Chapter V

Soviet Systems

A. Introduction

From the Soviet perspective, "The development of antiaircraft defense after the Second World War may be divided into two periods: the first, from 1946–53, and the second, from 1954 to the present."[1] The break between the two periods is delimited by the formation of PVO (Strany) as a co-equal with other services of the Soviet armed forces in May of 1954. Coincidently, the 1953 date conforms to more general Soviet military histories, which acknowledge 1953 as the year of Stalin's death and the year in which the Soviet Union demonstrated its first thermonuclear weapon. A third stage seems also to be doctrinally accepted which acknowledges "the revolution in military affairs." This last phase is marked by the formation of the Rocket Forces as another service in 1960 and the adjustment of military doctrine to nuclear and missile weapons. Within these divisions, Soviet writers usually characterize the first period as one in which Soviet air forces were equipped with modern jet aircraft. The second period is generally characterized by the deployment of missiles for both ground and aviation air defense components. The third period might be characterized by attempts at ABM defense. In keeping with the Soviet view of the earliest period, this history will focus on the decisions involved in the process of aircraft modernization and the development of jet technology. Subsequent volumes will focus on surface-to-air missiles and Soviet ABM programs in turn.

Not only does the focus on jet aircraft accord with the Soviet view of early post war history, it also takes advantage of unique insights into the Soviet process of decision making. Aircraft designers and test-pilots occupy a special status among Soviet heroes. They write and they talk more freely about their activities than other segments of the society and they appear somewhat open about their activities with members of the aviation press—that is if a decent period (about 20 years) has passed to preclude possible disclosure of military secrets. In addition to the remembrances of key figures in the Soviet development community, there are also a number of defectors who round out the picture of Soviet aviation, particularly in the areas of applied research and aircraft production. Thus, in retrospect, a fair picture emerges as to how decisions were made with regard to aviation in the late Stalinist period; it is a picture which is substantially corroborated by intelligence of the period and by more recent Soviet official documents.

From the standpoint of historiography, the focus on aircraft developers and development decisions may be dangerous. It may distort conclusions drawn with the benefit of a wider focus. This potential bias is acknowledged, but discounted, for several reasons:

(1) The personal role of Stalin in military decisions, particularly aviation matters

(2) The purge and politicization of air force leadership in 1946

[1] Dzhordzhadze, "The Role of Historical Experience," p. 41.

(3) The subordination of the air forces to ground forces requirements and leadership
(4) The continuing pattern of political domination of the military establishment and military force structure decisions which persisted after the death of Stalin
(5) The exclusion of members of the military and political leadership from weapons decisions made among Stalin and his principal advisors.

These factors lend credence to the picture of Soviet decision makers portrayed in the following materials. A further, and compelling, reason is that few data exist to develop alternate foci. Therefore, the following materials approach aviation decisions through the designers and include additional data which broaden the perspective.

Rather than detail what strategic defense forces developed, or how, the intent is to ask "why?" It is the contention here that design activities provided a menu of weapons from which a number were chosen for production and deployment. It is in this context, that one gains a grasp of "why?"

By extension, understandings gained from a study of aviation decisions can be applied to developments in the realm of antiaircraft artillery, surface-to-air missiles, and radar systems. In two major respects, however, decisions related to complementary defensive systems differ. First, it seems they did not involve Stalin as frequently. Second, they took place in a framework where domestic institutions were less well developed and where reliance on foreign technology was higher. This chapter thus discusses the observable developments within these other categories of systems. It closes with a discussion of civil defense developments to complete an overall appreciation of the strategic defense effort.

B. History of Fighter Aircraft of PVO

1. Pre-War Experience

Patterns of organization, institutional behavior, and decision making in Soviet aviation derive from the pre-WWII formation of the Peoples Commissariat for Aviation Industry and from the emergence during the late 1930's of a group of young and competent designers who since have been sustained in their independent development activities. The industry was *highly competitive* in the process of designing alternative prototype aircraft, *political* in the allocation of resources and *centralized* in the exchange of information.[2] It became an establishment in which the designers played a key role protected by a ministerial-level institution along with key producer industries. Within this establishment, the user organization, the air forces, did not necessarily have the predominant voice.

The character of the Soviet aviation industry was much influenced by the purges of scientists and engineers during 1927–1929. In effect, these purges, which culminated in the Industrial Party (Promparty) Trial of 1930, virtually wiped out the entire technician class of that generation.[3] The principal designers of the thirties—Nikolai Polikarpov, in fighters, and Andrei Tupolev, in bombers—fell into disfavor in 1929 and Polikarpov was imprisoned for industrial sabotage or "wrecking."[4] During this period, the Central Design Bureau was organized under the State Political Administration (GPU or Secret Police). Among its facilities was the "Seventh Hangar" organized under the "internal prison" (Vnutrennaya Turma), where Polikarpov

[2] See Institute for Research in Social Science, and Alexander R&D for detailed description.
[3] Solzhenitsyn, pp. 377–399. Of approximately 30–40,000 engineers in the U.S.S.R., Solzhenitsyn estimates that 5,000 were arrested (p. 387).
[4] "Prolific Pioneer," Flying Review International, July 1968, p. 405.

and other aviation notables lived and worked under heavy guard.[5] During that period, Alexander Yakovlev, Sergie Iluyshin, and probably Artem Mikoyan received their training in this same Central Design Bureau Complex. In 1933, after the successful flight of his I-5 prototype, Polikarpov was released. By 1934, it was Tupolev's turn. He received a ten-year sentence for sale of military secrets to Germany, but worked his way out after two years with the design of the gargantuan eight-engine "Maxim Gorky" propaganda and passenger craft.[6] He was returned to prison on two later occasions in 1937 and in 1940.[7] In 1937, another name in Soviet aviation gained prominence—that of Semyon Lavochkin. The design of the LAGG-I and the team of Lavochkin, Gorbunov, and Gudkov emerged, again from prison.[8]

a. Structure of the Aviation Industry

Four basic functions were organized under the Commissariat and the Ministry of Aviation which succeeded it. They were and (in 1975) still remain:

(1) Basic Research
(2) Prototype Design
(3) Testing and
(4) Production.

Basic research is conducted within the Central Aerohydrodynamics Institute (TsAGI) for airframe problems and within the Central Institute of Aviation Motor Building (TsIAM), the All Union Institute of Aviation Materials (VIAM), and the Scientific Institute for Aviation Equipment for related subjects. Design activities are the province of the Central Design Bureau (TsKB) and of semi-autonomous Experimental Design Bureaus (OKBs) which operate under it in the fields of airframes, engines, and armament. Testing is conducted by centralized testing establishments, most notably the Flight Test Institute (LII) and the Scientific Testing Institute of the air forces (NIIVVS). Production is organized among individual factories responsible to the Ministry.[9]

b. Elites

Within Soviet air forces, there are two parallel series of ranks; one for the operational side and another for the technical. The operational ranks range up to Chief Marshal, but the engineering ranks stop at the next-lower Colonel-General rank. Notably, only Army officers are eligible for the highest rank, Marshal of the Soviet Union. This, however, does not indicate that officers of the Aviation Engineering Services carry less weight; quite to the contrary:

> It is more difficult to obtain an engineering rank than an executive one, as the prefix "engineer" is only given to those who have received the highest technical air education, and is usually reserved for those who have passed through the Zhukovski Military Engineering Academy. Exceptions are occasionally made for distinguished inventors. In the schools and experimental stations of the Soviet Air Forces, the technical side outranks the non-technical. For example, an Engineer-Major may even hold a post which would normally be filled by a non-technical Major-General.[10]

[5] Ibid. and Yakovlev, *Target*, p. 84.
[6] "Chief U.S.S.R. Aircraft Designer," *Air Intelligence Digest*, Jan. 1950, p. 16 CONF.
[7] "Soviet Big Five Aircraft Designers," *Air Intelligence Digest*, Feb. 1954, p. 32 CONF.
[8] "Lavochkin" *Air Intelligence Digest*, Mar. 1950, p. 36.
[9] Institute for Research in Social Science, and Alexander, *R&D*.
[10] Tokaev, *Soviet Imperialism*, p. 42.

The Zhukovski Academy is a centralized post-graduate institution devoted to aviation studies (and Marxist-Leninism of course). Its students and graduates are distinguished by special pay, privileges, social access, uniforms, and bearing. Its senior staff members frequently enjoy direct access to the Politbureau and some relief from political imperatives which are imposed on the remainder of the Soviet population. Alumni of the academy share a "scientific" ethic and generally recognize each other on the basis of individual competence. ". . . We are therefore school-mates. A strong comradely friendship binds us. We frequently consult with each other and help each other solve complicated problems."[11] Among names frequently mentioned in this study, Yakovlev, Mikoyan, Iluyshin, Lavochkin, and Tokaev were Zhukovski graduates. Tupolev, Polikarpov, Klimov, and Yakovlev were at one time staff members. Those who do not fare as well, Sukhoi, for example, appear to be graduates of other technical institutes.

The ethic which binds the technical elite extends, in part, to their subordinates. The open literature contains several examples of direct appeals as high as Stalin[12] for review of sentences on behalf of technical staff and of confrontations with political officers to allow individuals to continue with competent work with less interference.[13] This "backing up" of personnel may explain the strength and loyalty of design teams.[14]

c. Design Competition

The tradition of design competition evolved during the 1930's as a number of designers began working independently of the major institutes. In 1936, a requirement was issued for a light multipurpose fighter. Four designers responded with development programs. Later that same year, the specification was revised to favor the light bomber role and a Sukhoi prototype (the Su-2), developed independently of his mentor Tupolev, was accepted.[15]

The epitome of design competition was that held in late 1939. Over 20 designers were given assignments to provide prototypes against two or three basic requirements. A fairly detailed account of that competition is resorted to because it is prologue to the decision patterns and criteria that prevailed until Stalin's death in 1953.

The competition derived from a conference in the Oval Hall of the Kremlin. Among those present were "all who had proved themselves to be aviation designers or inventors and who had in recent years made some contribution to aviation."[16] The meeting was presided over by Stalin, V. M. Molotov (Premier), and K. Y. Voroshilov (Minister of Defense), with Molotov moderating. What ensued was a general review of the status of Soviet aviation and a debate over the utility of four-engined bombers. Subsequently 20–25 engine and airframe designers were again called to the Kremlin for personal interviews before a panel of Stalin, M. M. Kaganovich (Commissar for Aviation), Molotov, Voroshilov, F. A. Agal'Tsov (Assistant Director of the Air Force), and another member of the Politburo.[17]

Among Yakovlev's recollection of his interview is the following dialogue:

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[11] Yakovlev, *Target*, p. 416.
[12] Ibid. p. 420.
[13] Tokaev, *Comrade X*, pp. 112–115.
[14] "Tupolev," *Air Intelligence Digest*, Jan. 1950, p. 15.
[15] Nemecek, Feb. 1966, p. 373.
[16] Yakovlev, *Target*, p. 163.
[17] Ibid.

[Stalin] ". . . Are you aware that we have ordered this kind of fighter from several other designers, and the winner will be the one who not only gives the best fighter in terms of flight and combat qualities but also delivers first, so that we can get it into series production sooner?"

[Yakovlev] "I understand, Comrade Stalin."

[Stalin] "It's not important if you understand. You've got to produce it sooner."

[Yakovlev] "What time limit?" [the key question!]

[Stalin] "The sooner the better. By New Year's?"

[Stalin] "We ourselves are very much aware that we don't need that many planes. But, the good Lord willing, out of all these we'll get five or six that can be put into series production. And that many new aircraft won't confuse us."[18]

Yakovlev states that he left the meeting "inspired with the spirit of creative competition and with unwavering intentions of beating our rivals."[19] Eleven other designers were competing against the same requirement, but Yakovlev produced before his counterparts—by the New Year's deadline. The first three available prototypes (YAK-1, MiG-3, LAGG-3) were committed to production before testing was completed. On January 9, 1940, Yakovlev was appointed by Stalin to be Assistant Commissar for Aviation Industry at age 35.[20]

Several points are illustrated by this vignette which characterize subsequent aviation decisions during the Stalinist era. The points are underscored because they represent a pattern repeated in post war decisions:

(1) The dominant role and personal involvement of Stalin
(2) The weight of *political* and *technical* representation in the process as opposed to the one representative of the air forces general staff
(3) The importance of the design community in the process
(4) The official encouragement of the competition concept
(5) Compressed lead times and the importance of arbitrary and seldomly explicit dates
(6) The rewards, both in terms of production commitment and of other honors, which attend the design of the first prototypes fielded (reinforced by the negative rewards of Hanger Seven)
(7) The continuity of the key figures in the decision pattern. Yakovlev remained Assistant Commissioner until 1948, and the competing bureaus are, for the most part, still active.

d. Information Flows

Among Yakovlev's innovations in 1940 were the design handbooks and reorientation of the TsAGI. The design handbooks amounted to a standardization program for the aviation development community. The multiplication of independent design activities necessitated a common code of procedures. An initial version was produced in 1940. The second edition which appeared after the Soviets entered WWII consisted of 11 parts:

(1) Aerodynamics
(2) Hydromechanics
(3) Strength of materials
(4) Flight tests of aircraft and equipment
(5) Engines
(6) Aircraft equipment

[18] Ibid., p. 165.
[19] Ibid., p. 166.
[20] Ibid., p. 169.

(7) Aircraft armament
(8) Landing gear and mechanisms
(9) Standard systems
(10) Materials
(11) Semiproducts[21]

Among contributors to the handbooks were the foremost Soviet authorities on aviation science and design with a leavening of test pilots. The second edition was intended to incorporate construction and combat experience gained from the immediate pre-war generation of fighters. The design handbooks became a virtual encyclopedia of Soviet aviation and the principal means of communicating research results to the practical engineering level. They also provided a medium for reconciling conflicting perspectives of the military, scientists, engineers, production specialists, and maintenance people. The handbooks are a feature of Soviet aviation today and are thought to be a principal source of continuity and conservation in Soviet aviation technology.[22]

e. Use of Foreign Technology

In its early years, the Soviet aviation establishment relied heavily on foreign technology, but with the express aim of freeing itself from dependence on such assistance as soon as possible. Before 1925, Italy, France, England, and the Netherlands had supplied the Soviet Union with most of her planes and as late as that year a German-directed Junkers Company produced 500 aircraft in Russia.[23] Independent Soviet airframe designs began to emerge during the mid-1930's with independent engine designs emerging somewhat later. Purchases of foreign aircraft were not completely stopped and a concentrated effort to obtain U.S. technology followed the resumption of U.S.S.R. U.S. relations in 1933. As late as 1936, U.S. aircraft were purchased under license.[24]

During the pre-war period, a diversified program to exploit foreign technology accompanied the reorganization of design activities. Emphasis was placed on legitimate procurement of equipment and information, along with official visits and student exchanges. Generally, material was open for sale one year after it began production.[25]

During the war, the United States and Britain sent about 18,000 aircraft to Russia. These are compared by the Soviets to approximately 126,000 Soviet-produced craft to demonstrate that "the Soviet Union fought with its own strength."[26] It is the opinion of Robert Kilmarx that of these thousands of these lend-lease craft were held back to conserve them for use during the later period of transition to jet aircraft.[27] According to General John R. Dean, head of a U.S. military mission to the U.S.S.R., "we never lost an opportunity to give the Russians equipment, weapons, or information which we thought might help our combined war effort."[28]

The overt Soviet effort was supplemented by covert and grey activities. Toward the end of the war, the Soviet Purchasing Commission in Washington numbered over 1,000 people and high priority was given to

[21] Yakovlev, *50 Years*, p. 40.
[22] Alexander, *R&D*, pp. 15–16. Declining influence of the handbooks is discussed in Alexander, 1973 Trip Report, p. 9.
[23] Institute for Research in Social Science, pp. 58–59.
[24] Ibid.
[25] Kilmarx, pp. 165–166.
[26] Yakovlev, *50 Years*, p. 97.
[27] Kilmarx, p. 208.
[28] Ibid.

collection of information on jet aircraft. An effort to obtain information on America's first jet (the P-59) and on General Electric and Westinghouse jet engine developments is well documented.[29] Andrei Schevchenko, a legal representative to Bell Aircraft and later of Amtorg who engaged in espionage, reportedly mentioned a Lenin prize of 500,000 rubles for a jet aircraft design by the end of 1945.[30] Another report of the 1945 deadline is attributed to a Russian in this country.[31]

2. Performance of Soviet Aviation During WWII

In its simplest, the story of Soviet Air Forces during WWII is one of initial debacle and remarkable recovery aided by the overextension of German power. Despite the massive destruction of Soviet aircraft in June of 1941, a credible local defense began to be marshaled around Moscow in that same autumn. The winter-enforced lull in the air war, coupled with increasing numbers of new Soviet fighters, changed the momentum of the air battle. Stalingrad appears to have been the turning point where German aviation operated with impunity during the early stages of the siege, but suffered increasing losses as the campaign wore on. German losses exceeded resupply, while the Soviets were rapidly increasing their air forces based on industrial capacity, recovering from relocation to the east of the Urals.

In January of 1943 USAAF daylight raids combined with RAF night attacks on Germany to force the build-up of Luftwaffe homeland defenses at the expense of forces supporting the Eastern Front. As this homeland air front began to absorb over half of Germany's air resources, the balance shifted overwhelmingly in favor of the Soviets. By late 1943, a Soviet force of from 12,000 to 15,000 thoroughly modern aircraft faced a German Eastern Front air strength of from 2,000 to 3,000. During the Kuban and the Kursk-Orel campaigns in the summer of 1943, Germany did mass to contest the air, but at heavy cost in aircraft and crews. The Soviets could absorb losses; the Germans could not. Thereafter, local Luftwaffe commanders came to regard unfavorable odds of 12:1 as routine.[32]

a. Lessons Learned—Fighter Aviation

Despite Western historians who credit Soviet successes to improved airbase attack, the following emerged in 1949 as doctrine distilled from WWII experience. It relates to the relevance of fighter combat as opposed to other techniques of air defense or air superiority[33]:

(1) The experience of the past war showed that fighter aviation is the decisive factor in the struggle for air superiority. It also showed that the outcome depends mainly on air combat, which is the most effective way of destroying enemy aircraft.

(2) The experience of the war undermined the theory of German-fascist military circles about destroying an enemy air force by lightning war consisting mainly of strikes against enemy air bases.

(3) It also undermined the theories of Anglo-American military circles about gaining air superiority through air strikes at the military economy of the enemy, especially against his aircraft industry, his fuel reserves and his air training establishments. (Concentrated actions against the centers of the enemy's aircraft industry are certainly useful in gaining air superiority and they can hasten the

[29] Hearings, Un-American Activities, Jet Propulsion, p. 121.
[30] Ibid., p. 120.
[31] Ibid., p. 121.
[32] Lee, 1959, p. 70.
[33] Volkov, Col. A., "Fighter Aviation in Contemporary War," Voennaya, Mysl', Feb. 1949, pp. 55–69. From extracts. Note that a separate doctrine of "Air Defense Operations" was emerging among PVO troops during this period. See above Chapter V.

defeat of the enemy air force, but this can be only a supplementary means of winning air superiority. The main method must be destruction of enemy aircraft in the air and on air bases.)

(4) The struggle for air superiority and with it the main efforts of fighter aviation should be centered primarily about the ground effort. The reason for this is that only by means of ground action can the strategic aims of the war be attained. No independent air action can achieve results equal in importance to those air actions carried out in the interest of the success of the overall effort. In this context, air combat becomes as a rule extremely savage and calls for the greatest pressure and energy. Both belligerents can expect to suffer heavy losses as new air reserves are brought into action in the effort to secure freedom of action for the ground forces.[34]

From the contemporary U.S. perspective of "strategic," these lessons appear to relate to "theater" applications. However, from the Soviet experience, the Wehrmacht was Germany's strategic instrument. From the Soviet view:

> . . . Soviet military science considers that the outcome of war under contemporary conditions is decided on the field of battle by means of the annihilation of the armed forces of the enemy and that one of the most important tasks of aviation is active assistance to the ground and naval forces in all forms of their combat activity. This definition of the fundamental mission of aviation is not contradicted by the need to employ part of its forces to strike the deep rear of the enemy, or his military-industrial targets, but our military science does not consider such blows an end in themselves, but only a helpful means of creating favorable conditions for the success of the combat operations of the ground and naval forces. The structure of our military air forces is established on the basis of the scientific definition of the role and significance of aviation in contemporary war.[35]

In the context of early post war decisions these doctrinal statements are interesting in that they obscure the difference between frontal and defense aviation. The perception of an integrated air superiority mission epitomized by fighter-versus-fighter battles simplified potentially conflicting priorities by way of establishing a single set of interceptor requirements. Such a perception was not without foundation until 1957 when SAC released its fighter wings to the Tactical Air Command; U.S. B-36 doctrine called for fighter escort.[36]

b. Lessons Learned—Institutional

Beside the sanctification of fighters as the primary instrument of air power, the WWII experience confirmed the "correctness" of institutional arrangements in Soviet aviation. During the war years the Soviets produced 126,000 to 157,000 aircraft[37] of a quality comparable to those operational anywhere in the world—the German jets excepted. The Soviet perception was that "Our aircraft surpassed the enemy's in both quality and quantities."[38] While this perception of Yakovlev was self-serving since he was then Deputy Commissar for Aviation Industry, it is nevertheless important because he continued in that position through the period of significant postwar decisions. Moreover, it soon became a test of loyalty among the Soviet population at large to put down everything that was foreign and to proclaim the superiority of Soviet technology.[39]

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[34] Nikitin, Col. Gen. of Avn. A., "Soviet Aviation," Voennaya Mysl', Feb. 1949, p. 62. Quoted in Garthoff, p. 173–174. An early post war attempt to define a strategic doctrine more in line with Douhet's theories was unsuccessful. (Ibid., p. 172.) This does not deny that an extremely high priority was given to long range developments which would lead to an intercontinental "strategic" weapon. See Tokaev, Stalin Means War, pp. 91–121.

[35] 85th Cong., 1st Sess. DoD Appropriation for 1958, HR, Hearings, pp. 917–918. Quoted in Futrell, Ideas, Concepts Doctrine, p. 465.

[36] From Soviet figures. Yakovlev, 50 Years, p. 97. These figures are slightly conservative when compared with U.S. intelligence estimates circa 1949. The range is accounted for by the addition of Jan.–June 1941 (pre-war) production to the lower figure.

[37] Yakovlev, *Target*, p. 286.

[38] Tokaev, *Stalin Means War*, pp. 107–108.

[39] Lee, 1959, pp. 143–144.

The perception of design and industrial success on the part of the Soviets was appropriate in many regards. From the design standpoint, Asher Lee summarizes a widely held respect for the machines that were produced after 1943:

> . . . Their own YAK, MiG and LAGG fighters were more than equal in performance to the British Hurricanes and American Aerocobras and Kittyhawks—even the improved versions which they were getting in hundreds every month under Lend-lease. Indeed, the technical gap between the German and Soviet single-engined fighters had virtually closed by the end of 1943. French pilots who have flown the YAK, the Spitfire and the Messerschmitt 109 declare that the Soviet plane was the equal of its German and British counterparts. . . .[40]

From the production standpoint, the Soviet perception of success also is justifiable when compared with the production of its enemy. By 1944, Soviet monthly aircraft production was running ahead of the German industry. Despite the fact that over half of the Soviet aviation industry was relocated in 1941, production recovered within the year. In 1944, the last full year of the war, Soviet production reached 40,300 and German production was 40,953.[41] (No less remarkable than the Soviet recovery, however, was the German success at maintaining such a production rate in spite of allied air attack by dispersed use of underground facilities and other expedients.) The Soviet 1944 monthly production rate of 3,300 compares with a peak wartime U.S. rate of 7,100 although such comparisons ignore the large proportion of bombers in U.S. production which would reflect on an alternate measure of airframe weight. Despite qualifications, the perspective of institutional success appears justified. The Soviet aviation establishment had fielded a force roughly equivalent to that of its primary enemy; on the other hand, that enemy had other battles to fight. On the Eastern Front the Soviets had a rough 6 to 1 numerical superiority toward the end of the war.[42]

c. Lessons Learned—Design

A primary effect of the war was to emphasize the producibility of Soviet designs and modifications:

> The designer cannot forget for an instant that any improvement, no matter how necessary for increasing the quality of a piece of armament, must be introduced only with the consideration that it be reflected minimally in fulfillment of quotas. Therefore, the designers were in closest contact with the series production plants. Prior to introducing any innovation into an existing piece of armament, they had to anticipate in their own minds in minute detail what difficulties this improvement might entail in the mechanical processes. The designers had to effect their changes in such a way that they might be put into series with only a minimal loss in the daily output quota of aircraft sent to the front. This was an extremely difficult task, especially difficult when a new type of aircraft entered into series production. Under war-time conditions, the designer must also consider this fact in developing a new aircraft and his new product must make maximum use of existing technology in a given series factory.[43]

Another basic lesson was that of a relation between simplicity and utility in combat. Simplicity affected predictability but it also affected how fast weapons were available at the front. To train for the use of simple weapons was easy.[44]

The over-riding lesson was the necessity for technical capability. "To the designer, war is a difficult school. However, the lessons he learns stay with him throughout his life and serve as the motto: 'Be ahead!'"[45]

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[40] Kilmarx, p. 318.
[41] Lee, 1959, pp. 69–74, passim.
[42] Yakovlev, *Target*, p. 337.
[43] Ibid., p. 357.
[44] Ibid., p. 358.
[45] Ibid., p. 357.

d. The Commitment to Jet Interceptors

The Soviet aviation establishment was left in an uncomfortable position during later stages of the war. Work on advanced designs was discouraged in order not to divert resources from the production effort.[46] However, as Soviet forces penetrated Eastern Europe, the aviation community became aware of the array of weapons its enemy had in prototype and on the drawing boards. In late 1944, Soviet forces captured a quantity of Junkers JuMO-004 and BMW-003A jet engines and a number of these were provided to Soviet designers for experimentation.[47] Later when the German plants were occupied, they were returned to production as Soviet plants tooled up to produce the engines also. About the same time, a program was initiated to copy U.S. B-29 bombers, four of which began to fly into Soviet hands in August of 1944.[48] In November of 1944 with these precedents, a special committee under the Council of People Commissars, headed by Malenkov, was created to oversee the exploitation of the German economy.[49] This appears to have coincided with the focusing of intelligence collection efforts on U.S. jet designs.[50]

It was not until 1945 that a jet aircraft design effort was given official sanction by Stalin. The date may have been either in February[51] or in May when, with the German surrender, aircraft production was sharply curtailed.[52] In June, a party of about ten senior officers was dispatched to Berlin to organize the exploitation of German aeronautical science. By August 15, a Soviet program was initiated for flight testing the German Me262 jet. Meanwhile, during the autumn of 1945, the Aviation Commissariat had developed a detailed review of the "dangerous situation" in advanced technology and design.[53]

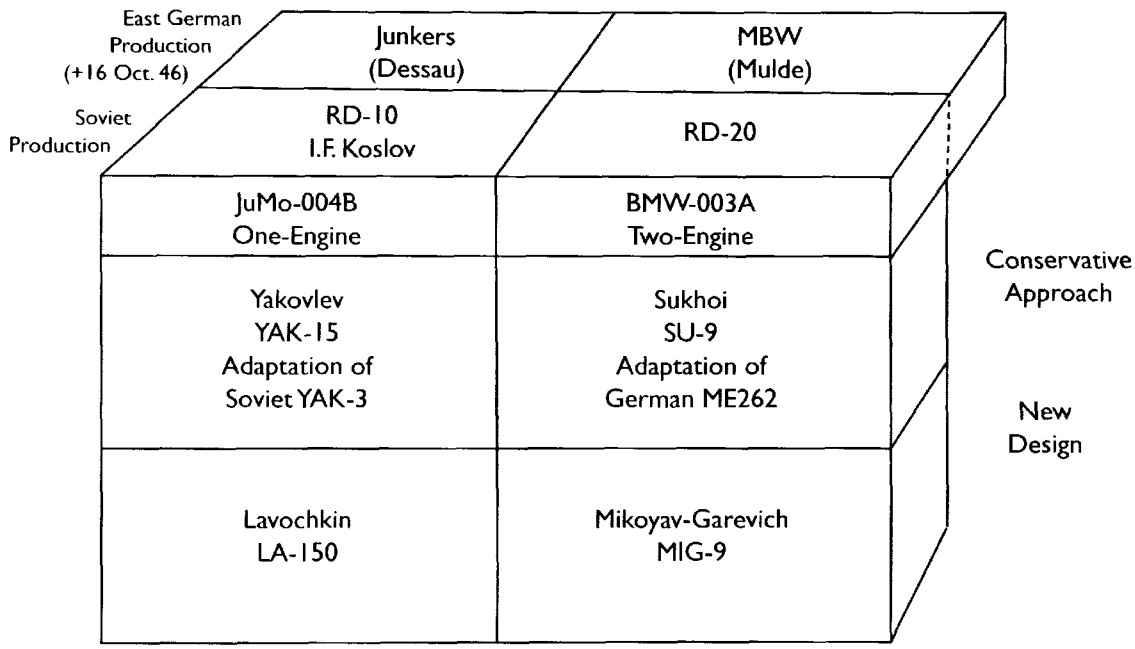
Among proposals surfaced in conjunction with the Commissariat review was one to commit the Me262 to production. During the presentation of the Commissariat's proposals to Stalin, however, Me262 production was opposed by Yakovlev on the basis that the aircraft was unstable and unsafe, that such production would divert resources from native designs and that more advanced prototype would soon be forthcoming from both his own and the Mikoyan-Gurevich design teams.[54] The proposal was rejected and a tentative deadline, the August 46 Tushino air show, was set for the new prototypes. Detailed project designs were approved for Lavochkin, Mikoyan, Sukhoi, and Yakovlev at about the same time. Concurrently, the Commissariat was reorganized as the Ministry of Aviation Industry and M.V. Khrunichev was appointed as Minister replacing Kuznetsov. The name and the appointment accompanied a general realignment of Defense Ministries. Nonetheless, it would be Khrunichev's responsibility to give concrete form to the Party commitments.

In all, four designer teams were involved in building fighter prototypes around the captured Junkers and BMW jet engines. Those which received the more powerful Junkers engines of 2,000 lbs. thrust, Yakovlev and Lavochkin, focused on a single engine design. Those which received the 1,800 pounds of thrust BMW engines, Sukhoi and the Mikoyan-Gurevich team, would focus on a two-engine design. Within both the single- and double-engine approaches, divergence emerged as to the conservatism of

[46] Lee, 1959, pp. 231–232.
[47] Green, "Billion Dollar Bomber," July 1971, p. 105.
[48] Kilmarx, p. 213.
[49] Hearings, Jet Propulsion, p. 121.
[50] Air International, "First of Many," p. 233.
[51] Yakovlev, *Target*, p. 362.
[52] Ibid., p. 363.
[53] Yakovlev, *50 Years*, p. 102, and *Target*, pp. 363–364.
[54] Air International, "First of Many," p. 233.

design. On the single-engine side, Yakovlev took the more conservative approach of fitting the new engine to an established airframe—that of the YAK-3 fighter. Meanwhile, the Lavochkin team committed itself to a new design. Among the two-engine competitors a like phenomenon was observed. The Sukhoi design focused on a refinement of the general concepts of the Me262 while the Mikoyan-Gurevich collective attempted a new design. Meanwhile, the aircraft engine establishment attempted to bring both the engine types into series production—the Jumo as the RD10 and the BMW as the RD20. Although the intention does not appear to have been documented, the program decisions for a successful jet were well hedged. Should either engine prove unworkable, an alternative was available. Should either the MiG or the Lavochkin designs fail, a more conservative back-up design was in progress using either engine. Should either domestic engine program fail, East German factories were kept in operation. A matrix of this hedging effect appears in Figure 7. Predictably, Yakovlev's re-engined version of the established conventional aircraft was the first of the four ready for testing in October of 1945. Not predictably, all four prototypes were basically successful.

Figure 7—Hedging Effect of Initial Jet Prototype Design Decisions



The claims about which Soviet jet aircraft was first to fly are[55] in dispute. Supposedly it was settled by the toss of a coin. Full flight of Yakovlev's aircraft had been delayed pending wind tunnel tests during the winter of 1945, while airfield conditions delayed both Yakovlev and Mikoyan until April 24, 1946.[56] With the coin toss, Mikoyan's air craft flew first and Yakovlev's followed. Both aircraft were supposedly demonstrated at the Tushino show on August 19, although only the MiG-9 was reported by USAF intelligence. The Su-9 flew in August and the La150 in September.

[55] Yakovlev, *Target*, p. 365.
[56] Ibid., p. 371.

3. Post–World War II Developments

a. The Ministry of Aviation Production Plan

In December of 1945 the status of Soviet aviation had come under debate in the Party Central Committee. The Aviation Commissariat proposals debated at that time culminated in a comprehensive program to eliminate any lag in the field of aircraft design or research. In March of 1946 a party of senior aviation personalities, Yakovlev among them, visited Germany to assess first-hand what could be obtained there. By April 2, a long-range plan for the development of jet fighters was laid before Stalin.[57]

The strategy for post war development of jet fighters was based on the rapid achievement of superior jet engine capability. Although the Soviets had some background in jet turbine design dating back to 1937, the work of its most experienced jet technician, Arkhip Lyulka, had been interrupted during the war. After working on an unheralded rocket aircraft project, Lyulka returned in 1942 to jet turbine work. By the end of the war he was bench testing an experimental engine of 1,543 pounds thrust and had initiated work on a 2,866 pounds thrust engine intended for flight testing.[58] It was apparent, however, that these engines were behind the world standard and would require extensive development while German engines were already available. The Commissariat plan would allow attention to be given to advanced engine design while native designed aircraft would be based on engines of foreign derivation. Key to the strategy was the purchase of British Rolls Royce centrifugal compressor engines—the Nene and the Derwent. In reacting to this strategy, Stalin is said to have remarked, "Just what kind of fool would sell his own secrets!"[59] Nevertheless, the Russians had had considerable experience with the British unclassified lists during the war and were aware that licenses for production of these engines were being sold in a number of countries. The successful attempt to purchase these engines would proceed.

The 1946 Plan addressed three stages of engine development with associated design activities[60]:

(1) Transitional aircraft based on 1,800–2,000 pounds thrust German engines. This stage was nearing fruition as the YAK-15 and MiG-9 were already in preliminary testing.

(2) Combat capability based on British Nene and Derwent engines of 3,500–4,850 pounds thrust. A requirement for such aircraft would emerge concurrently with the plan.[61] All four fighter design teams would submit prototypes which evolved to the MiG-15, the YAK-23, Su-11, and the La-15.

(3) Advanced aircraft based on engines by Klimov, Mikhulin, and Lyulka in the range of 6,600–17,600 pounds thrust. It was planned that these would be available in 5 to 6 years. Eventually, the Klimov VK-1 would power the MiG-15 bis, and the MiG-17; the Mikhulin AM-5 would drive the MiG-19 and YAK-25; the Lyulka AL-7 eventually powered the Su-9 and Su-11 of the late fifties.

The 1946 plan coupled with the December 1945 commitment of resources by the Central Committee would allow the Soviets to achieve superiority in jet engine technology in the early 1950's.[62] It facilitated early emphasis on advanced technology by leap-frogging intermediate stages of development with adapta-

[57] Air Enthusiast, "Lyulka," pp. 297–298.
[58] Yakovlev, *Target*, p. 372.
[59] Ibid., and Yakovlev, *50 Years*, p. 103.
[60] Flying Review International, "Mikoyan Quarter Century," Nov. 1965, p. 159.
[61] A regression analysis of Soviet and U.S. jet engine characteristics, conducted by RAND, concludes that Soviet jet engine technology led U.S. technology until roughly 1950–1953 depending on whether U.S. or Soviet forecasting equations were used. See Alexander and Perry, 1972, pp. 30–32.
[62] U.S. evolution from British technology is described Ibid., pp. 11–19.

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