissance unit would not be matched until Germany's response in 1917 with Gotha bombers, and the development of fighter aviation paralleled the rise of France's Nieuport Bebe and Germany's Eindecker.

Without a doubt, the EVK had emerged as the shining star, proving to the world and to her own army that Russian aviation was not hopelessly outclassed. Despite the disruption of several relocations which finally placed their home base at Pskov, the EVK and Sikorsky's flying ships proved their worth. Stavka praised the Ilya Muromets in a telegram to CMTD on 5 November:

> The excellent work of these planes has been attested to by all officers of the army headquarters in whose regions these planes have been employed. A captured German aviator says that the Muromets planes have caused considerable damage in the enemy lines, and that much anxiety and apprehension is being felt in the German army over these planes. . . . The value of this plane is incalculable, and it is only hard to say whether it is of more value for

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[31]Ibid., 116-125.

> use by army headquarters, as an air battery, or as a means for distant reconnaissance.[32]

During combat operations in 1915, the Murometsy flew about one hundred missions, dropped nearly 20,000 kilograms (44,000 pounds) of bombs, and took hundreds of reconnaissance photographs. Convinced of its value, CMTD placed orders for 32 more Murometsy. But, at the beginning of 1916, there were still only nine heavy machines, four for combat operations and five for training .[33]

Limited production capacity remained Russia's singular problem. During the first sixteen months of war Russian firms received orders for 1,970 aircraft, of which only 851, or 43 per cent, were delivered to CMTD. Of these, only 724 were dispatched to the front because of acceptance delays. Of the twelve types ordered, obsolescent Parasols and Voisins remained the favorite of CMTD, despite abysmally low production rates. Only 235 of 535 Parasols ordered at Duks and Slesarenko were completed and a mere 104 of 809 Voisins ordered were delivered from Lebedev, Shchetinin, and Anatra. Although the total industry average output had risen to 55 planes per month, continuing high wastage rates and the demands of the expanding air force had outpaced deliveries. Therefore, the Russian dependence on France persisted. To 1 December, 586 machines were ordered from French firms, 306 of which were delivered.[34]

Russia's aero-engine shortage was even more severe. The seven motor companies in Russian, led by Gnome in Moscow, Lebedev, and Moscow Motor Works, received orders for 1,720 aero-engines but were only capable of producing 472 by 1 May 1916. The production rate, approximately 21 engines

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[32]Ibid., 109-110.
[33]Ibid., 119. Finne, 115. Jones, 25.
[34]Kozlow, 117-118.

per month, had doubled but remained inadequate. As a result, foreign orders remained high, numbering 1,928. CMTD continued its affiliation with French firms, awarding them the lion's share of aero-engine orders, reaching 1,688. The remainder went to English and Italian companies. Poor weather and the Central Powers' blockade, though, limited deliveries to only 544 engines by 1 December.[35] This number, however, was still more than domestic production could achieve. The "motor famine" was a serious problem that severely curtailed EVK and IRAF activities.

The aviation industry needed to continue its growth if the Russian air force was to meet its expectations for 1916. The EVK required a much larger fleet of IM's for it to become a truly formidable and militarily significant bomber force. And fighter aviation, both in the EVK and IRAF, meant little on paper or in the minds of men unless the units received a sufficient number of machines. In 1916, high hopes for the S-16, the world's most capable fighter, would remain only hopes until production made them a reality.

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[35]Ibid., 120.

FIVE

1916

In many regards, Russian aviation came of age in 1916. The IRAF, tempered by a year and a half of difficult, desperate fighting, had learned the tough lessons of modern warfare. The organizational, administrative, and doctrinal changes that the IRAF implemented during the course of the year indicated a growing maturity that was not unlike the developments of aviation in the west. And yet, the glaring problems that were revealed in 1914 persisted. The mobilization of Russia's technical-industrial capabilities, symbolized by the mixed fortunes of Sikorsky's S-16, remained her enduring challenge.

The expansion

In 1916 Grand Duke Alexander endeavored to make the IRAF a true combat force. At the beginning of February he ordered the formation of fighter squadrons equipped with fast, armed aircraft to be assigned to each numbered army. Their purpose was to protect the air operations which had become vital to the army's prosecution of the war, most notably by correcting artillery fire, and to deny enemy aircraft and observation balloons the freedom to do the same. Fighter sections, with two aircraft in each, were also added to the TO's of each

regular corps and army squadron to afford them their own organic fighter escort and air defense capability.[1]

The air force's expansion proceeded remarkably well, considering the disarray wrought by the retreat of 1915. At the end of January, the IRAF possessed 52 squadrons with two divisions: 42 corps squadrons, 8 army squadrons, one field squadron (which was assigned to VIII Army on 23 February), one squadron for the protection of the Tsar's residence, and seven maintenance companies. By mid-year, in preparation for Brusilov's summer offensive, the expansion yielded 25 additional squadrons and ten new divisions, achieving the previous year's goal of 77 squadrons.[2]

To man the new IRAF with skilled aviators, the War Ministry authorized a new training program to improve the quality of training as well as increase the quantity of pilots and observers. Previously, Russian pilot training had concentrated on theoretical course work, stressing principles of flight and aerodynamics taught by Russia's famed aerodynamicist Nicholas Ye. Zhukovskiy at the School of Theoretical Aviation. The new program focused more on the practical phase, affording pilots and observers more operationally pertinent training and more actual flight time. A total of twelve flight-training schools were operating, with Gatchina and Sevastopol as the two major facilities, providing well conceived and demanding courses for pilots, pilot-observers, and engine mechanics.[3]

Recruits flew in a variety of aircraft, primarily Farman trainers, and had to pass a grueling battery of check rides that included high-altitude, cross-country navigation sorties, aerial reconnaissance, and engine-out forced landings. Pilot-

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[1]Mikheyev, 14. Kozlow, 96.
[2]Kozlow, 96.
[3]Hardesty, in Riaboff, 17-19.

observer training, especially, began to assume greater importance reflecting the army's growing reliance on aviation as an effective tool to assist artillery and for reconnaissance. The new emphasis on fighter aviation was reflected by the opening of the School of High Pilotage located at Lustdorf, just outside Odessa. Top pilot training graduates were assigned to Lustdorf to learn advanced flying techniques including aerobatics, formation flying, and gunnery. Other pilots were sent directly to their front line units or to the Baku Maritime School of Aviation for training in floatplanes and flying boats.[4]

The upgraded and specialized training program undoubtedly contributed to the improved effectiveness and aggressiveness of the IRAF in 1916. The demand for aviators, though, remained high and by September the IRAF's 502 pilots and 357 observers were barely enough to maintain minimum manning levels.[5] However, the timely implementation of this program precluded a personnel shortage of the gravity that would plague the western powers, especially England's Royal Flying Corps (RFC), at the end of the year and into 1917. Although the demands placed on aviation in the west were decidedly higher, given the awesome requirements of the battles of Verdun and the Somme, Russia, nevertheless, did a relatively better job of meeting her personnel needs.

It appeared too, that Russia's aviation industry was turning the corner. Of the 1,455 machines sent to the front by the first of May, 961, or two-thirds, were manufactured in Russia. Only 494 were of French origin. The industry had seemingly met the forecasted need for a 600 plane fleet in a satisfactory manner. Even in September, during the terrific demands of the offensive in Galicia, the

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[4]Ibid., and 38, 67. Riaboff's memoir discusses training in detail on pages 37-67.

[5]Jones, 22.

IRAF maintained a fleet of 716 aircraft. This still, however, left few reserves and the quality of the machines remained marginal.[6]

As the IRAF grew in size and improved its effectiveness, its administrative autonomy grew as well. In May, the Grand Duke was appointed head of the Department of Military Aviation and assumed control of all matters pertaining to the air force that the General Staff and CMTD had previously handled. On 24 November, this department was replaced with the office of the General Inspector of the Military Air Fleet of the Supreme Commander in Chief, which gained a higher standing at Stavka and more functional "control of aviation and air navigation of the active army."[7] Grand Duke Alexander's authority expanded from merely an organizational and advisory role to a position of real power, directly responsible for the organization, training, equipping, and employment of the IRAF. Although the IRAF was still subordinate to the army and did not achieve complete administrative autonomy and operational independence that the RFC gained in 1918 when it became the Royal Air Force, its growing organizational status symbolized the increasing importance of aviation to Russian military operations.

The need for fighters

At the start of the year, Russia's attempts to procure a quality machine in sufficient numbers continued. Despite the official pronouncements espousing the employment of fighter aircraft, materiel shortages persisted, undermining the IRAF's exploitation of the air weapon. As late as 4 March, a front aviation

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[6]Kozlow, 119.
[7]Ibid., 100.

inspector complained to his supervisor that "there are no machine guns for light aircraft, only two [airplanes] have armament: one in the XII army, and one in the XI army."[8] With so few armed machines, air combat was still scarcely possible.

In January General Shidlovskiy, also critically in need of fighters for the EVK, became irritated at CMTD's delays in accepting the S-16's. Impatient, he ordered Avia-Balt to dispatch aircraft Nos. 207, 208, and 209 to EVK without waiting for CMTD's official acceptance. The first two were assigned to the EVK's First Fighter Squadron in Zegevold (Sigould), just outside Riga, and No. 209 was sent to the EVK's Southern Fighter Squadron, based at a village near Tarnopol. The two airplanes sent to Zegevold were armed only because Shidlovskiy had ordered that machine guns be reserved especially for the new fighters.[9]

Alarmed by Shidlovskiy's improvisational requisition and concerned at CMTD's indolence, Stavka wired CMTD to encourage action:

> It is necessary to take urgent measures to supply the EVK with the S-16 small machines. Their slow acceptance made it necessary to take to the EVK six [Nos. 154, 155, 156, 207, 208, 209] still unregistered aircraft, two of these are employed at the Zegevold base and in the Tarnopol region two more are occupied in the EVK school for instruction, one [No. 154] already left the line due to storm damage. If unable to organize the release from the factory, grant acceptance authority to the EVK.[10]

Stavka's expressed concern motivated CMTD to accelerate the validation of subsequent S-16's. Between February and March, all of the remaining machines were completed and officially accepted. On 29 March Nos. 214 and 215 were also sent to the First Fighter Squadron. No. 206, after repairs, went to the EVK's

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[8]V. Kulikov, "Strazh Vozdushnik Korablei. [The Guard of the Air Ships]," Modelist-Konstructor (November 1991): 45-49, reprinted in Bulletin of the Russian Aviation Research Group of Air Britain 31/110 (June 1992): 21-25.

[9]Mikheyev, 12.

[10]Ibid.

flight school in Pskov along with No. 212 on 7 April. The delivery of aircraft Nos. 210, 212, and 213, however, was further delayed because of engine malfunctions that seriously degraded their performance. S-16 No. 210 also remained at Avia-Balt for modifications and testing with higher powered Rhone engines.[11]

The models that did see action received enthusiastic endorsements from EVK pilots. When word of the S-16's superior performance reached pilots staffing the IRAF fighter squadrons, a collective cry went out requesting the Sikorsky fighter. The famous Russian ace Captain E. N. Kruten, commander of the Second Fighter Squadron, sent a telegram to Grand Duke Alexander's staff in February:

> EVK Combat Squadron Commander Lieutenant Lavrov wired to me that he has a Sikorsky with a machine gun intended for me, I only need to clear it with the staff. Request permission to receive it as an interceptor, even without a machine gun.[12]

The Grand Duke, though, was already maneuvering to obtain the highly regarded S-16. Ever since the EVK was removed from his command, Alexander had been jealous of Shidlovskiy and anything associated with the Ilya Murometsy. He had repeatedly demanded that Russo-Balt discontinue construction of IM's, deemed a waste of resources, in favor of light airplanes for his own units. Now that Avia-Balt had delivered a capable fighter, he quickly attempted to "cut another juicy piece from the EVK." After receiving a report on 3 February about the S-16 from General Vernander, head of the Aviation Formal Acceptance Commission, the Grand Duke attempted to intercept the assignment of S-16's to the EVK. He demanded that General M. V. Alekseev, Stavka Chief of Staff, grant "permission to send Sikorsky aircraft, which are the fastest, to the

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[11]Ibid.
[12]Ibid., 13.

7th and 11th Armies, since the EVK has not begun regular combat operations [due to relocation to the new airfields]. Otherwise," he warned, "the reconnaissance missions will no longer be possible."[13]

The Grand Duke's demands were supported by General A. N. Kuropatkin, Commander of the Northern Front. Friction between Shidlovskiy and Kuropatkin was also common knowledge. During a visit to the EVK's Pskov headquarters Kuropatkin, although only vaguely familiar with aviation and with no substantial evidence, jealously accused General Shidlovskiy of commandeering all of Russia's best pilots for the EVK. With this in mind, Kuropatkin demanded that the S-16's, which he planned to assign to his squadron at Jacobstadt, be accompanied by EVK pilots to fly them.[14]

Shidlovskiy "exploded" and was "outraged" when he learned of the Grand Duke's scheme. He bombarded Stavka with telegrams, reminding them that the S-16's were to be used only in conjunction with the Murometsy--for training IM pilots, protecting EVK bases, and escorting IM's during bombing and reconnaissance missions. Furthermore, at that time only two of the S-16's were equipped with machine guns, and the use of unarmed aircraft, he declared, "will only cause the unnecessary death and destruction of the personnel and machines, which only recently have been prepared for combat, and are better suited for the future missions." Taking advantage of the Stavka's heightened awareness of the S-16 situation, Shidlovskiy added that it was necessary to replace the deficient Gnome engines with more powerful Rhones, which were available at warehouses in limited supply.[15]

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[13]Ibid.
[14]Finne, 117.
[15]Mikheyev, 13-14.

Alekseev responded in support of Shidlovskiy, forbidding the delivery of S-16's to units outside the EVK, but he also instructed Shidlovskiy to consider the possibility of providing S-16's to the IRAF. Shidlovskiy, who saw this as an opportunity to secure additional military orders for Avia-Balt, accepted the suggestion. On 8 February he wired Stavka, stating that "S-16's armed with a machine gun may become a serious threat to the enemy airplanes. . . . Out of the twelve machines not yet appropriated by the EVK, I would deem possible, without depriving the Squadron of supplying six " to the IRAF, and he suggested retraining IRAF pilots at the EVK school in Pskov. The news of Shidlovskiy's agreement was immediately relayed to Grand Duke Alexander, who also agreed, but haughtily denied that retraining was necessary, saying that "any moron can fly a Sikorsky." (Sikorsky took this comment as a compliment to his design.) On 11 February Stavka issued the order transferring six completed S-16's to Alexander's command.[16]

Operations

By that time the pilots of the IRAF had earned an unflattering reputation among their colleagues across the front lines. Hans Schröder, a German pilot fighting on the Eastern Front, recalls that "the Russian airmen were not obstinate fighters." For the most part, German and Austrian pilots performed their missions with complete impunity; and, if they encountered a Russian plane, it would make a hasty retreat. With the notable exception of bombing missions, the IRAF was decidedly unaggressive. The following passage from Schröder's memoir does not speak well of the Russian air force:

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[16]Ibid.,114. Kulikov, 45.

> We devoted the next few flights principally to artillery reconnaissances, our mission being to discover and photograph the Russians' new battery positions, to harass the Russian airmen when they were at work and to make as much a nuisance of ourselves as possible to the enemy's artillery. I should have been more interested in directing our own artillery fire, but got no chance of doing so. Our Russian colleagues were continually bombing Weesen, a place to the south-west of Livenhof, and I was instructed to take off on a defense flight. We were hardly above Weesen before a Russian loomed up on the horizon, and this time he was a genuine one, but as soon as he recognized us, he went into a turn and made off as quickly as he came. Half an hour later a second one did a similar bolt; I did not get a single shot in, but took my revenge by bombing a Russian battery at Wumber when I saw it firing. . . . I had my first air fight with one of these Russian colleagues a few days later. He tried to get away, and I fired burst after burst at his two-seater as it went down, but the machine crossed the lines in a steep glide and finally vanished from our view. . . . it was apparent to us that the Russian airmen were no fighters. . . . There came a time when we were practically all day in the air and only flew home for fresh supplies and petrol. We got most excellent results from the mortars, and often I was so delighted that I transgressed strict rules by wirelessing down in plain: 'Bravo, Jolas! Direct hit!" . . . Occasionally we heard bullets rattling about our ears, as in Courland; then there would be a brief encounter with some Farman or Nieuport. But when Kessler gave them a series of bullets from the forward guns, intermingled with a few of the tracers which were the latest invention at that time, they made off at once.[17]

The Russian pilots, flying inferior machines often without machine guns, usually had no choice but to avoid a fight. Besides, it was better to save the aircraft and crew than foolishly engage the enemy with little hope of victory.

Alexander hoped to correct this impotency with the reforms put in place at the start of the year. The new training program would take time to bear fruit, but better airplanes equipped with synchronized machines guns were available

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[17]Hans Schröder, A German Airman Remembers, trans. Claud W. Sykes (London: Greenhill Books, Lionel Leventhal Ltd., 1986) 39-40, 65.

immediately, albeit in small numbers. But, at that time, any number of armed fighters would improve the effectiveness of the IRAF.

The Grand Duke readily accepted six of Shidlovskiy's S-16's and immediately assigned the first one available, No. 205, to Lieutenant Konstantin Konstantinovich Vakulovski, who would soon become one of Russia's aces. On 17 March No. 205, especially equipped with a superior Rhone-80 engine and a Vickers machine gun, was delivered from Petrograd to Kreuzburg, where Valukovski's 33rd Corps Squadron was stationed. The squadron's commander, Staff-Captain Zaborovski, officially received the fighter on 26 March, and the following day the aggressive Vakulovski tested the new fighter in actual combat. He speedily intercepted and promptly shotdown a German scout over Kreuzburg-Kokenhausen. Unfortunately, he would not repeat this victory. During the next flight, a reconnaissance sortie on 2 April, Vakulovski was shot down by friendly fire over Schtockmannshof. The Russian artillery battery, confusing the unfamiliar machine with Germany's Fokker biplane, fired upon Vakulovski's S-16 with deadly accuracy . The third shell exploded directly beneath the plane killing the engine and damaging the aileron control cables. Vakulovski was momentarily knocked unconscious by the blast but recovered and, despite the damaged ailerons which induced an uncorrectable left bank, glided to a safe landing in a nearby swamp. Dazed and confused, he was retrieved from the bog by a Cossack cavalry unit; and his prized machine, which suffered a broken propeller and fractured struts during the forced landing, was unceremoniously dispatched for repairs to the regional maintenance company. The sudden rise and even more rapid fall of S-16 No. 205 was unfortunate but

appropriate, for it was emblematic of what would befall the rest of Sikorsky's fighters.[18]

Alexander assigned the remaining S-16's to the VII and XII Armies to comprise the first two Russian fighter squadrons. The XII Fighter Squadron was commanded by an old friend of Sikorsky's, Junior Lieutenant Max German von Lerhe. His unit received S-16's No. 203 and 211 on 22 March. The VII Fighter Squadron, stationed at Kiev, was led by Junior Lieutenant Ivan Alekseevich Orlov, an outstanding pilot and air theorist, and recipient of the St. George Cross.[19]

Orlov received aircraft Nos. 201, 202, and 204 on 19 March, and a number of the first Russian-made monoplane fighters, the Mosca MB, manufactured in Moscow. The VII was the first unit to employ Russian biplanes and monoplanes together. Under Orlov's command were several other experienced pilots including Jr. Lieutenant Bychkov, Ensigns Sergei Matveevich and Yuri Vladimirovich Gilscher, and a volunteer called Yanchenko. The observers (letnabs) were Cornet Lipski, Sotnik Ilyin, Jr., Lieutenant Sakovich, and Ensign Kvasnikov. Orlov flew aircraft No. 204 and assigned No. 202 to Bychkov and No. 201 to Gilscher. Ensign Matveevich was a backup pilot for the S-16 and Yanchenko flew a Mosca. After hurried preparations, Orlov reported to the Grand Duke on 4 April that the first Russian fighter unit was raised and ready for deployment to the front.[20]

By the middle of April, the VII Fighter Squadron was installed at an airfield adjacent to the Galician town of Yablonov. Immediately, the unit began combat

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[18]Mikheyev, 14-15.
[19]Ibid., 15.
[20]Ibid.

operations in support of the air activities preparing for the impending offensive.[21] Indeed, at this time, IRAF operations reached an all-time high and achieved remarkable efficiency. Reconnaissance and aerial photography were especially important as Brusilov demanded thorough mapping of the entire frontline and each Austrian artillery battery.[22] The IRAF also maintained the careful secrecy of the buildup, which was so crucial to Brusilov's success. To avoid tipping off Austrian and German scouts that IRAF units were relocating to a certain sector, for example, squadrons deployed in piece-meal fashion, flying aircraft individually and not as a large formation, to the new location.[23] The IRAF also improved its use of radio, employing it to great effect by directing artillery fire when the offensive commenced on 4 June.[24]

The change in character of the IRAF did not go unnoticed by German and Austrian aviators, however. Not only were encounters with Russian aircraft more common, they were also becoming dangerous. "Flying activities were extremely lively," Schröder reports, "the air positively hummed with machines, including Russian ones, which suddenly became unusually aggressive."[25] The VII Fighter Squadron was especially active during the later half of April. On the 15th, it received its baptism of fire when Orlov and Lipski took-off in No. 204 to intercept a formation of attacking aircraft. They drove off the enemy, but an engine malfunction forced the crew to break off the pursuit and return to base.

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[21]Ibid., 15-16.

[22]Stone, 238.

[23]Boris V. Sergievsky, Boris Vasilievich Sergievsky, 1888-1971, eds. Professor Constantine Belousow and Colonel Serge Rianansky (New York: The Association of Russian-American Scholars in U.S.A., Inc., 1975) 52.

[24]Ward Rutherford, The Russian Army in World War I (London: Gordon Cremonesi, 1975) 198.

[25]Schröder, 74-75.

The following day Orlov, with Kvasnikov as observer, intercepted another scout, and Gilscher and Bychkov made their first combat flights in Nos. 201 and 202.[26]

On the 17th and 18th, Orlov and Bychkov both made successful intercepts, despite synchronizer malfunctions and poor weather. On the 18th, Orlov did not find his target until he climbed to 4,000 feet, above the cloud deck where the Austrians were hiding. Surprised by the aggressiveness of the Russian pilot and fearful of the lethal synchronized machine gun, the Austrians dove for the protective cover of the clouds and reversed course, heading home.[27]

Ensign Matveevich flew No. 202 against a German Albatross two-seater, which was directing artillery fire on 20 April. Again, the armed fighter took the enemy aircrew by surprise. Not accustomed to being assailed by Russian planes, the German aircrew allowed Matveevich to approach dangerously close. When the pilot saw the machine-gun firing over the S-16's cowling, he made a sharp evasive maneuver and hastened back to the front line. Ensign Matveevich pressed the attack but carelessly maneuvered and allowed the German observer to shoot a long burst from his ring-mounted machine gun into the engine, wings, and fuselage of his S-16. The precious fighter was severely damaged, but Matveevich managed to return the crippled machine to the airfield and entered a note in the aircraft's logbook: "Damaged in air combat was S-16 #202 led by Ensign Matveevich."[28] The S-16, one of only three available to the squadron, required repairs that eliminated it from combat operations.

The two remaining S-16's flew almost daily, sometimes several times a day. Ensign Gilscher and Lieutenant Orlov had flown the most hours: 13:45 and

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[26]Mikheyev, 15-16.
[27]Ibid., 16.
[28]Kulikov, 45.

9:32, respectively. Dogfights occurred on nearly every flight and, as a rule, resulted in the German or Austrian planes being driven back across the front-lines. The number of "kills," though, was difficult to determine. Because the intercepted aircraft usually made their way to friendly territory, downed or destroyed planes could not always be confirmed. The IRAF only acknowledged kills that occurred on the Russian side of the lines or those that could be verified by the ground troops. Therefore, many planes that the S-16 pilots and other fighter pilots successfully shot down were often not credited.[29]

The triumph of the S-16 was brief, however, ending the same month that it began. On 27 April, Ensign Gilscher flew what would be the last S-16 combat sortie for the IRAF. The weather was poor that day with gusting winds that severely buffeted the aircraft, but it did not seem to bother an Austrian scout that was observing VII Army positions adjacent the town of Burkanov. Gilscher spiraled up to meet his adversary. Upon reaching an altitude above and behind the Austrians, with the sun at his back, he jumped the unsuspecting scout with a fierce spray of bullets from his Vickers, turned and abruptly attacked again. Now aware of the danger that had befallen them, the Austrian aircrew frantically maneuvered to return fire from the observer's machine-gun, but Gilscher skillfully avoided their aim. The enemy scout, unable to endure, bolted for home. Gilscher relentlessly pursued despite the heavy turbulence that pounded his fighter and fired 120 rounds into the retreating machine until thick smoke poured from its engine. The Austrian plunged to earth giving Gilscher the first of his many victories.[30] This victory, though, was the S-16's last.

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[29]Mikheyev, 16. Sergievsky, 56.
[30]Mikheyev, 5.

Persistent troubles

Ensign Gilscher returned from his victorious flight and rested briefly before taking-off on another mission, this time with an observer, Ensign Kvasnikov. The Russian crew patrolled the skies but found no enemy planes in the air. The Austrians, humbled by the IRAF's new assertiveness and mindful of the worsening weather conditions, had ceased flight operations for the day. Gilscher had decided to return to base as well when he noticed that the airplane failed to respond to his control inputs. Something, it appeared, was blocking the S-16's aileron control mechanism. As he struggled with the controls, the aircraft abruptly rolled three times and started a steep descent. Both Gilscher and Kvasnikov fought to steady the S-16, but their efforts were useless. The aircraft entered a spin and crashed. The second of the VII Fighter Squadron's S-16's, No.201, was destroyed but miraculously, despite dropping from over 2,500 feet, Gilscher and Kvasnikov survived.[31]

The cause of the accident was never determined, but it made little difference. Based upon their experience with the S-16, the pilots reported that it was unsuitable for combat. Upon learning of the VII Fighter Squadron's report, Grand Duke Alexander sent a telegram to the XII Fighter Squadron with a loaded question: "S-16 airplanes were not suitable for usage in the VII Fighter Squadron. . . . What results do you have?" The response, not surprisingly, was unfavorable. The XII Fighter Squadron did not participate in combat so the S-16's, Nos. 203 and 211, were evaluated based only on training flights. Apparently the aircraft performed adequately because the report was less negative than the VII's, but it did not facilitate their continued employment.

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[31]Ibid., 16.

Grand Duke Alexander, anxious to discredit Shidlovskiy and Avia-Balt, ordered that S-16 operations cease and the remaining models be returned to Petrograd. At Stavka, General Alekseev was suspicious of the report from the VII and reassigned the planes to EVK where he believed they would be of use. By the middle of May, just one month after entering combat, all the S-16's were withdrawn from fighter squadrons and were returned to EVK by June.[32]

The S-16, despite the victories it achieved, simply proved unreliable. For the most part, the success of the VII's pilots arose from the complacency of German and Austrian pilots, whose vigilance had been dulled by the lack of Russian opposition in the air. But the advantage of surprise would not last for long; and, even with this combat edge, S-16 operations were problematic. The airplane's harried and improvised construction, which was interrupted by constant strikes and supply shortages, had taken its toll on quality and durability. Breakdowns occurred often, and periodic maintenance was required at impractically close intervals.[33] Combat squadrons did not welcome a high maintenance machine like the S-16, given the difficulties of field maintenance, which Austrian prisoners of war often performed due to the IRAF's shortage of skilled aviation mechanics.[34] Complaints were also common against the machine-gun synchronizers, which were extremely temperamental. Despite tedious adjustments after each flight, malfunctions persisted. The simplicity of Lavrov's synchronization mechanism did not guarantee reliability.[35]

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[32]Ibid., 16-17. On the report, Alexseev wrote, "Dumayu, shto delo mastera boitsya," [I think that the work is afraid of the master] meaning, possibly, that Alexander had outdone himself in his games of intrigue.

[33]Ibid., 17.

[34]Hardesty, 19.

[35]Mikheyev, 17.

The principal shortcomings of the S-16 stemmed from the shortage of quality aero-engines. According to technical specifications drawn up by Sikorsky and required in the contract, the S-16's were supposed to be fitted with Rhone or Gnome engines of 80 to 100 horsepower. The first S-16's, Nos. 154 and 155, received quality Gnome engines built prior to the war that were mated with optimized "NEZh" (N. E. Zhukovskiy) propellers manufactured at the Moscow Aerotechnical Works, accounting for their exceptional performance in 1915. Subsequent models, however, received Gnomes made during the war. The Moscow Gnome Works, like Avia-Balt, could not maintain high quality production standards during the austere wartime conditions. As a result, many of the engines could not attain their rated horsepower. The number of engines produced also remained low, requiring that S-16's employ previously used and rebuilt engines. Only one S-16, No. 205 flown by Vakulovski, was fitted with a quality, French-made Rhone-80, which may explain why he made no complaints about the aircraft.[36]

To make matters worse, CMTD was unable to supply Avia-Balt with propellers that met the technical specifications required for the S-16. The first batch received by Sikorsky was optimized for use on Nieuports with Gnome engines and, therefore, were unsuitable. Anticipating the delivery of the powerful Rhones, Sikorsky requested that CMTD deliver special propellers of 2.55 meter (8.36 feet) diameter with a 2.15 meter (7 feet) blade from the Petrograd Integral Works. But when it became clear that the weaker Gnomes would be used instead, Sikorsky urgently requested that the blade be reduced to 2.05 meters (6.7 feet), and later to 1.8 meters (5.9 feet). The poor supply system coupled

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[36]Mikheyev, 17, 32.

with incessant changes in specifications required that the S-16's be fitted with a variety of different propellers, not always with optimal parameters.[37]

Not surprisingly, the S-16's performance suffered dramatically. At best, the serial produced models could only reach 120 to 125.5 kilometers per hour (74.4 to 77.8 miles per hour). The rate of climb fell precipitously to an abysmal 60 meters per minute (200 feet per minute) and some machines were unable to attain 2,500 meters (8,200 feet) altitude. With its Rhone-80 engine Vakulovski's S-16 could fly at 150 kilometers per hour (93 miles per hour). No. 210, which was tested at Avia-Balt with a variety of higher horsepower engines, including the Gnome-Monosoupape-100, and Rhone-110 and 120, reached 155 kilometers per hour (96 miles per hour). But even these speeds were not enough.[38]

The S-16, first designed in 1914, was outclassed by new aircraft appearing in France and Germany. The persistent series of delays throughout its development and production had sentenced the S-16 to obsolescence before it could be produced in sufficient numbers to have serious impact. By comparison, the French Nieuport 17 fighter and newer Morane fighters, both built in Russia under license, effortlessly reached speeds of 155 kilometers per hour and could attain 170 kilometers per hour (105 miles per hour) with the higher powered engines. The Nieuport, which began entering fighter squadrons in great numbers during May, was not more structurally sound or more maneuverable than the S-16. But it was a French design and its higher speed, rate of climb, and greater availability made it more attractive to the IRAF.[39]

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[37]Ibid.
[38]Ibid., 17. Kulikov, 45.
[39]Mikheyev, 18. Kulikov, 45, 48. Jane's.

German aircraft had also advanced, overtaking the sophistication and performance of the S-16. Hans Schröder was very confident in his Albatross, equipped with a powerful and efficient Mercedes 120 horsepower water-cooled in-line engine and "armed with a forward gun, which shoots through the propeller."[40] The Fokker biplanes and Roland S II two-seat fighter, which was fast and more heavily armed, were also superior to Sikorsky's fighter. The S-16's two year old design and inferior powerplant simply could not keep pace. I. F. Polovtsev, a well known deputy of the State Duma and aviation enthusiast, summed up the situation quite well when he wrote in May that the "Sikorski-16 fighters with Gnome-80 engines are unsuccessful, for they fail to provide either a fast climb, sufficient speed, or quick descents, so that when engaging Fokkers, they can neither pursue, nor retreat. With the 90 and 110 horsepower Rhone engines they were quite good in their first edition."[41]

The EVK

In 1916, the Ilya Muromets bombers continued their fine work despite increasing threats and the lack of escort fighters. EVK squadrons were posted near Riga, on the northern front, near Minsk, on the western front, and in Galicia to support the offensive on the southwestern front. IM-Kievskiy, assigned to the First Combat Squadron working out of the airfield at Kolodziyevka near Tarnopol, was instrumental to VII Army operations during the Brusilov Offensive. Flying numerous long-range reconnaissance and bombing missions the venerable machine supplied "precise intelligence about the numbers and

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[40]Schröder, 60-61.
[41]Kulikov, 45, 48. Mikheyev, 17.

positions of enemy batteries and about movements of troops and also conducted flights into the enemy-held rear areas."[42]

This work, however, became much more perilous. The Germans had strengthened their anti-aircraft defenses and deployed a formidable number of fast fighters to the east in response to the EVK's effectiveness. Clashes between Murometsy and enemy fighters were regular occurrences as German pilots had received special orders to down the huge, multi-engine Russian bombers. They took every opportunity to intercept them and attacked the aerodromes at Riga and Zegevold repeatedly.[43]

On 26 April, for example, IM-10 lost three engines to anti-aircraft fire over the heavily defended railyard at Daudzeva. After successfully performing an emergency landing, Lt. Yankovius and his crew counted seventy shrapnel and bullet holes throughout the aircraft. On 23 September, a German fighter jumped IM-6, piloted by Staff Captain Golovin, over the Bay of Riga. The aircraft and crew survived the savage attack but learned how lucky they had been when they returned to the airfield and discovered 293 bullets holes in their bomber. Three days later, four German fighters destroyed an Ilya Muromets, IM-16, near Lake Krevo. "Finally," a German radio broadcast declared, " we have downed the huge Russian quadrimotor aeroplane, although the air battle cost us three of our own fighters."[44]

To provide better defenses, Sikorsky made a series of modifications that became known as G, D, and Ye models. The G variant introduced a strengthened wing structure and carried six machine guns, including a tail-gun accessible by a rail-trolley running the length of the fuselage. D models were fitted with a

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[42]Finne, 123.
[43]Ibid., 124.
[44]Ibid., 128-130, 132-133, 135-138.

fully glazed cockpit for better visibility and the fuel tanks were protected in enclosed positions on top of the fuselage. On the Ye version Sikorsky made arrangements for two additional machine guns. Sikorsky also employed 10 mm. thick armor in the cockpit to protect the pilots.[45] These innovative upgrades improved the bomber's survivability and, when flown in defensive formations, made them especially formidable, though not immune to enemy attack. These changes were required because adequate escort was lacking. Ironically, IM-16 was destroyed during one of the few missions that employed fighter escorts. The "parasol type monoplane and three or four Voisin aircraft" that flew with the bomber were clearly ineffectual.[46]

By July, with the transfer of S-16 No. 210 from Avia-Balt, EVK had all of the operational S-16's at its disposal. Although they often served as impromptu interceptors against attacks on IM airfields, the EVK realized, as the IRAF had, that the "Sikorsky Jr's" were not suitable for combat escort duties. For the most part they performed the squadron's auxiliary functions, primarily as trainers and communications aircraft, relaying messages between EVK squadrons and EVK Headquarters.[47]

Maintaining the S-16's continued to be a challenge, even for the relatively well-equipped EVK repair shops, which quickly repaired Nos. 202 and 205, and kept several models in sound condition up to the revolution. The experienced EVK personnel, under the leadership of Sikorsky and Lavrov, were able to overcome some of the S-16's flaws caused by sloppy assembly and the lack of quality materials. Some of the well-tuned aircraft were able to achieve sufficient performance to provide quality training for the EVK's student pilots. Most of the

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[45]Ibid., 173-175.
[46]Ibid., 136.
[47]Mikheyev, 18-19.

machines, though, were simply cannibalized for parts, owing to the austere shortages and tremendous amount of time required to keep them flying. The weather also worked against the EVK, inflicting significant loses. In November, for example, after deploying to Vinnitsa on the Southwestern Front in preparation for the Rumanian offensive, a particularly intense fall storm ruined three S-16's.[48]

The principal reason for the S-16's limited use as a fighters was, again, the lack of adequate aero-engines. Shidlovskiy could only acquire repaired engines for the EVK's light aircraft, and only with great difficulty. Grand Duke Alexander continued to be uncooperative and refused to assist in providing the EVK with new, more powerful engines. He simply had too few to spare and was not concerned with the fate of the Murometsy, maintaining that their supposed "invulnerability" should preclude their need for escorts. Therefore, the EVK was forced to scavenge whatever engines could be found, often obtaining decrepit Rhones, Gnomes, and Kalep's from old Farman trainers.[49]

The fighters were plagued by the dearth of machine-guns as well. Because Lavrov's synchronizers continued to cause problems, the guns were moved to the upper wing to fire over the propeller arc. These weapons, like the engines, had to be procured through Shidlovskiy's "connections." Many were second-hand models, acquired after being repaired at the Tula Armor Works. Naturally, equipped with worn-out engines and ineffective weaponry, the EVK's S-16's provided little more than moral support as a fighter. During intercepts, they were only capable of deterring enemy bombers, for they were unable to pursue and mount their own attack.[50]

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[48]Ibid.
[49]Ibid., 19-20.
[50]Ibid., 20.

Preoccupied with improving the Murometsy and with production at Avia-Balt, Sikorsky simply could not devote much of his time to improve upon the S-16. He made a few attempts at designing an adequate escort for the bombers, notably the S-17 and S-18, but they did not come to fruition. Initially, the two-engine S-18 seemed promising but its development was delayed too long and did not extend beyond the experimental stage.[51] Sikorsky's S-20, an improved version of the S-16, was also developed and was easily the most capable light aircraft he designed. For a short time in 1916, N. N. Polikarpov, a 24-year-old engineer, supervised the production of Murometsy enabling Sikorsky to focus on development of the S-20. It was built for the Gnome-Monosoupaupe-100 or Rhone-120 powerplant and combined the agility of the S-16 with the speed of the Nieuports. An outstanding aircraft, capable of flying at 118 miles per hour and climbing at 1,000 feet per minute, the S-20 represented the next step in design that returned Russian aviation to the technical level of progress in 1916 and 1917. The S-20, however, also never made it past the experimental stage of production.[52]

Avia-Balt, after years of neglect by CMTD, due to the demands made by IM production and due to the hardships brought on by war, was unable to retool production to make manufacture of the S-20 worthwhile. Instead, production of the S-16 continued and by the end of the year 16 new airframes were complete, awaiting engines and machine-guns. The IRAF also overlooked the S-20, a

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[51]Ibid., 13. Kulikov, 45. Shavrov, 184-188.

[52]TsGVIA, f. 2008, op.1, d. 512, l. 100; f. 2003, d. 623, ll. 88, 289; d. 624, l. 179; f. 2008, d. 492, l. 32; d. 630, l. 54, cited in Shavrov, 188. Heinz J. Nowarra and G. R. Duval, Russian Civil and Military Aircraft 1884-1969 (London: Fountain Press, 1971) 43.

technically superior machine, because of the continued preference for French designs.[53]

Conclusion

In 1916 Russian aviation made significant advances in organization and doctrine that improved its operational effectiveness. The introduction of fighter squadrons and the coordinated employment of aircraft with army ground units during the Brusilov Offensive paralleled the use of aviation in the air battles of Verdun and at the Somme. However, persistent supply and production difficulties remained. Although the IRAF had 724 machines, theoretically enough to equip its squadrons, many units were forced to curtail operations because the aircraft were obsolescent and often unequipped with engines and armament. The chief of staff of the XII Army reported in September that his aviation units possessed "no engines, no aircraft or machine guns--only complete unpreparedness."[54]

Despite all of the reform efforts, Russia's chief problems remained, and it seemed clear that technical advances and industrial output in the west would permanently exceed Russia's ability to keep pace. Although the number of aircraft produced seemed sufficient, it was an illusion, just as in 1914. The game of catch-up that Russia was forced to play had sentenced her industry to the manufacture of French aircraft that became obsolescent faster than industry could retool with advanced designs--even though they existed in her own

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[53]It is quite possible that high level Russian officials were paid by French firms to prevent competition from Russian industry, see Nowarra, 43. Mikheyev, 41. Finne, 33.

[54]J. Alexander, 149. TsGVIA, f. 16255, d. 15240, ll. 148-149, quoted in Duz' 246.

country. Effectively, Russia lost her technological edge. "The development of the German air forces (as also those of France and Great Britain)," N. N. Golovine concluded, "had made such enormous progress that the Russian army was, at the end of 1916, even more defenseless in the air than it had been in 1914."[55]

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[55]Golovine, 151.

SIX

CONCLUSION

Epilogue: 1917

During the winter of 1916-1917 a strange sense of optimism existed in the IRAF. Grand Duke Alexander felt as if his command was "riding on the crest of the wave. Hundreds of airplanes," he wrote, "manned by courageous officers and armed with the latest type of machine guns awaited the signal."[1] Igor Sikorsky and K. N. Finne, too, believed that the fortunes of Russian aviation would continue to rise. "Our armies," Finne said , "already possessed sufficient quantities of artillery, ammunition, and war materiel to deliver a powerful blow against the enemy--a blow that would enable us to achieve a decisive breakthrough. Everyone believed success was at hand."[2] And, Sikorsky, anticipating an expansion of the EVK, optimistically expected "much more serious results" from his giant bombers.[3]

In some respects, their hopes were not entirely unfounded. Alexander's air force was much more than the "single salon car which housed both [his]

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[1]Alexander, 285-286.
[2]Finne, 142-144.
[3]Sikorsky, 139.

clerical and [his] fighting forces" in 1914.[4] The IRAF had grown to 91 units possessing over 1,000 machines.[5] Its fighter forces, led by aces I. A. Orlov and E. N. Kruten, Russia's air tacticians of the Boelcke tradition, consolidated into fighter groups and maintained a relatively high level of combat activity through the summer.[6] And, Russia's factories had managed to increase monthly aircraft production from 205 in 1916 to 352 in February 1917.[7] The EVK, too, deployed for action on the Rumanian Front, anticipated continued success.[8]

Yet, the main problem that limited the IRAF's and EVK's effectiveness since 1914 had not been rectified. Only 545, or slightly more than half, of the IRAF's aircraft were serviceable. The chief deficiency remained the shortage of quality aero-engines. Domestic production remained miserably low, averaging less than 40 per month, and imports could not make up the difference. Moreover, the engines shipped from abroad were of limited use. They were rarely accompanied with spare parts and were often the scraps of the Western Front; used engines that, if repaired, did not perform well. Russia's overtaxed technical-supply and maintenance network simply could not keep up with the demand for aero-engines. As a result, some squadrons had only two operable engines for every five or six aircraft.[9]

The revolutions of 1917 effectively snuffed out what little glimmer of hope remained in Russia's air force. Industrial production, plagued by intermittent strikes and austere shortages since 1915, became so dislocated that the

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[4]Alexander, 285-286.

[5]Morrow, 258. J. Alexander, 149.

[6]J. Alexander, 157-158. Edgar Meos, "Allies on the Eastern Front," Cross and Cockade 4,2 (Summer 1963): 319-323.

[7]Morrow, 259.

[8]Finne, 142-144.

[9]Ibid., 120-121. Morrow, 258-259.

continued supply of air units was scarcely possible. And, although morale and discipline were far better in the IRAF and the EVK than in regular army units, the revolutionary fervor that swept through the ranks and caused the disintegration of the Russian Army eventually brought about their collapse as well. By November, on the occasion of the Bolshevik takeover, the Russian air force and aviation industry expired.[10]

Conclusion

In September 1913, the Russian War Ministry held the third military aeroplane competition at the Korpusnoi Aerodrome in St. Petersburg. The Russo-Baltic Rolling Stock Company decided to enter two Sikorsky machines, the S-10A competition biplane and the S-11 monoplane. In order to accommodate these aircraft in the rented hangar, Igor Sikorsky's other attraction, the large, four-engine Grand, was moved out into the open on the grassy infield. On 11 September, the last day of the competition, Adam Haber-Vlinski demonstrated a Möller No. 2, a Russian tail-boom pusher biplane. As he flew around the airfield and over the spot where the Grand was parked, the Möller's Gnome-Monosoupape-100 engine came loose from its mounts, fell from the aircraft, and crashed through the left wing of Sikorsky's prized multi-engine machine. Haber-Vlinski, unsure of what had happened, continued his approach and managed to perform a safe landing. The damaged Grand was not worth repairing. Instead, Sikorsky stripped it of its useful parts, particularly the Argus engines, for use on

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[10]Finne, 145-160. Sergievsky, 64-65, 7-78. Morrow, 258-259.

his next giant, the Ilya Muromets, which was already taking shape at the R-BVZ factory in St. Petersburg.[11]

This freak accident is curiously apropos, for it illustrates the major themes of Russia's early aviation experience. The accident occurred during a Russian aircraft competition sponsored by the Russian War Ministry and featured Russian-designed and manufactured machines--an indication of the state of Russia's "airmindedness" prior to the war. The accident itself was the near destruction of one aircraft, a "heavy," by another, a "light"--symbolizing the friction that would arise between the IRAF and the EVK. The implement of destruction, the aero-engine, nearly spelled disaster for both types, just as all of Russian aviation would be hampered by the "motor famine" throughout the war. It also inaugurated the practice of cannibalizing Argus engines--the parallel here is clear. Finally, the engine that caused the accident was a French Gnome--foretelling of Russia's crippling dependence on foreign industry.

It is clear that Russia's struggle to produce, acquire, and maintain aero-engines was her chief difficulty. This stemmed, in part, from the general lack of knowledge about aviation's complex technical requirements before the war. "Although this was a comparatively new field which commenced development in the early part of 1911," historian N. Kozlow concludes, "the War Department, by energetic and intensive activity could well have placed our aviation on a proper footing."[12] This might be true, but Russia was not alone in the struggle to integrate aircraft into the army. What she did not do, unlike the western powers, was build up her domestic technical-industrial infrastructure. As historian Carl

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[11]Harry Woodman in Carl Bobrow, "A Technical Overview of the Evolution of the Grand and the Il'ya Muromets," W. W. I Aero 127 (February 1990): 40-55.

[12]Kozlow, 143.

Bobrow points out, Russia "had many of the advanced metallurgical techniques to produce aluminum and light weight alloys as well as the engineering necessary to design and build aero-engines."[13] What was missing was the highly technical industrial base needed for large scale production. Instead of investing in this industrial base, Russia chose simply to purchase European aero-engines that were readily available and inexpensive. "The production of domestic engines," Bobrow states, "was not considered necessary or economically feasible."[14]

Russia's self-imposed reliance on foreign production proved disastrous. When the horrific demands of the Great War made it clear that imports would not be sufficient, there existed few alternatives. During the desperate scramble to increase production, quality was sacrificed for quantity. But, because the aviation industry was so modest, output remained low, sentencing the IRAF to a relatively small air fleet with obsolescent machines. Once behind, it was difficult for Russia to regain position. "The technical base of Russia was too weak," Soviet historian Peter Duz' wrote, "and Russian aviation was not able to catch-up with the rapid progress of aviation engineering in Europe and America."[15]

The IRAF air effort was small, and seemingly crude, when compared to the tremendous operations of the western air forces. But, a closer look at the aviation activities in Russia before and during the war reveals a sophistication that is not readily apparent. The early enthusiasm for flight, the recognition that aircraft were essential to modern warfare, the development of fighter aviation, and the strategic use of multi-engine airplanes are evidence of Russia's aviation refinement. Russian aviation engineering, too, is worthy of recognition. Carl

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[13]Bobrow, 20.
[14]Ibid.
[15]Duz', 246.

Bobrow explains that, "though Russia obtained equipment and ideas from Europe and the United States, their own technological development not only equaled but in some cases surpassed other countries despite the lack of a highly industrialized society."[16] And, he continues, Russia was "able to contribute directly and indirectly to the overall development of aviation. . . . A number of designs and material used were innovative if not equal to what was being utilized in the rest of Europe and America. Examples can be seen in the use of plywood for monocoque fuselages, welded steel tubing in airframes, the use of ailerons in most cases instead of wing-warping, and the use of skis for winter take-offs and landings."[17]

The story of the S-16, in conjunction with the evolution of the EVK and the IRAF, provides evidence that Russia was not hopelessly backward. In fact, Russia was an active participant in the new, modern era of flight.

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[16]Bobrow, 18.
[17]Ibid., 20.

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