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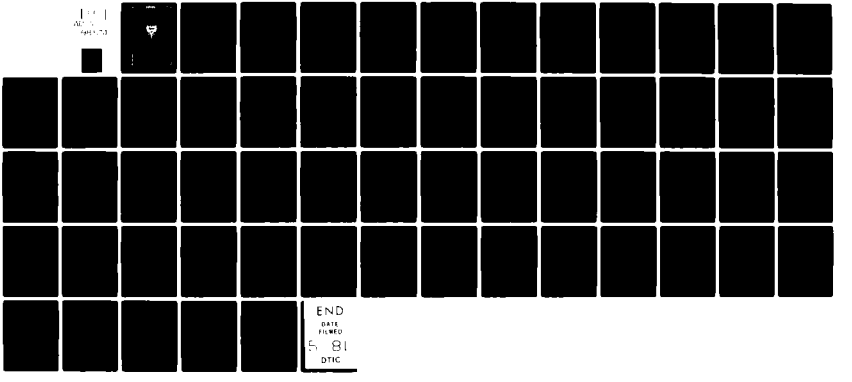

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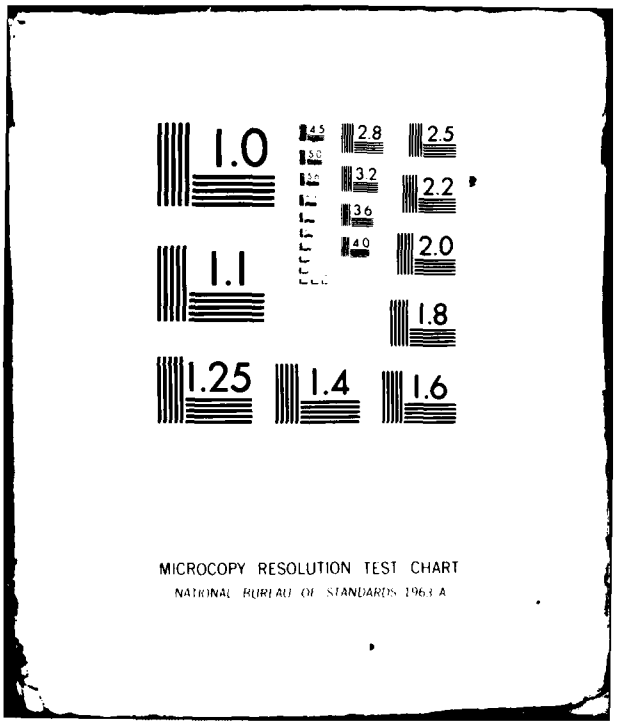
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STUDENT RESEARCH REPORT

THE TANK BUILDERS:
A HISTORY OF EARLY SOVIET ARMOR
RESEARCH AND DEVELOPMENT

MAJ GREGORY G. GOVAN 1979

GARMISCH, GERMANY

APO NEW YORK 09053

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MAJOR GREGORY G. GOVAN

June 1979

US ARMY RUSSIAN INSTITUTE

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F O R E W O R D

This research project represents fulfillment of a student requirement for successful completion of the overseas phase of training of the Department of the Army's Foreign Area Officer Program (Russian).

Only unclassified sources are used in producing the research paper. The opinions, value judgements and conclusions expressed are those of the author and in no way reflect official policy of the United States Government, Department of Defense, Department of the Army, the US Army Intelligence and Security Command, or the Russian Institute. The completed paper is not to be reproduced in whole or in part without permission of the Commander, US Army Russian Institute, APO New York 09053.

Interested readers are invited to send their comments to the Commander of the Institute.

ROLAND LAJOIE
LTC, MI
Commanding

"Unfortunately, a series of mistakes were allowed in the reference article, in regard to questions which touch on the history of tank technology."

V. Mostovenko

"A significant number of works have been written about Soviet armored forces. However, in the majority of books and articles, development and growth have been pictured without sufficient study of archival sources. Thus several problems, manifestations and facts often are evaluated one-sidedly."

A. Ryzhakoye

The author accepts the cautionary advice of Soviet historians, and dedicates this paper to Art Volz, to whose painstaking research these remarks can not apply.

SUMMARY

In this paper the author surveys the history of Soviet tank building from the first Soviet tank until the end of World War II. He identifies organizations involved with armor research and development, with special attention to the armored vehicle design bureaus. He examines the Soviet method of tank building to find elements of a Soviet design philosophy, including materiel requirements levied on the designers, and an identification of problems that the Soviets encountered. The author concludes that the history of Soviet tank building is relevant to contemporary problems; that Soviet tank design is a mix of designers' initiative, technological constraints, and a particular Soviet perception of the role of and threat to armored forces; and that the growth of Soviet armor was not as rapid or as purposeful as might be assumed. The paper is based almost entirely on Soviet sources and includes full citation of the Soviet literature with appropriate remarks on historiography in the notes.

I. INTRODUCTION

Tanks and other armored fighting vehicles are an essential component of modern land armies. They are also expensive, complex, take a long time to design and develop, and tax a nation's productive capacity; only a dozen or so nations today produce tanks (not all of which can be called original designs).

Russia employed no tanks in World War I. Along with this lack of experience, the Soviet Union inherited a limited industrial base with which to produce, or even design, tracked armored vehicles. By the time a sustained effort to build an armored force was undertaken in 1927, the Soviet Union was at least a decade behind the leading Western tank producers. Within twelve years of intensive effort, the Soviets had closed this gap and laid down the base for successful quantitative and qualitative competition with Germany. The Soviet Union had also accepted into its inventory a medium tank which, with modifications, saw it through the entire war and is generally acknowledged to have been the best all-around combat vehicle of that conflict.

It is the purpose of this paper to investigate the achievement of the Soviet tank builders, the institutions involved in the development of Soviet armor, how decisions were made and requirements fulfilled, and why development took the course that it did. The paper relies primarily on Soviet sources.[1] While there is a sizeable body of Western literature[2] or the subject of the development of Soviet armor, it is often undocumented, frequently cites other secondary Western sources when Soviet materials are available, tends to concentrate on hardware rather than the process that produced the hardware (or argues the process from the hardware), and tends to give short shrift to the period before World War II as unimportant to contemporary problems. This paper will attempt to trace all possible assertions of fact to a Soviet source. It will attempt to describe tank building rather than tanks. It will identify the tank builders' failures and problems as well as their successes. Finally, it will attempt to establish a contemporary relevance for the history of Soviet tank building.

II. SOVIET TANK BUILDING: A SUMMARY[3]

Prior to the October Revolution, Russia had done some experimentation with tanks, but had not produced more than one or two copies of a few experimental armored vehicles. Later Soviet authors take pains to develop a rich Russian legacy in armor ideas and concepts and to show a continuity of effort; but the new weapon and the new political system were born about the same time, and the most objective assessment probably is that, "the Red Army 'inherited' from the old imperial army neither tanks nor any kind of experience in their employment."[4] Armor for the Red Army in the Civil War and during the time of foreign intervention was limited to armored cars, armored trains, and such tanks as could be captured. In 1920 production of 15 light tanks began at the Krasnoye Sormovo Plant in Gorky (at that time, Nizhniy Novgorod); the vehicles were modified copies of a Renault model captured in the Ukraine. Even this modest beginning was not followed up, and for the next seven years the "Russian Renault" and a series of abortive design efforts were all the Soviet Union could manage in tank building. The total inventory in 1927 was 144 tanks[5] of various types, most of foreign manufacture.

After a series of false starts, a sustained tank program finally got underway in 1927 with the design of the T-18 (or MS-1) light tank, a logical outgrowth of the "Russian Renault". Production began, eventually running to about 960 by the end of 1931.[6] The T-18 allowed field experimentation with actual tanks and provided a test bed for further experimentation. Organizational changes saw the emergence of an office with direct responsibility for tanks and armored forces, the Directorate of Mechanization and Motorization, which conducted extensive tests and developed tactical-technical requirements for new vehicles. By this time, several plants had been drawn into tank design and production, including "Bolshevik" in Leningrad and the Kharkov Locomotive Factory.

The rapid industrialization of the Soviet Union meant, among other things, the possibility of increasing greatly the development and acquisition of armored vehicles. Soon after adoption of the first five-year plan, an ambitious tank development program began, calling for industry to create experimental tanks in five classes, with deliveries to begin in less than two years. The program was aided by purchases of British and American tanks. Experimental tank construction began at five Soviet plants,[7] and by the end of 1931 the Red Army had three tanks in series production, the T-26 light, T-27 tankette, and the BT wheel-track fast tank. These models derived from, and bore more than a passing resemblance to, the Vickers 6-tonner, Carden-Loyd Mark VI, and Christie T-3, respectively, which the Soviets had purchased.[8] By 1933, and the start of the second five-year plan, original Soviet designs for a medium tank, the T-28, and a heavy tank, the T-35, had also been put into production.

The pace of tank development quickened with the pace of industrialization. Over thirty experimental models were produced during the first two five-year plans. With close Communist Party supervision and intervention, new engineers were drafted into tank design and production. Leningrad emerged as a fertile design center for all classes of vehicles. Kharkov concentrated on modifications to the mass-produced BT series, while a plant in Moscow designed and produced a series of light amphibious vehicles that made use of automotive components. In the late 30s a second plant in Leningrad, the Kirov Plant (formerly Red Putilov), began to specialize in heavy tanks. By the end of the second five-year plan annual tank production was over 3,000 and the tank park of the Red Army had in excess of 15,000 vehicles.[9]

In the late 30s the Soviets faced the disquieting prospect that their large

inventory of tanks, over three-fourths of which were light tanks or tankettes and virtually all of which were armored only against small arms,[10] was likely to be outmoded by the widespread introduction of antitank artillery. The search for heavily armored vehicles ran through several prototypes put forth by designers in Leningrad and Kharkov. In 1939, after much testing and some bureaucratic delay, a new medium tank, the T-34, and new heavy tank, the KV, were adopted. Full series production of these vehicles had only just gotten started when Germany invaded the Soviet Union in 1941.[11] A long series of light tanks culminated in the T-40, adopted just before the German invasion. At the same time the T-50, intended to replace the veteran T-26, was withdrawn from production because it was too complicated.

The Soviet Union at war, then, had three models of tanks: The T-34 medium, KV heavy, and T-40 light. The war years saw the struggle to produce large numbers of these vehicles, complicated by the need to evacuate the three plants where mass production was originally laid down. In addition, product improvement was necessary to keep pace with German armor developments or to correct faults in the Soviet vehicles. The T-34 was upgunned in late 1943, as well as subjected to other modification. The KV also was upgunned, then replaced by the JS series. The T-40 was replaced by the T-60 and the T-70 in rapid succession, then production of light tanks was terminated completely. In addition to pure tanks, there was also a crash effort to produce assault guns, commonly called SAU (samokhodnava artilleriyskava ustanovka, self-propelled artillery mount), on light, medium, and heavy tank chassis.

III. DEVELOPMENT ORGANIZATIONS

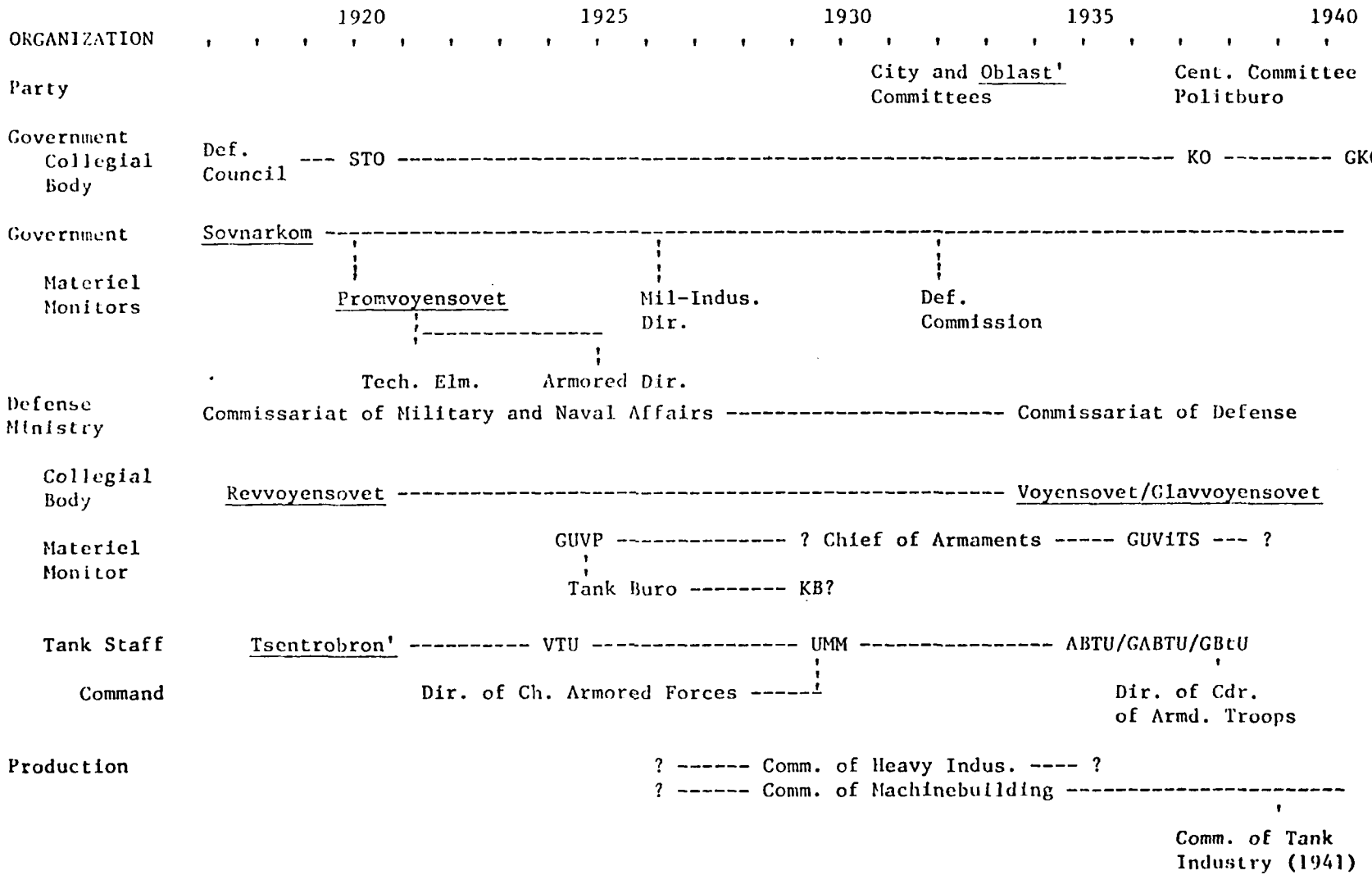
Many institutions were involved in Soviet tank building as planners, decision-makers, and executors. In this section we consider those bodies or organizations that ordered and controlled the tank builders.[12] In the next, we shall examine the design bureaus, where concepts, decisions, and guidance were translated into combat vehicles. The names and Soviet acronymns are somewhat confusing; Figure 1 lists the organizations discussed in this section, together with an indication of when they were active and where they belonged in the over-all scheme of things.

The Party. The Communist Party has affected the Soviet armor program chiefly as an expediter. Stalin's highly personal intervention in decision-making cannot be taken solely as a mark of Party intervention. There are, however, other examples of Party involvement. S. M. Kirov, Party boss of Leningrad, was instrumental in getting young engineers assigned to the design bureaus and production facilities which were developing rapidly in his city in the early 30s. Kirov is also portrayed as personally involved with the work and problems of the Leningrad tank facilities, especially the Red Putilov Plant, which would later bear his name.[13] During the war, the Gorky oblast' Party committee had a secretary for tank production who was an expediter and troubleshooter--as well as occasional hortator--for Gorky's two major tank plants.[14] A. A. Yepishev played a similar role in Kharkov and Nizhniy Tagil, having graduated from Party organizer of the Kharkov Tank Plant to oblast' secretary, then moved with the evacuated plant to its new location in the Urals.[15] Sergo Ordzhonikidze also intervened personally to have qualified young engineers assigned to tank industry plants and design bureaus, but it is impossible to decide whether he did so as a member of the Party elite or as Commissar of Heavy Industry.[16]

On at lease one occasion, the Party Central Committee revised requirements that had been laid down by itself and the Council of People's Commissars earlier, in a unilateral decree giving more restrictive, but still broad, guidance for armor development and accelerating the acquisition program.[17] On at least one other occasion the Central Committee held a special tank meeting attended by military leaders, designers, and tank industry workers. The meeting, in August 1938, does not appear to have been unlike congressional hearings, with the exception that its findings, calling for new vehicles answering modern requirements, appear to have carried more of a sense of urgency in their implementation. What exactly prompted this Party review is not specified by the reference,[18] which itself is at pains to make the role of the Communist Party in Soviet military force development as pervasive and positive as possible. There was at this time a protracted and apparently bitter dispute about future armor developments, but there are no other indications that it was resolved by the Central Committee; other sources[19] point rather to the collegial body within the Defense Commissariat. What emerges, then, is the possibility that the Party may have been the final arbiter of factional disputes unresolvable within defense circles. Its most pervasive role has been that of expediter outside the normal chain of command, intervening to obtain scarce resources or to coordinate--often by ignoring or circumventing--various elements of the government bureaucracy.

The Government. The Soviet government created from the very outset of its existence a number of broad, coordinating bodies that influenced the course of tank research and development (R&D). The Council of People's Commissars (Sovet Narodnykh Komissarov)(Sovnarkom) functioned as a collective executive. This body had various subordinate organizations at various times, plus obscure relations with other government coordinating bodies. Some of the latter appear to have been ad hoc organizations, created to address certain problems or to deal

Figure 1
DEVELOPMENT ORGANIZATIONS



with a new issue until it could be assigned a bureaucratic home. This would have been the case with much of military force development, and armor in particular, as the new nation at war for its survival managed most defense matters by exception.

Identified as subordinate to the Sovnarkom was a Military-Industrial Directorate, which was discussing a three-year tank program in 1926.[20] The Sovnarkom also had a Defense Commission which, in 1932, expanded the system of military academies, thereby increasing the pool of tank commanders and designers.[21] Also within the government, but at an unknown level of subordination to the Sovnarkom, was the Council of Military Industry (Sovet Vovennoy Promyshlennosti), known by its Russian abbreviation Promvoyensovet. Formed in September 1919, the Council appears to have had a broad role in coordinating all industry with a military potential. It is known that the Council made the decision to produce the first Soviet tank at Krasnoye Sormovo and reported to Lenin on the first tank in December 1920. There was a Technical Element that conducted tests, and an Armored Directorate that, in 1923, began to take responsibility for management of armored materiel. This was short-lived, however, as the directorate was disbanded, and the supervision of armored developments appears to have shifted to the Defense Commissariat.[22]

An increasingly important element of the Sovnarkom was a series of groups exercising coordinating authority at the highest levels. At first this was the Defense Council, chaired by Lenin, which was involved in the actual ordering of the first Soviet tank. This body became the Labor and Defense Council (Sovet Truda i Oborony)(STO) in March 1920. Especially active during the five-year plans, this organization was involved in the so-called great tank program around 1931 and adopted various decrees in implementation of military five-year plans in 1933-35.[23] According to a Western source[24] the STO had eleven members, including Stalin, and exercised powerful control over economic development during the initial five-year plans.

In April 1937 the Defense Commission and the STO were superseded by the Defense Committee (Komitet Oborony)(KO) of the Sovnarkom (after 30 June 1941, renamed Main Defense Committee (Glavnyy Komitet Oborony)(GKO)). This body coordinated all high-level defense planning, including national resource allocation. Of importance to armor development, the KO/GKO approved tactical-technical requirements for new equipment, approved the results of tests of new equipment, and made decisions on series production. In January 1938 it created a standing Military-Industrial Commission to deal with problems of mobilization and preparedness. The KO/GKO had authority to coordinate individual commissariats, enterprises, and design bureaus.[25]

The Defense Commissariat. Though in theory the KO/GKO controlled everything, in practice many of the tank building decisions, as well as other problems, were resolved within the Defense Commissariat. Until June 1934, despite name changes of its parent commissariat, the decision-making body for military affairs was the Revolutionary Military Council (Revolyutsionnyy Voyennyy Sovet), or Revvoyensovet. It was intimately involved in the 1929 tank program, issuing a decree calling for the immediate development of five classes of experimental tanks. It approved the tactical-technical requirements for these vehicles, and accepted new tank models into the inventory. In at least one case, it not only accepted a vehicle, but awarded production to a specific plant. It was also the Revvoyensovet that accepted a proposal in July 1929 to form an experimental mechanized unit, the first in the Red Army. In a description of force planning during the first five-year plans, the Revvoyensovet received broad strategic guidance from the Sovnarkom and Party Central Committee, and approved the detailed

plans developed by the Army Staff and directorates of the Defense Commissariat.[26]

The Revvoyensovet was disbanded in June 1934 at the same time that the Defense Commissariat was reorganized and renamed. The new "peacetime advisory organ" to the Defense Commissariat was called the Military Council (Voyennyy Sovet, after March 1938, Main Military Council, Glavnyy Voyennyy Sovet). The Glavvoyensovet was chaired by the Commissar of Defense and had ten members, one of whom was Stalin. Its decisions were carried out by the Defense Commissariat; a special group of the General Staff monitored the implementation of Glavvoyensovet decisions. In the tank area, these decisions included permission to the Kharkov plant to continue development of a controversial vehicle in August 1939, opening the way for fielding the T-34 the next year. On the question of whether to retain the tank corps as a unit, the Glavvoyensovet established a commission, then did not accept its findings and disbanded the corps and dispersed tanks to infantry units, a decision generally recognized as erroneous. It appears that the Glavvoyensovet also attempted to resolve a serious tank design argument--the "tracks only" debate--by means of an authoritative commission in the same year.[27]

The collegial head of the Defense Commissariat, by whatever name, acted much as a corporate Secretary of Defense. We must look to subordinate echelons of the Commissariat to find the line and staff organizations that actually worked on the day-to-day force development program.

The Commissariat from the earliest time had some element that monitored the materiel aspects of force development. Initially this was extraordinary and plenipotentiary post of the Council of Workers' and Peasants' Defense, whose responsibility was for equipping the Red Army.[28] The Promvoyensovet assumed many of these responsibilities under the Sovnarkom, that is, within the government bureaucracy as a whole. Within the Defense Commissariat, these materiel acquisition functions fell under the Main Directorate of Military Industry (Glavnoye Upravleniye Voyennoy Promyshlennosti)(GUVP), known to be active in tank research (quite probably assuming this function from the Armored Directorate of the Promvoyensovet), attempting to define the state of the art in tactics and design as the Soviets then understood it. By May 1924 GUVP had a Tank Bureau for design work and assistance to production facilities, and within a year had produced a prototype tank.[29] It was probably this group that contained or supported the early, single design bureau whose work culminated in the first mass-produced tank in the Soviet Union, the T-18. Significant armor R&D was hampered by the lack of an industrial base, however, and the GUVP, together with tank development, entered into doldrums.

By late 1929 the five-year plan was beginning to have the desired effect on the ability of Soviet industry to reequip the Red Army with modern hardware. Accordingly, the next materiel monitor in the Defense Commissariat was created in November 1929, the post of Chief of Armaments (Nachal'nik Vooruzheniy).[30] The first chief was I. P. Uborevich; after June 1931 M. N. Tukhachevskiy occupied the post. The Chief of Armaments was abolished in 1936, allegedly because the mission of the second military five-year plan had been accomplished. Tukhachevskiy continued to have responsibility for combat preparedness, but the function of Chief of Armaments was assumed by the Main Directorate of Armaments and Technical Supply (Glavnoye Upravleniye Vooruzheniy i Tekhnicheskogo Snabzheniya)(GUViTS).[31] This office was subordinated to the Defense Commissariat, but worked by General Staff directive. It contained three sections (mobilization and planning, inventions, and standardization) and a technical inspectorate. Its tasks included the development and coordination of plans for inventive, scientific, design, and research work; planning for materiel mobilization needs; and inspection of the

condition, storage, and use of materiel. The functions of GUViTS have probably been absorbed by a similar main or functional directorate of the Ministry of Defense.

Tank Staff. Another series of organizations may be considered as the emergence of a tank staff within the Defense Commissariat. The first of these elements, the Council of Armored Units (Sovet Bronevykh Chastev), or Tsentrobron', was organized in January 1918, mostly to deal with control over the limited but important armored assets of the Red Army (armored cars and trains). Tsentrobron' entered briefly into the early tank development story when it heard several experts give testimony in 1919 on the difficulties of building a tank in Russia.

The next tank-oriented staff element was the Military-Technical Directorate of the Workers' and Peasants' Red Army (Voyenno-tekhnicheskoye Upravleniye RKKA), established in 1924. Both the title and the tank connection bear a remarkable similarity to a tsarist organization, the Main Military-Technical Directorate (Glavnoye Voyenno-tekhnicheskoye Upravleniye), whose technical committee reviewed armored proposals in World War I and which financed the giant-wheeled Lebedenko project (the "Tsar tank").[33] I. A. Khalepskiy, one of the pioneers of early Soviet armor development, was the first chief of the Military-Technical Directorate, and when it was reorganized in 1929, Khalepskiy became the first head of the Directorate of Mechanization and Motorization of the Workers' and Peasants' Red Army (Upravleniye Mekhanizatsii i Motorizatsii RKKA). This office appears to be where most of the actual work in force development was done. The Directorate conducted extensive tests in 1930-1931 with newly manufactured T-18 tanks and BA-27 armored cars. It also developed both tactical-technical requirements for equipment and theory for its employment.[34]

The Directorate went through several renamings in the 30s and 40s, becoming eventually the Main Armor Directorate (Glavnoye Bronetankovoye Upravleniye) (GBtU) during the war.[35] It may be assumed that the GBtU continues to this day as one of the "Main and Central Directorates" of the Ministry of Defense with responsibility, in the armor area, for directing, monitoring and controlling research, experimentation, and design; supervision of research institutes and institutes of higher education; development of tactical-technical requirements for new equipment or improvements to existing materiel; and contracting with industrial producers.[36]

Tank Command. In addition to a tank staff, a tank command element also emerged in the defense sector. Tsentrobron' probably had some such command responsibility for the armored detachments of the Red Army. In the early 20s there was also a Directorate of the Chief of Armored Forces of the Workers' and Peasants' Red Army (Upravleniye Nachal'nika Bronevykh Sil RKKA). Tank proponency then seems to have belonged to Khalepskiy and his associates in the Directorate of Mechanization and Motorization and its descendents. The existence of a separate tank arm can be dated positively from December 1942 with the creation of a Directorate and Chief of Red Army Armored and Mechanized Forces (Upravleniye Komanduyushchego Bronetankovymi i Mekhanizirovannymi Voyskami Krasnoy Armii). With name changes, there has been a direct succession to the present post of Chief of Tank Troops (Nachal'nik Tankovykh Voysk) and its Directorate.[37] The involvement of the Tank Chief in materiel acquisition is not known, but it may be assumed that this office is primarily responsible for training and maintenance of existing materiel and is likely to be the office of advocacy for user requirements.

The Chief of Tank Troops probably commands the Military Academy of Armored Troops. At one time this school, set up in 1932 on the basis of existing

mechanization-oriented military schools in Moscow and Leningrad, contained industrial and design branches. These appear to have been dissolved, and the Academy's research limited to tactics and doctrine.[38] Kotin, the leading heavy tank designer at the Leningrad Kirov Plant, was associated with the academy from 1932 to 1937.[39] Two instructors, one of whom at least can be identified with World War II tank design, were awarded State Prizes for "outstanding scientific and technical discoveries" made at the Academy.[40]

Other Organizations. Three other organizations must be mentioned because of the influence they had on tank R&D. During World War II developmental decisions, like all other decisions, were within the purview of the Supreme High Command and its Stavka. The Supreme High Command gave orders to improve the T-34 and not replace it in 1943.[41] The Stavka reorganized tank armies in the course of the war, and also became the final arbiter for materiel decisions.[42]

Actual production of tanks was carried out by industrial ministries. The all-important design bureaus that belonged to plants also belonged to these ministries (or Commissariats). Ordzhonikizae's Commissariat of Heavy Industry was certainly involved in early tank production. The Commissar personally intervened to get young engineers into tank building; for its part, at least one subordinate plant--Red Putilov--used its association with the priority tank program to justify new equipment and get itself added to the list of "super-shock" enterprises, thereby insuring first priority on finances and materials during the hectic days of the first five-year plan.[43] The Commissariat of Machinebuilding was also involved with tanks, and it was from this organization that the Commissariat of Tank Industry, headed by V. A. Malyshev,[44] was detached in September 1941. Malyshev, his assistants, and Ordzhonikidze in the prewar years are identified in memoir literature chiefly as expediters and tough, on-the-scene troubleshooters. Their main concern appears always to have been production, and their relationship to the design bureaus is something of a mystery.

The last organization to be mentioned is the scientific community. Little is said about the contribution of researchers and academicians to military R&D, although it must exist and is probably coordinated by some standing organization whose mandate and functions are similar to those of the GUVP or Glavvoyensovet. One well-attested example[45] of scientific assistance to the tank builders is the case of Ye. A. Paton, a member of the Ukrainian Academy of Science's Institute of Electric Welding. Paton headed a team that introduced automatic welding of tank armor, greatly speeding wartime production of vehicles.

IV. DESIGN BUREAUS

Perhaps the most interesting organization in the R&D process is the design bureau (konstruktorskoye byuro)(KB).[46] This section presents an historical summary of the development of KBs and identifies some of the more prominent designers. Figure 2 illustrates the periods when various KBs were active, together with their principal designers and products.

Early KBs, 1919-1929. The Soviet Union had no tracked military vehicle design bureau prior to 1924. In that year some sort of design office was set up in the GUVP.[47] With little industrial base and less hope for large-scale production, tank design was probably limited to paper projects and mockups. The ad hoc group at Krasnoye Sormovo that had, beginning in late 1919, responsibility for engineering the production of the 15 "Russian Renaults" evidently had dissovled; it was, in any regard, little more than a fitting together of admiralty armor, AMO engines, and a simple French design, rather than a true KB.[48]

The single KB in GUVP was responsible for the T-18 design, a rework of the Krasnoye Sormovo tank. Production was awarded to the Bolshevik Plant in Leningrad; a small, production-oriented KB was probably formed in the plant.[49] No Soviet source names members of the GUVP KB, but Polish sources identify the lead engineer as Professor V. I. Zaslavsky. He and the other engineers in the GUVP KB developed other light tank and tankette designs at this time, none of which was placed into production.[50]

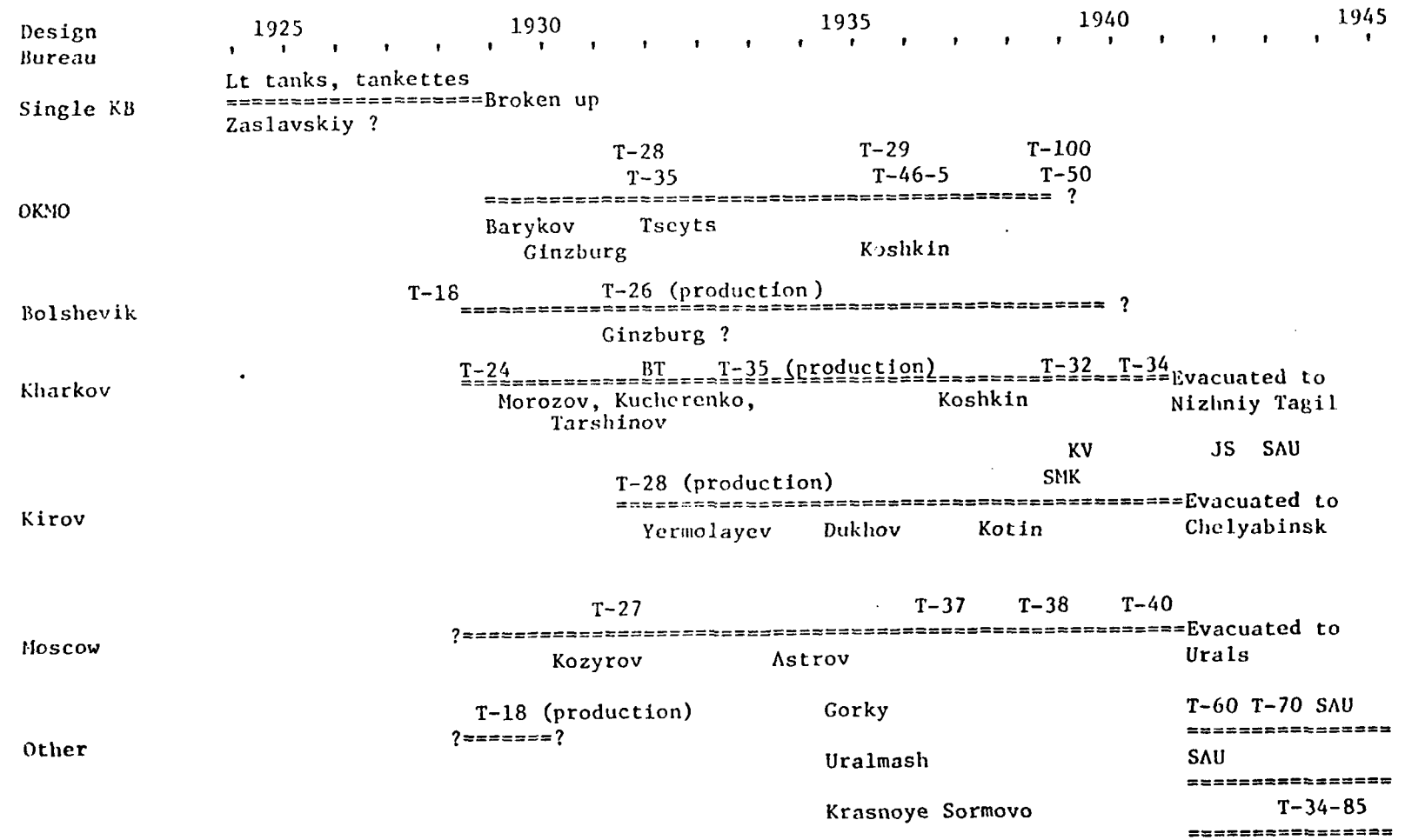
One of the effects of the 1929 tank program was to break up the single KB, giving more rein to the KBs in plants engaged in tank production.[51] In addition to Bolshevik, this included the Kharkov Locomotive Plant, which, in 1929, began production of the T-24, a local design done with the coordination of Zaslavsky.[52] The Kharkov project ran into difficulties, and only 25 T-24 were built.[53] The Bolshevik KB was no more successful in getting another vehicle into production, but the bureau was quite a bit more prolific in its efforts. It experimented with variants of the T-18 then in production, as well as tankettes and medium tank prototypes.[54] The Bolshevik operation became known as OKMO (for Opytnyy Konstruktorsko-Mekhanicheskiy Otdel, experimental design-mechanical section) and may, during this time, have been detached from Bolshevik to be a separate design and experimentation plant.[55]

1929-1937. The next impetus to the growth of the KBs was the decision by the Directorate of Mechanization and Motorization to buy foreign tanks, have production facilities work on them, and, if possible, put them into series production. As many as five plants were involved in experimental construction;[56] three definite KBs can be identified. The OKMO at Leningrad, led at the time by N. V. Barykov, worked with the Vickers 6-tonner and produced the T-26 under lead engineer S. A. Ginzburg.[57] Kharkov, by now also referred to as the Kharkov Tank Plant as well as Locomotive Plant, received the Christie T-3 and turned it into the wheel-track, fast tank BT series.[58] A plant in Moscow worked on the Carden Loyd Mark VI and produced the T-27 tankette.[59] As for the other two, about this time the Gorky Plant, probably was involved in production of the T-18, supplementing Bolshevik.[60] The Red Putilov plant (after 1934, Kirov Plant) in Leningrad got involved in T-26 production in 1932 and formed a small, production-oriented tank bureau.[61]

Until 1937, the KBs were relatively stable. Kharkov was committed to series production of the BT and its modifications, building about 5,000 by the end of

Figure 2

DESIGN BUREAUS



the second five-year plan (1937).[62] The KB was involved almost exclusively with modifications to this vehicle; production continued until 1940. A number of designers who were to become prominent later grew up with the BT during this period, most notably A. A. Morozov, N. A. Kucherenko, and M. I. Tarshinov.[63] The OKMO seems to have divorced itself from production, although the T-26, built at Bolshevik, went through a number of modifications, and was produced, like the BT, up until shortly before World War II. Also like the BT, the main concern over the T-26, in addition to continuous product improvement, was high production rates. The T-26 was the most numerous tank in the Red Army of the 30s; over 6,780 were produced by the end of the second five-year plan (1937).[64]

Despite the commitment of Ginzburg to the T-26, the remainder of the OKMO was involved in a broad range of projects. A team under N. V. Tseyts designed the T-28 medium tank by the end of 1931. Production of this original Soviet design was awarded to the Red Putilov Plant, which assumed full responsibility for T-28 design and production in October 1933.[65] Tseyts also developed a five-turreted heavy tank, the T-35, in 1931-1932. This tank, accepted into the inventory in 1933, also was farmed out for production, to Kharkov in this case, where less than 100 were built between 1933 and 1939. The OKMO may also have been involved with some tankette and amphibious tank work.[66]

In 1934 Mikhail Il'ich Koshkin joined the OKMO as assistant chief designer. Destined to become the most famous alumnus of the KB, he was one of several graduates of Leningrad Polytechnic Institute who had been detailed to work with the city's tank builders at the personal behest of S. M. Kirov. Koshkin was responsible for designing the T-29, a wheel-track version of the T-28 tank, and for the T-46-5, the first Soviet experimental tank to carry more than bullet-proof armor. For the latter design he received the Order of the Red Star. Koshkin was posted to Kharkov as chief designer in 1937.[67]

The third KB, at a tank plant in Moscow, continued to design and put into production a series of light amphibious tanks that used automotive drive train components. The series had begun with the T-27 tankette and continued with the T-37 (possibly with assistance from the OKMO), T-37A, T-38, and T-38 modifications. The head of the light tank KB was N. N. Kozyrev, then N. A. Astrov.[68]

At the Red Putilov Plant, the tank bureau benefited from high-level patronage. The small KB headed by Olimpiy Ivanov, consisting of about 25 engineers, was reinforced with two out of the seven new graduates of the Armored Academy who were assigned to the plant at the personal request of Ordzhonikidze. One of these was Afanasiy S. Yermolayev, later one of the three most important designers of heavy tanks. The second new designer was Raise Kompaneyets, the only woman tank designer mentioned in Soviet sources. The Putilov KB apparently was fully occupied with production problems on the T-28.[69]

1937-1941. Significant personnel changes occurred in 1937, and there was a decided shift in KB work. It is probably not accidental that these changes occurred at this time. The precise effect of the Great Purge on the tank builders is not known, but there is reason to believe that the designers themselves were not immune (see Section VII). As noted above, Koshkin went at this time to head the KB in Kharkov. He found there a talented group that had already cut its teeth on the BT series. Koshkin continued to press for product improvement of the wheel-track tank, chiefly by increasing armor protection. Not many months passed, however, before he formed a small task force of designers to work not just on product improvement, but on an entirely new design. On their own initiative the designers put forward a medium tank without the dual propulsion

system of the BT series, armed with a heavy tank gun, and carrying armor proof against most existing antitank guns. Koshkin fought for this original idea and was eventually rewarded by the acceptance of the Kharkov KB's greatest achievement, the T-34 medium tank. Koshkin died in September 1940, before he could receive the State Prize, First Class that he deserved.[70]

The light tank KB in Moscow does not appear to have changed its orientation. The T-38 was product-improved in 1938. Further experimentation continued, and the T-40 tank entered service in 1940.[71]

The OKMO may well have been the victim of some purging. Tseyts is not mentioned again after his work on the T-35. The Barykov team did some work on a multi-turreted heavy tank in 1938, the T-100. Somewhat later, L. S. Troyanov, an OKMO engineer, led a design group that developed the T-50 as a candidate to replace the aging T-26 light tank. Troyanov went on to win a State Prize for his wartime work with heavy tanks and assault guns.[72]

The Red Putilov, or Kirov Plant KB was greatly affected by changes at this time. In May 1937 Zhozef Yakovlevich Kotin arrived from the Armored Academy to be the new KB chief. Amazed at the cramped, crowded and disorderly state of the KB, Kotin was apparently successful in obtaining more room and more resources, and in getting the KB organized. He soon had the group working on heavy tank design projects. By 1938 Yermolayev was leading one design team in developing a twin-turreted, heavy tank similar to, and probably in competition with, the OKMO T-100 project. In what was to be a characteristic move by the Kirov Plant KB, this tank was given not a number designator, but initials of a prominent Soviet, in this case, SMK (for S. M. Kirov). SMK apparently won out over its rival and a model competed in the fall 1939 trials. At about the same time that the SMK project was underway, Kotin launched another Kirov Plant designer, Nikolay Leonidovich Dukhov, on construction of a single-turret, heavy tank using the newly developed tank diesel engine. This tank was christened KV (Kliment Voroshilov).[76]

Wartime KBs. The war disrupted and displaced the KBs and their plants. It also resulted in an expansion of the number of KBs as more plants were mobilized into production. The Kharkov KB was evacuated to Nizhniy Tagil and was concerned with its responsibilities for production as the lead plant for the T-34. Some developmental work continued under Koshkin's successor as chief designer, A. A. Morozov.

The OKMO disappeared as an entity; the only prewar designer mentioned as active after 1938 is Troyanov.[75]

The Kirov Plant KB relocated to Chelyabinsk where it did all wartime work on heavy tanks and participated in design of assault guns on heavy tank chassis. This included product improvements of the KV series and development of three wartime models of the JS (Joseph Stalin) heavy tanks, plus assault guns on KV and JS chassis.[76] Chelyabinsk also built T-34s and was one of the main producers of tank diesel engines.

The light tank KB moved from Moscow; Astrov was associated with the GAZ plant in Gorky. After work on the T-60 as a replacement for the T-40, the KB designed a T-70; production of light tanks terminated in 1943, but the KB continued to be active in design of assault guns on light tank chassis.[77]

Other KBs grew up in plants mobilized into tank production. Initially these were production offices, responsible for adaptation of drawings to local conditions and equipment. Gradually the KBs would introduce some production-associated product improvement, such as new assembly techniques or component fabrication.[78] In time, most KBs also became involved in major modification of the model their plant was producing, leading to design of a new combat vehicle. For example, a plant producing light tanks, evacuated from Moscow, was originally concerned with putting out the T-60 light tank. The KB, under S. G. Suren'yan, later worked on T-70 drawings, then developed an experimental, self-propelled air defense gun on the light tank chassis.[79]

The Ural Machinebuilding Plant (Uralmashzavod) also became a prime mobilization tank producer. Its KB, probably headed by F. F. Petrov, became the design center for assault guns based on the T-34 chassis. L. I. Gorlitskiy, a prominent assault gun designer who worked with both Uralmash and Chelyabinsk KBs, probably was originally with Uralmash.[80]

Krasnoye Sormovo, where the first Soviet tank was built in 1919, became one of the first plants to be ordered into mobilization production of the T-34. Its Kb, under chief designer V. V. Krylov, was totally committed to organizing production at first. The KB then introduced minor improvements, with the permission of the lead plant, Nr. 183 at Nizhniy Tagil, and the GBtU. In 1943 Krasnoye Sormovo introduced the most significant wartime change to the T-34, its upgunning from 76 to 85 mm.[81]

Postwar KBs. What became of the KBs after the war can only be guessed at, based on fragmentary biographic data. Aleksandr Aleksandrovich Morozov returned from Nizhniy Tagil to Kharkov.[82] He had tried to increase the armor of the T-34 in 1943 (the T-43), but the new tank was not accepted, since it retained the 76-mm gun of the T-34. More significant was Morozov's attempt, postponed by wartime exigencies, to increase the frontal armor of a tank similar in most respects to the T-34; thicknesses of 100 mm should have been possible by the simple expedient of mounting the engine transversely and applying the saved weight (because of reduced dimensions) to the frontal armor plate. Something like this was achieved with the T-44, designed by the Morozov KB as the war came to a close. The T-44 was an interim model, with many problems attributable to wartime haste. Morozov corrected these in the more carefully developed T-54.[83]

The T-55 was also undoubtedly the work of the Morozov KB, and the T-62 a strong possibility. Morozov won State Prizes in 1942, 1946, and 1948; these can be associated with his work on the T-34, T-44, and T-54 tanks. He also received a Lenin Prize in 1967 at the age of 63; this prize was not announced in relevant sources at the time, suggesting that it was for still-current defense work.[84] Morozov may be assumed to have continued leadership of a KB devoted to medium tanks and may only recently have retired, allowing some relaxation of censorship about his awards. Morozov is not known to have written any books or articles.

Two members of the Chelyabinsk KB can be traced in post-war tank activities. Nikolay Leonidovich Dukhov, though nominally assistant to Kotin, was probably more directly responsible for design work on the KV and JS tanks for which both get credit. After the war Kukhov was a designer in an unspecified sceintific research institute (1948-1954), and from 1954 until his death in 1964 he headed a "newly organized" KB. Dukhov received five State Prizes between 1945 and 1954, and a Lenin Prize in 1960.[85] It is tempting to think that he continued heavy tank design after the war with the JS/T-10 series, and may have been involved in the design of heavy tank-like missile carriers. Dukhov is not known to have written any books or articles. The identification and location of the KB he

headed for ten years cannot be established.

Zhozef Yakovlevich Kotin is probably the most prominent of the tank designers. He has consistently spent more time away from the drawing board than his two contemporaries. During the war Kotin was Deputy Commissar of Tank Industry at the same time he was nominally chief designer for the Kirov Plant complex in Chelyabinsk. In 1968 he was named a Deputy to the Minister of Defense Industry; in 1972 he became a member of that ministry's Science and Technology Council. Kotin holds three-star rank (Dukhov and Morozov have two and one stars, respectively). Kotin has appeared in print as an author and as subject of an interview. After the war, Kotin worked, by his own account, in several cities, then in Moscow. He developed the PT-76 amphibious tank soon after the war, and designed tracked missile carriers. At some time he may well have returned to Leningrad and the Kirov Plant, for he also claims to have contributed to the KT-12 and K-700 tractors, civilian vehciles built at the Kirov Plant. Kotin's last State Prize was in 1948.[86] His eclipse in the late 50s and early 60s may well be due to the relative success he had under Stalin's highly personal system. The tone of Kotin's remarks and the currying of favor he used in naming his designs after prominent patrons may well have marked him for obscurity under Khrushchev. Kotin's appointment to government posts in defense industry in 1968, at the age of 60, may be nothing more than a sinecure awarded by a regime willing to remember Stalin and Stalin's favorites with more esteem.

Of the other designers and KBs, there is only silence. Many undoubtedly continued in defense work. Many, like Krasnoye Sormovo, returned to civilian tasks.[87] Whether the pre-war triad of KBs at Leningrad, Kharkov, and Moscow that specialized in heavy, medium, and light tracked combat vehicles was reconstituted after the war cannot be determined from Soviet writings; it appears to be a reasonable conclusion from sketchy evidence.

V. METHOD

How were the Soviets able, from a standing start, to construct a fleet of first class armored fighting vehicles? While we do not possess a materiel need statement serving as a directive for designers, nor do we have a Soviet document describing the acquisition process per se, we are able to see in the Soviet literature elements of a design philosophy, a Soviet approach to development, and an outline of what kind of requirements, if any, were the driving force behind the tank building process. In short, we see a Soviet method.

Foreign Technology, Foreign Threat. One of the first things to strike the observer of Soviet tank development is the use of foreign technology. The first Soviet tank itself was a copy of a foreign model. The single greatest impetus to the tank program was acquisition of several British and American tanks which were then studied intensively and, with modifications, put into production. Soviet writers show a great sensitivity to this question, and bring it up in order to refute the idea that the T-17, T-26 and BT tanks were mere copies of foreign models.[88] The main arguments used are that the Western tanks in question were not in mass production in their home countries, and that adaptation to full series production was a Soviet achievement. In addition, the Soviet engineers made substantial modifications to all of the foreign tanks.

Going to foreign technology was justified, say Soviet commentators, in order to gain time. A crash program to build tanks of all types in less than two years, with very little production and design base, almost necessitated that the Soviets turn to foreign producers and designers with over a decade's experience.[89] Mostovenko, chief historian of Soviet armor, in particular defends the foreign acquisitions as absolutely necessary to shorten the design process by taking short cuts blazed by foreign developers. He maintains that the Soviets did not attempt to buy and produce blindly the newest tank models in foreign inventories, but rather bought those models which answered, to some degree, Soviet requirements, especially in mobility.[90] This contention is borne out in that each foreign model became the first of a family of vehicles with a particular type of suspension and running gear, and that the Soviets made significant modifications in the armament and thickness of armor carried.

Although the 1930-1931 acquisitions are the only major infusion of foreign technology that the Soviets mention, and then only to defend it, there are other examples that crop up. One the Soviets do not mention at all is joint military cooperation with Germany. Western sources, drawing upon accounts by the German partners, are able to specify a tank school and experimentation center at Kazan that was in existence by 1927, and that was to include shared work in materiel development.[91] When the Soviet Union turned to British acquisitions, these were to supplement the German models they were supposed to receive. This may also have been used by the Reichswehr as a means of circumventing restrictions imposed on it at Versailles.

Apparently the whole issue of German cooperation is too sensitive even for rebuttal by Soviet writers. One conclusion is that it may not have been very profitable in the tank area. A Western scholar concludes that there was nothing in Soviet armored innovations (materiel or doctrinal) directly attributable to the German influence, but also that

> the exact relationship between early Soviet work on and experimentation with the tank, as a machine and a weapon, cannot be determined with respect to the fortunes of the Kazan tank school, but, as with Soviet military aviation

> concentration upon a highly specialized arm coincided with intensification of work in the joint Soviet-German training and experimental centers.[92]

There are further hints that a willingness to use foreign technology, both as a stop gap and a spring board, was not confined to the earliest days of Soviet tank building. The BT series was powered by an imported Liberty engine until a native design was available in the second five-year plan.[93] And, while this new engine was made in the Soviet Union, it may well have been produced under foreign license, or been a highly derivative design. As late as 1939 foreign metallurgical developments were being followed closely to assist in the Kirov Plant development of a tank with better shell-proof armor.[94]

Closely related to the willingness to incorporate foreign technology is the idea of a sensitivity to foreign developments as threats. To what extent did the Soviet tank program respond to foreign threats, expressed in scientific and technical intelligence (S&TI)? To what extent did S&TI guide or inform their own work?

Once the Soviet Union was at war with Germany, S&TI played a significant and undeniable role. Dmitri Ustinov, then Commissar of Armaments (responsible for, among other things, artillery) is alleged to have presented the case for assault guns (SAU) to Kotin in the classic pattern of foreign threat requiring friendly development.[95] A Soviet historian notes that the further development of SAUs was tied directly to S&TI on German heavily-armored vehicles. Specifically, the appearance of the T-VI "Tiger" led to experimental firing of existing cannon at a captured model, to see which gave the best performance. Improvements in the KV series, particularly increased armor protection, can be tied to German introduction of subcaliber kinetic energy penetrators and high explosive antitank (HEAT), or shaped charge, ammunition for their antitank artillery. Appearance of the T-VI was a good reason to accelerate the Soviet JS program, while at the same time was sufficient to cancel further work on the T-43, an experimental tank that would have increased the armor protection, but not the firepower, of the T-34 medium tank.[96]

In war, it is easy to see that foreign developments tend to write program requirements. Was this true as well during the stormy period of tank development in the Soviet Union from 1927 to 1941? One can certainly see that, to a large degree, the course of development was guided by comparison to foreign materiel. The first military five-year plan required that Soviet forces

> in numbers of troops not be inferior to our probable enemies in the main theater of war, and in the area of technology to achieve superiority over the enemy in decisive forms of armament: aviation, artillery, and tanks.[97]

How exactly this superiority was to be defined is not spelled out. Based on descriptions and criticisms, it would appear that comparisons were broad and pragmatic. Numbers were important (quantitative superiority), but so was a qualitative comparison of gun size, armor thickness, and mobility.

Yet, in the pre-war period, there are some facts which would seem to indicate that S&TI was merely contributory to, rather than the main force behind development. One of the major decisions of the 30s was the adoption of shell-proof, versus bulletproof, armor for tanks. Foreign antitank gun developments were used to justify the decision, but there is little evidence such developments

actually prompted the changeover to heavier armor in a timely manner. The testing of armor took place using Soviet weapons with no apparent attempt to relate their capability to that of foreign cannon, and tanks were described as proof against their own tank cannon, rather than those of a probable enemy.[98]

It is, of course, a prudent course to assume that an enemy is capable of at least the best you yourself can achieve. One fallacy lies in assuming that he is incapable of something you have not undertaken, or that he will equal all your existing capabilities. This is the problem of so-called mirror imaging. One of the things that it permits is the justification of decisions taken for other reasons to be couched in terms of a putative foreign threat. A classic case occurred with the Soviet tank program immediately prior to hostilities in 1941. For reasons not wholly clear, the Main Artillery Directorate (GAU), headed by G. I. Kulik, wanted to terminate production of the new 76-mm tank cannon, then vitally needed to equip KV and T-34 tanks, in favor of a 107-mm cannon not yet developed. The reason cited by Kulik was "intelligence" on German 100-mm or greater tank cannon and a considerable increase in armor thickness on new German tanks. Both "facts" were far from the truth, but the appointment of a Commission and indicision by Stalin (who sided with Kulik) resulted in the Soviets having neither a new, 107-mm cannon nor a sufficient quantity of the existing 76-mm gun for new medium and heavy tanks.[99] In this case, bad intelligence was used to justify an already bad decision.

In another case, opponents of the T-32 universal tank, being put forward by Koshkin as an initiative design, appealed to foreign experience (or more precisely, to a lack of it) with such a vehicle to recommend against it.[100] Foreign developments in blunt, monobloc penetrators were also used by the Kirov Plant to gain support for its pet project of the moment, the development of dual-hardness armor.[101]

A safe conclusion, then, is that the Soviets certainly see their armored program shaped by broad comparison to foreign developments. In actual combat, the process becomes very much one of action-reaction. Without the direct pressure of combat, however, the Soviets have not been immune to the temptation to mirror-image, to design against their own capabilities, and to use intelligence data to justify, rather than guide, materiel acquisition decisions.

Pragmatism. A second characteristic of Soviet tank building is a strong pragmatic streak. This is reflected in two ways: the extensive use of combat or quasi-combat experience, and the prevalence of direct testing (as opposed to study or simulation), often with a flair for the dramatic.

The use of combat or quasi-combat experience goes back to the very birth of Soviet armor. The need for the first tank came out of Civil War battles where the Whites had tanks and the Red Army did not. Every time Soviet tanks were employed in the interwar period, there was a spate of lessons learned to influence future developments. It is true, however, that quite often the combat experience was misinterpreted and the wrong conclusions were drawn. This is especially true in the doctrinal conclusions reached after the Spanish Civil War (1936-1939), and the fact that materiel arguments following Soviet involvement in Spain were still being couched in the same terms after the Winter War with Finland (1939-1940). Thus although Soviet writers pay lip service to combat experience from the Chinese Eastern Railway (1929), Lake Khasan (July-August 1938), Khalkin-Gol (May 1939), Spain, and Eastern Poland (September 1939) (as well as second-hand observations about the blitzkrieg in western Poland and France), one wonders how effectively the lessons were learned. Every engagement

underscored the thinness of armor of Soviet vehicles as a weak point, and yet such lightly armored tanks continued to account for the bulk of production right up to the first year of World War II.

On the other hand, there is no question that the Soviets learned best from concrete employment of tanks. Only with the Kiev maneuvers of 1935, when an inventory had been built up sufficient to allow more than 1,000 tanks to participate at one time, did tank doctrine become more than theory. It was combat that drove home the requirement for assault guns and that gave the tank builders their most unequivocable requirements. And finally, it was actually getting equipment in the field and in use that identified design problems, ranging from the lack of power assists on the JS-2's 122-mm gun to poor visibility from inside early T-34s.[102]

The prevalence of direct testing is another aspect of pragmatism in Soviet tank building. When a point was to be made or a concept defended, the usual method was to devise some test, demonstration, or competition, often with a strong dash of showmanship. For example, ballistic tests seem to have been the only way to settle doubts about new models, techniques, or ways to deal with foreign materiel. When the Kirov Plant wanted to push its new silicon-chrome armor, it arranged firing tests at its own range, and made sure that prominent Party officials were on hand to see the dramatic results.[103] The first T-VI tanks captured from the Germans were fired on by various cannon to determine which production model (it turned out to be the 85-mm antiaircraft gun) could deal most effectively with this new threat.[104] When academician Paton introduced automatic welding of hulls, this obvious increase in production efficiency first had to be proven by firing on sample welded hulls to demonstrate that the integrity of the armor was no less than that of manually-welded tanks.[105]

Koshkin saw to it that one of the first pre-production models of the T-34 was fired on to demonstrate its improved protection.[106] This test also stressed the dramatic. The chief designer, sick with a cold, marked a tight triangle on the armor, betting the expert gunner lieutenant that he would miss. The shots hit dead center, but ricocheted or stuck in the plate and did not penetrate. As if to underscore the reliance on direct testing, during this firing one 45-mm antitank round "keyed" the turret, jamming between it and the hull. In combat, this would probably be a firepower kill, since the turret could no longer rotate. Designer Koshkin made the necessary notes for correction in production models. Why did this vulnerability only become apparent when an actual vehicle was fired upon by an actual weapon? One could ask as well why Koshkin and his design group at Kharkov determined the optimum angle for armor on the A-20 tank by firing tests.[107] Final proof had to be in actual use or in combat. But if results were unequivocable, they also sometimes brought up problems rather late in the R&D process.[108]

The dramatic test was not limited to live-fire testing of armor plate. Kharkov engineers were having difficulty convincing unnamed persons that tanks should be equipped with diesel engines rather than the gasoline models in exclusive use up to that time. The fire safety of the two type fuels was demonstrated dramatically by Kucherenko in the yard of the tank plant. He plunged a magnesium flare in a bucket of gasoline and a bucket of diesel fuel and let the results speak for themselves.[109] Koshkin also sent his first pre-production T-34s from Kharkov to Moscow by road march to dramatize their reliability; three models subsequently completed a 2,000 kilometer run that was part test and part show.[110] Both the KV and the T-34 were sent to the Karelian Isthmus to be tested against surviving Finnish antitank obstacles in the presence of a commission headed by

a general officer. The tests were a somewhat unusual application of "real-world" conditions to developmental testing.[111]

The empirical bias can also be seen in the Soviet approach to what may have been the most significant design problem they faced in the early 30s, suspension systems. The Soviets, as we have seen, purchased the best foreign solutions to suspension design problems, Vickers' proven reliability and Christie's novel wheel-track, dual propulsion. The Soviets then built tanks using these suspensions, and further refined and developed the designs. As Mostovenko summarized the situation, a lack of agreement on suspension design led to the use of multiple types and "permitted the determination of the most desirable design of tank suspension on the basis of considerable experience in exploitation and special research."[112] In essence, a decision to develop a particular type of suspension--or tank--was put off and multiple design options were continued.

This was seen also in the September 1939 competitive tes Unable to decide about the boldly innovative design for a new type medium tank, a commission reviewed everything that the multiple design approaches had produced to date. The tests, complete with grandstand, flashy driving by tank "aces", and death-defying acts that brought the crowd of dignitaries to its feet cheering, still did not result in a clear choice for what was to be the KV and T-34.[113] There was more deliberation by an "authoritative commission", more tests on the Karelian Isthmus, more appeal to the highest level of military decision-making to resolve a simple problem of technical feasibility. Throughout this extended process, the strong strain of Soviet developmental pragmatism was evident--get it in hardware and test it as thoroughly as possible.

Initiative. A third characteristic of Soviet tank building introduces the idea of design initiative. The conventional wisdom is that the Soviets are constrained in this area, that a chief problem is the inability to innovate or to sustain a high degree of innovation. Does the history of the Soviet tank builders bear out this conventional wisdom?

Individual initiative is evidently a sore point. Mostovenko goes to great length to counter the notion that many Soviet early developments were wholly derivative from foreign purchases in 1930-1931. This includes an elaborate attempt to create a tsarist legacy of native Russian ideas.[114] Mostovenko, and others, then go on to point to a large number of technological advances first made by Soviet tank builders. These supposed innovations include torsion bar suspension on a heavy tank, diesel engines in tanks, cast turrets, automatic electro-flux welding of armor plate, rubber-tired road wheels, combined machine gun and cannon armament on light tanks, electric power-rotated turrets, a coaxial machine gun, vertical stabilization of the gun sight, individual suspension, skirting armor to protect the suspension, wide tracks, welded hulls, tenon welding of side plates of the turret to the front, and high-obliquity hull shape as an essential element of ballistic protection.[115] This list, not exhaustive of Soviet claims, may well contain some "innovations" with Western antecedents or precedent The Soviets are generally correct, however, in claiming that even when an idea was pioneered in the West, Soviet tank builders were the first to incorporate it in large-scale series production models.

Whatever the outcome of laying claim to specific advances, it is known that the Soviets attached a high priority to innovation in tank design, even while they were forced to resort to imports of foreign expertise. Shortly after the first Soviet tanks were built, the government sought to encourage initiative through the simple expedient of a tank design contest, held in 1920. The winner

at that time was an amphibious design put forward by engineers from the Izhorsk plant that had supplied armor plate for the first Soviet tank. A second contest in 1922 had seven entries. The second winner, like the Izhorsk amphibious tank, did not get beyond the mockup stage.[116] The idea of a contest was also applied to solving engineering problems that arose in tanks already in production. Morozov, while still a junior engineer at Kharkov, won such a contest to correct a transmission flaw in the BT-5.[117]

Apologists for both Kotin and Koshkin claim that these two chief designers advanced the state of the art on their own initiative. For Kotin and the Leningrad Kirov Plant, the claim is made that the SMK was an initiative design using shell-proof armor, that the plant on its own advocated replacement of high-alloy steel armor with silicon-chrome plate, that casting of turrets was a plant initiative, and that Kotin and his KB were instrumental in the switch to diesels in tanks.[118] All these efforts went somewhat against the grain of contemporary developments and were a mark of design initiative.

Koshkin emerges as a more convincing innovator. He is generally credited with the first Soviet tank design employing anti-shot armor, the T-46-5, and holds the medal to back up his claim. This was at a time (early 1937), unlike the SMK, when a requirement for such armor had not yet been articulated. Koshkin, and Morozov as his successor, consistently exceeded literal requirements. The T-32 is the prime example. Given the requirement to improve the armor protection of the BT, Koshkin and his KB did just that with the A-20, "exactly answering the requirement". But then they went on to take the opportunity to design a new type, universal tank from the ground up. This "initiative" tank became the T-32, then the T-34. Koshkin even sketched out a tank like the T-34, but with 100-mm frontal armor, thanks to a transversely mounted engine. Morozov, in the middle of the war, attempted to realize this concept with the "initiative" T-43.[119]

In all this, the designer himself emerges as something of an entrepeneur. It is not at all clear who, if anyone, ordered or authorized all the initiative efforts of the OKMO or plant KBs. The designers apparently had some freedom to pursue their own projects, if they could be sold, but had a certain latitude for initiative regardless. In this regard, the KBs were apparently equipped to build experimental vehicles off the production line. An experimental shop, employing the best workers and under the direct supervision of design engineers, built the first, pre-production T-34s at Kharkov.[120] Krasnoye Sormovo had a similar "experimental sector" that did proof testing and experimentation on design improvement, even in the middle of wartime production.[121] All the production facilities, and their KBs, appear to have had their own, or at least had access to, firing range facilities.[122] The designers had, then, both the freedom and the materiel base to make use of that freedom. And, far from being tied slavishly to existing requirements, KB heads developed task groups to pursue specific initiatives, sometimes at variance with the official tasking on which the remainder of the KB was working.

The most prominent designers were clever about selling their efforts. Koshkin especially relied on a trained group of test drivers to help in the operational testing of new tanks and to be effective advocates for new vehicles.[123] Kotin proved to be a good salesman with Stalin himself, managing what, in 1938, could have been a dangerous confrontation over multi-turreted heavy tanks.[124] In late 1939 Koshkin saved his T-32 project in a dramatic meeting of the Glavvoyensovet, a meeting reminiscent of a US Defense Systems Acquisition Review Council decision session. The group was going against Koshkin's project because the A-20 answered requirements, because BT tanks had done well in recent action (with wheel-track, dual propulsion), and because the T-32 represented more technological risk and

doctrinal innovation than most would allow. Koshkin made an effective appeal, found support, and saved the tracks-only new tank.[125]

Both Kotin and Koshkin could court favor for their projects. Kotin insured the support of the powerful Leningrad Party organization by getting the leadership involved with his projects and tests. He openly curried favor by naming his designs after famous communists. Koshkin was more subtle, but no less effective. When the T-34 was first shown to Stalin and others in the Kremlin, the briefing officer for the new tank was a young engineer-tanker who just happened to be the son of Defense Commissar Voroshilov.[126]

Other. There are other aspects of what might be called the Soviet style of tank building, some of which have been touched on before. These include the personal intervention of the Communist Party and its leadership in the overall plan of tank development, as expressed in the military five-year plans, and in specifics of design, such as how many turrets a tank was to have.

Simplicity was both a goal and a result. Simplicity of design was recognized as the basis of reliability, and the struggle for simplicity in design, documentation, and production paid off during the trauma of evacuation of the core of Soviet tank production facilities at the beginning of the war and subsequent mobilization of less-skilled engineers and workers.[127]

A common practice for KBs was the development of new components on the basis of existing equipment. The MS-1 tank, for instance, was used as a design base for a variety of modifications. Upgunning was a common technique in production models (T-26, BT, T-35 secondary armament, T-34, KV, and JS) and even in experimental models (A-30 was an upgunned A-20). The new tank diesel engine was tested out in the BT-5. When the need for assault guns was finally stated, SAUs were developed on the basis of each type tank then in production.[128]

Closely related to the use of existing models for test of new componenets was the Soviet stress on commonality. Divergence and multiplicity of approach were encouraged where the final solution was uncertain and any or all variations showed promise. Such was the case with suspensions in the early 30s. When a component had proven out, or was in some way critical, it tended to be standardized, even among KBs. For example, the engine may well be the most critical component of a tank, in terms of length of time to design and test. Engines, accordingly, were fairly well standardized among tank models of similar type, and more important, were more often as not off-the-shelf, or slightly modified, engines already available in Soviet industry. The V-2 diesel, made especially for tanks (but not without its own antecedents outside the tank industry) was rapidly standardized and, in modified form, continued to be the basis for armored vehicle propulsion long after World War II.

Soviet tank guns were also well standardized. Indeed, the tank builders could count on new cannon designs from GAU more readily than on their own breakthroughs in vehicle design. In addition to the great commonality within tank circles of the 45-, 76-, and 85-mm cannon, one should also note that many of these designs were common to other field, antiair, and naval artillery applications. Finally, even suspensions, once settled on, became common property. Different suspension systems were the very basis of initial KB specialization, and yet the individual torsion bar, once proven by the Kirov KB on the SMK, quickly found its way into the T-40 of the Astrov KB, the T-50 at OKMO, and eventually the T-44 at Morozov's KB.[129]

Soviet tank development can also be characterized as having occasioned, and

survived, bitter factional struggles. We have already noted a rivalry between KBs. The history of the Kirov Plant makes clear that there was no love lost between the OKMO/Bolshevik and Kirov/Red PUtilov. Kirov Plant partisans cite the many errors in the T-28 design done by the OKMO, the difficulty of supply of drawings and materials, and hint that transfer of design and production responsibility for the T-28 in October 1933 was the mark of Kirov's victory in this feud.[130] The SMK and T-100 were probably rival designs, since they were too similar to have been put forward by one KB, and the Kirov history talks only of the SMK. It is only speculation, but Kirov may have benefited from whatever disaster overtook the OKMO in 1938-1939, picking up surviving engineers, such as Troyanov, and gloating over the disappearance of its rival.

Kirov's rivalry with Kharkov is no less significant, if more muted. The Kirov history implies a Kharkov inability to sell the deisel engine developed by Kharkov engineers and first tested in a Kharkov-produced tank. It belittles, by implication, the achievements of the brightest star of OKMO and Kharkov, Koshkin, by not mentioning his achievements in Leningrad, and giving scant attention to anything done at Kharkov. Allegedly, it was Kirov men from Chelyabinsk who saved the Kharkov Plant in Nizhniy Tagil from Beria's meddling in T-34 production, the ultimate condescending slight![131] This professional jealousy probably went beyond chauvinistic pride. Koshkin, with his T-32, was laying claim to a universal tank, with almost the mobility of a light tank, armor protection almost of a heavy tank, and armament equivalent to the largest then carried by any tank. A good medium tank might make heavy tanks superfluous. Tankers probably were lining up behind the rival KBs, insisting that tanks be designed to do what they wanted them to do, whether to break through prepared defenses in a repeat of World War I, or pursue the offense-in-depth theory that had fascinated some Soviet tankers since the 20s. The KB rivalry, then, probably reflected some deep divisions in the military over the use of tanks.

Another controversy was whether to go from bullet-proof to shell-proof armor. The appeals of both sides to the presence or absence of foreign threat antitank artillery was not nearly so compelling as the ability or inability of the Soviet Union to produce a sufficient quantity of heavy plate armor. Because KBs tended to specialize, some developed an institutional stake in lightly armored vehicles, and this merged with resource allocation problems in steel and fabrication sectors to complicate what should have been a straightforward military tactical and technical decision on bullet- versus shell-proof armor.[132]

A similar, but even more virulent controversy involved whether to allow Kharkov to continue to develop a medium tank with pure track propulsion. Koshkin was counting on technological development--pursuing a high risk course--with regard to both the diesel engine and track performance. He was flying in the face of demonstrated poor reliability of tracks, particularly at the high speeds he called for, on existing tanks, both foreign and Soviet. But the argument involved more than technology forecasting. The decision whether to build this new tank also struck a cleavage in military ranks over the role of tanks: were tanks only to break through, to exploit, or both? And were specialized tanks required for each role? What, in retrospect, seems a blind commitment to unwieldy and limiting dual, wheel-track propulsion delayed for some time a final commitment to the T-32/T-34.[133]

A final consideration of Soviet tank building is that it demonstrates more of an ability to concentrate resources than to plan. Tank building was a priority sector. The Kirov Plant could justify some of its expansion merely as a tank sub-contractor.[134] The GKO ordered an increase in tank production in 1932 even if it meant the exclusion of other defense programs.[135] People and material

resources were diverted from other critical areas of industrialization to bolster the tank plants and their KBs.[136]

But for all the concentration, there were problems of planning that ran from the overambitious to the absurd. The program laid down in connection with the first military five-year plan in 1929 must be assessed an unrealistic crash effort. It called for test models of seven tank and armored auxiliary vehicles to be completed within 18 months; production was to begin in two to three years. This was required of a production base which had not yet built more than about 100 tanks of any kind. Yet the plan was to go to an inventory of over 1000 in less than two years. It is little wonder that it soon became obvious that the program would take more time than originally planned.[137]

But this first plan was not an isolated occurrence. Nearly everything about Soviet tank building had a crash program aspect to it.[138] For one reason, although the original plan foresaw their utility, assault gun/self-propelled artillery weapons were not put into series production until well into World War II. Then production was ordered in ridiculously short times--25 days for the SU-152 from initial requirement to first production model. SAUs were required with such haste that design and production planning proceeded simultaneously. This precipitate haste also helps account for the fact that nine separate models of SAU were put into production in three years, 1942-1945.[139]

The quality of planning in Soviet armor development is also called into question in individual production decisions made in both peace and war. In the mid-30s the wheel-track T-46 tank was developed; it was similar in appearance to the T-26, but with a BT-type suspension (with four drive wheel pairs instead of one when running without tracks). Production of the T-26 was discontinued in favor of the T-46, but after putting out a small number of the new tank, it was found to be overly complex and less reliable than other Soviet tanks of that time. It was belatedly discovered that the T-46 also duplicated the BT series with no improvement in combat characteristics. The T-46 was then withdrawn from the inventory and T-26 production started up once more.[140]

The T-50 light tank also suffered from a premature production decision. It was planned and programmed as the replacement for the T-26 series vehicles. It actually entered production, but was withdrawn after 65 were built. While a fine tank, the T-50 was complex and would have demanded almost as much material and labor as a medium tank.[141]

One of the most curious incidents of planning--or lack of it--was the decision in 1943 to upgun the T-34. The plant responsible for engineering the modifications to the tank was Krasnoye Sormovo; it designed and tooled up for a new turret (that also corrected other design problems of the original T-34). This new turret was specifically designed to accomodate the 85-mm gun then in production. At the same time, the V. G. Grabin artillery KB developed a new 85-mm cannon to be used for upgunning the T-34 and KV. As luck would have it, the new gun did not fit the new turret. The heads of GAU and GBtU, Commissars Malyshev (tank production) and Ustinov (artillery production), Grabin, and the chief marshals of tanks and artillery descended on Krasnoye Sormovo. The tankers wanted Grabin to modify his cannon, the artillery men wanted Krasnoye Sormovo to redesign and retool its turret production. Tempers flared and strong words were exchanged. In one account, Moscow intervened; in another, it was decided on the spot among the contenders to send Grabin back to the drawing board.[142]

VI. REQUIREMENTS

A close look at Soviet writings not only says something about the style of their armor R&D, but also reveals some of the specific requirements levied on the tank builders.

Concepts as Requirements. Some tactical concepts almost certainly served as requirements. In 1927 tank regulations were contained in those issued for infantry; provisional instructions for tanks were issued separately in 1928. Beginnings of a doctrinally distinct armor branch can be dated from 1929 Field Regulations (PU-29). Calling for five classes of tanks, PU-29 was clearly ahead of the materiel on hand (foreign models, a few Krasnoye Sormovo tanks, and the first few MS-1s). A review of the rich tactical and doctrinal literature of the 20s indicates that theory was outrunning equipment; this theory could be conceived of as materiel need statements to be fulfilled by industry. But there was also an interaction. The setting up of experimental units reflected the realization that even provisional regulations were based on theory rather than experience, and that a great deal of practical work had to be done with real vehicles before doctrine could be laid down with assurance. Mostovenko, the equipment-oriented observer, states that in the late 20s instructions for employment of tanks followed existing equipment capabilities. And, perversely, a Soviet anthology of early doctrinal writings footnotes the opinion that a "cautious approach" in defining missions of early mechanized units was attributable to the materiel qualities of equipment at that time.[143]

It would appear that the Soviets have not sorted out in their own history the degree to which tactics and technology determine one another. Official statements of tactics, of course, must be based on equipment in the field; in this regard, doctrine is constrained by materiel. But there were also visionaries writing in the 20s and 30s, whose theory became the statement of requirements towards which the KBs pressed. One such visionary was V. K. Triandafillov, author of "Instructions for the Conduct of Deep Operations" (1932), the three-volume Character of Operations of Contemporary Armies (1932), "The System of Tank-Tractor-Vehicle-Armored Equipping of the RKKA" (1929), and major contributor to PU-29.[144] Such writers did push the development of the state of the art in tank building, particularly when one remembers that Triandafillov and Khalepskiy not only wrote, but occupied positions where they could act on their opinions. Khalepskiy in particular was instrumental, as the first head of the Mechanization and Motorization Directorate, in acquiring foreign tank models to start the rapid expansion of Soviet tank building.[145]

Combat Experience as Requirements. Combat experience was less ambiguous than theory as a source of requirements, although we have seen that experience with lightly armored vehicles in Spain and elsewhere was variously interpreted. Early maneuvers, as quasi-combat experience, certainly helped specify some requirements, particularly speed and reliability. In combat such things as the maximum effective engagement range, tank against tank, acquired extreme importance, and the decision to upgun the T-34 and KV can be attributed to a perceived range disadvantage: German tanks could kill Soviet tanks before the latter could get close enough to be effective.

Characteristics as Requirements. Most interesting to consider are the specific characteristics that were set as requirements. These can be inferred from the qualities used by Soviet writers to characterize or compare tanks, especially those qualities to which a numerical value habitually is attached. Some characteristics were given for the tank builders, for instance engines and tank guns.

These were the result of work at other KBs. But the choice among such off-the-shelf components (where it existed) and the struggle with characteristics over which the tank designer did have control indicate what physical or performance values were desired and probably issued as requirements to the tank builders. These requirements included high speed, high mobility (a low ground pressure), constrained weight, relatively heavy armor, large caliber main armament, and ease of production. We shall consider each of these below.

A requirement for high maximum speed was behind the prolonged Soviet involvement with wheel-track, dual propulsion and the Christie fast tanks. High speed certainly was a requirement for the BT and any tank that would replace it.[146] Significantly, Mostovenko traces a predeliction for speed all the way back to tsarist tank prototypes. Soviet writers fault their tanks of the 30s on several counts, but never of speed; on the contrary, failures of the 30s, such as the T-46, might be criticized as not fast enough in comparison with the T-26 or BT.[147] Generally, the BTs ran in excess of 50 km/hr on tracks, 70 on wheels. The beauty of the T-34 was that, with track propulsion alone, it could also move in excess of 50 km/hr, yet carry much heavier armor. A speed requirement was probably expressed as so many km/hr or no slower than some existing model.

A closely connected requirement was for high mobility. This was a decisive factor in early foreign acquisitions. Mostovenko is critical of German tanks because of their poor power-to-weight ratio and high ground pressure, both indices of overall mobility.[148] The detail in which ground pressure is discussed, and the attention paid to the introduction of wide tracks on heavy tanks, indicate that ground pressure was a stated requirement. Improved mobility was the goal of several modifications, especially the wartime modification of the KV-1S.[149] Key mobility requirements were probably expressed as so many kg/cm^2 ground pressure, the ability to negotiate given obstacles, and a cruising range of so many kilometers. Based on World War II tank characteristics, ground pressure was probably held to no more than 0.83 kg/cm^2 and range to at least 400 km (medium tank on roads).[150] Engine horsepower is often cited as a mobility characteristic, the designers could only use the engine available. With horsepower given, it is logical to assume that ground pressure and weight became the critical variables.

Maximum permissable weight was unquestionably a stated requirement. Virtually every early tank that underwent modification had some "weight gain". This was usually the result of upgunning and increased armor. But it is clear that weight was recognized as the critical design parameter. This was especially true of heavy tanks, where it is well-attested that the weight of the JS could not exceed that of the KV it was designed to replace. Mostovenko states that "all basic design decisions for the JS-2 tank were subordinated to the fulfillment of this requirement."[151] Gross weight is important, considering the significance attached to mobility as a desired characteristic and the fact that undue weight increase would require a new engine to get equivalent performance. Mostovenko is critical of German armor for letting weight get out of hand with the T-VI Tiger and Ferdinand assault gun. He notes especially that the JS was able to achieve thicker armor and still weigh less than the T-VI.[152]

The debate about shell- versus bullet-proof armor is indicative of armor protection being a design requirement. Evidently, what was specified was impenetrability to given calibers of antitank weapons at certain ranges. The term "effective thickness" did not occur in Soviet writings, but the concept of sloping armor plate to increase its effectiveness was certainly applied.[153] Armor thickness is usually given for tanks without reference to its obliquity,

however, and may have been so specified in tactical-technical requirements.[154] Quality of armor plate was apparently a KB and plant matter, rather than a requirement. A reasonable conclusion, then, is that the military requirement was specified in terms of invulnerability to kinetic energy penetrators, with the KBs left to decide what combination of thickness, quality, and obliquity of plate was required. The introduction during World War II of shaped charge, chemical energy rounds that could penetrate any practicable thickness of battlefield armor must have complicated the Soviet process for stating requirements for armor protection. The literature provides no indication of how they modified their approach. There is a hint that armor protection requirements were not seen in terms of a gun-armor race any more, but rather as part of a direct comparison of tank versus tank.[155] That is, requirements for armor protection were then stated not as immunity to given weapons so much as relative protection that exceeds that of foreign tanks.

Soviet tanks habitually carried the largest caliber cannon then reasonably available and suitable for employment on a combat vehicle. Sometimes even the suitability requirement was hedged with such unwieldy weapons as the KV-2 and its absurdly outsized 152-mm howitzer mounted in a giant box turret.[156] Gun caliber seems to have been the basic requirement, although this may have been specified with an eye to weapons already available. Muzzle velocity was certainly a factor, but more of a requirement for artillery than tank KBs. Ammunition carried on board was a characteristic which seems willingly traded off for other requirements. During the war the main firepower requirement for tanks and SAUs was to carry a weapon large enough to defeat enemy tanks without an excessive range disadvantage. For tanks, this meant a steady increase in gun caliber. For SAUs, the overall trend was for larger caliber weapons, but more effective cannon were also used to replace less effective ones of larger caliber.[157]

The relative ease with which a given tank could be produced was certainly a requirement, but one that was probably imposed by the producer rather than the military customer. As already noted, two tanks at least were accepted, then removed from the inventory because it was too difficult to build them. The T-34 was left alone for two years so as not to disturb production rates, considered more important than correcting problems that had cropped up.

Ease of production was certainly motivated by the need for huge production runs to meet inventory requirements and to replace losses. The units formed in February and March of 1940 required more than 15,000 T-34 and KV tanks.[158] Once hostilities began, high loss rates complicated the problem of building up to and beyond this level. Loss figures are not readily available, but some indication can be gained from published data on production and inventory at selected points during the war. For instance, the end-of-war inventory of SAUs was about one-third of total wartime production; about 14,000 SAUs had been lost.[159] In January 1943, 13,200 tanks and SAUs were on hand, meaning that one and a half years of fighting had destroyed over half of all tanks produced since the war began (nearly 30,000) plus the entire pre-war inventory, which must have been well over 10,000.[160] A year later there were less than half as many tanks and SAUs, although 24,000 had been built in 1943; this puts the losses for that year at something like 30,000 vehicles.[161] Over 9600 tanks and SAUs were lost in the first half of 1944.[162] With this experience, it becomes evident why ease of production might be a valid requirement.

There were other requirements specified to the KBs. One was probably a late, and limited, concern for habitability, or crew comfort.[163] Mostovenko identifies another possible requirement, the need to balance economy of production with a desire to build many specialized vehicles. He also mentions what was probably

less a requirement than a fortuitous occurrence, that Soviet tanks had a long useful service life and room for system growth (upgunning being the prime example).[164]

One final word on requirements must note that whatever was specified to the KB, there was a considerable amount of free play. The major decisions of the late 30s involved abondoning dual, wheel-track propulsion on light-medium tanks and multiple turrets on heavy tanks.[165] Both developments were made in oppositon to the stated requirements then in force.

VII. PROBLEMS

It would be false to assume that Soviet tank building proceeded smoothly and without major difficulty. There were problems, some of which have been touched on already. The following is a summary of some of the difficulties which beset Soviet tank R&D.

Determining Requirements. Kotin bears witness to the fact that there was no unity of opinion on how tanks should be employed and hence how they should be built.[166] In addition to ambiguous statements of requirements, there were some that were celar, but inappropriate. One example was the "tyranny of the satisfied customer"[167] who desired light armor when this was increasingly inexpedient, or whose unreasonable demands for speed limited other development options. Finally, there were cases when guidance was simply conflicting. For example, what would be the reaction of the KBs to "specialists", some of whom were advocating tanks with the speed of a BT and others who were putting 20 km/hr as an upper limit?[168]

Reliability. Some of the most significant advances in Soviet tankbuilding came about as a result of a designer taking technological risks. This is all the more impressive when one considers that reliability in general plagued so many of the Soviet innovations of the 20s and 30s. Tracks in general were a problem. The clutch was an early source of difficulty for the T-34.[169] Opposition to the diesel engine was based on questions about its reliability. And entire models were so unreliable as to cause their withdrawal from the inventory; the T-46 light and T-24 medium tanks are two examples.[170]

Production Base Limitations. For all the words said about the presence or absence of enemy antitank artillery, the capacity of the Soviet industrial base to roll heavy armor plate and build large numbers of tanks by forming and welding such heavy armor was probably the main reason why lightly armored vehicles dominated until the late 30s. There are probably other examples of where requirements were set to what was possible and a tactical virtue made of production necessity.

Crash Programs. Every component of the Soviet tank building program was foreshortened. Individual designs were not allowed to mature, and projects, such as the T-44, often showed the effect of great haste. This is excusable in wartime, of course, but it also characterized the prewar years of industrialization. Comprehensive planning was impossible, and as a result little technical details as well as major concepts (such as the requirement for self-propelled artillery) fell by the wayside.

Early Production Decisions. We have noted the number of tanks rushed into production, only to be withdrawn shortly, or subjected to extensive modification. Partly this is due to the crash program atmosphere, partly to the evident Soviet penchant for working problems out in hardware rather than on paper. Such an approach is fine, if tanks are the only thing being developed; there is no great impact on R&D, short, of course, of tying up production lines for retooling. But tanks were never the only thing the Soviets wanted to do, and they had resource allocation problems. Quite possibly one reason SAUs were not built before the war is that the facilities to design and produce them were committed to tank programs that were not allowed to mature before being rushed into production. KBs became preoccupied with correcting faults and products improvement, often to the exclusion of substantially new work.

Resistance to New Ideas. Mostovenko mentions the "inertia of old design methods and approach to heavy tanks".[171] Rotmistrov was critical of the cavalry attitude

that wanted to mechanize horses, yielding tankettes, the large park of which proved useless at the beginning of World War II.[172] The story of the T-34 is certainly the story of resistance to the new idea, the new approach. Even the diesel engine had to force its way over the objections of those who were comfortable with the old, and dangerous, gasoline models.

Engines and Running Gear. Engines were a special problem in prewar tanks. We lose sight of this if we focus on wartime and postwar development, since the V-2 diesel largely met engine requirements for the next three decades. Mostovenko notes that it takes longer to develop and put into production an engine than a tank, given the engine.[173] This area must be considered at least one of the pacing technologies for Soviet tank R&D. It is expecially so when one adds running gear. The whole drive train probably gave more difficulty to the KBs than any other aspect of the armored venicle. It is interesting as well to note how much of the first rate design talent was intimately involved in propulsion problems. Morozov was intitally a transmission specialist and Dukhov's first work was with modification of the T-28's final drive.[174]

Rivalries. Looking back on the conflict between Kirov and Bolshevik/OKMO, and between Kirov and Kharkov, we must ask whether such rivalry was healthy or internecine. At times it seems to have encouraged different approaches, but on the other hand it may only have divided effort and squandered scarce resources.

The Purge. Erickson, a chief Western authority on the period, believes that the purge struck the military-industrial establishment all the way down to KBs, but that there was no appreciable effect in the tank sector.[175] There is ample evidence that officers concerned with tank tactics were hard hit. Tukhachevsky was killed and Khalepskiy demoted. The anthologies of strategic and tactical suggest that they were purged, while the introduction to the armored section of one anthology notes that the development of deep operations and employment of tanks was called into doubt because proponents were "repressed" and declared "enemies of the people".[176]

There is good reason to believe that the tank builders themselves also were affected by the purge. We have noted that the OKMO disappeared sometime around 1938-1939. Was Barykov, last mentioned in connection with the T-100 (1938) and not cited in any wartime KB, purged and his subordinates scattered? While we may never know the answer, Mostovenko, in a rare reference, notes that professor V. I. Zaslavskiy was "a victim of unfounded repression in the period of the personality cult".[177] It is a brief allusion to a man Polish writers identify as head of the first central tank KB in the Soviet Union. Surely there were others. The question is, did it have an appreciable effect on tank development, laying aside the human tradegy? We shall probably never know, but we can begin to see a reason for indecision and delays in 1938-1940. The almost fatal hesitation in fixing on the KV and T-34 tanks meant there were not nearly enough in the inventory by the time Germany invaded.[178] The hesitation of Commissions and frustrations of the KBs should probably be read in the light of the depredations of the Great Terror.

Lack of an Integrated Armor Viewpoint. In a rare (for a Soviet writer) moment of candor in the early 60s, Mostovenko asserted that it was a "serious ommission" on the part of planners that auxiliary vehicles were not integrated into the plans for tank R&D. The lack of self-propelled artillery; armored personnel carriers; specialized tanks; and high-speed, tracked prime movers meant that thanks could not be exploited fully.[179] We have already noted the lack of SAUs until the war was underway. The first good materiel need statement for these weapons was written as an after-action report on their initial employment. And, it was written by an artillery officer, GAU having taken over

proponency for SAUs.[180] The fight between artillery and tanks over who should have the SAU[181] is but one more example of a lack of integrated viewpoint. Too much was allowed to develop in isolation, a surprising statement about an economic system characterized by rigid centralization. Tank building may be a symbol both of Soviet difficulties and successes, of ability to concentrate and inability to control.

Decision-making. The mechanism for centralized control, plus, no doubt, the climate of fear engendered by the purges, had a decided effect on how efficiently decisions were made in respect to tank R&D. We have seen how long a final decision was delayed over the T-32, and how it was eventually thrown up to the highest levels for resolution. Minor questions of a technical nature seem to have attracted Politburo-level attention. The Kirov Plant proposal for dual-hardness armor was one such issue resolved by the Politburo.[182] The war changed this situation only slightly. The urgent necessity to get on with the business of winning led to some decentralization of decision making, but the strong pull of the center persisted. Two different sources mention the early morning calls from the Kremlin to tank plants, every day, to ask whether the plan had been met for the previous 24 hours. The story about the gun and turret that did not fit probably is more accurate in the version that required intervention by the same voice that asked the same question of the plant directors every morning at 3 a.m.[183]

Did rigid centralization continue without Stalin? The answer is beyond the scope of this paper, but we can suggest that the bureaucratic habit and organization was laid down in his time. The tendency to keep senior levels involved in details is also reinforced by the extraordinary longevity of the decision makers. To cite but one example, the armored troops chief from 1954-1969 was P. P. Poluboyarov. Counting his time as deputy in that post, he was directing the development and acceptance of new armored vehicles for over 20 years.[184] Poluboyarov could have brought with him the Stalinist style, and had the stability to insure its continued application. We might reasonably expect, then, an R&D process that runs along in different KBs and Directorates, but which takes an extraordinary number of decisions to the top leadership for resolution. If past example is valid, these decisions probably go beyond the armored branch chief to the highest levels of the Ministry of Defense, to collegial governmental organs, and even into the Party central apparatus.

VIII. CONCLUSIONS

In one source there is a strong hint that the description of problems faced by the T-34 was directed to the audience of 1969-1970.[185] Was a new tank, then being advanced, meeting resistance because it was too new, too much of a departure from accepted tank building? The past lives on, not only because the ground work for the present was laid in the 20s and 30s, not only because the same problems recur in only slightly different form, but also because contemporary Soviets appeal to past example to fight their current battles. The history of Soviet tank building, therefore, is relevant to contemporary problems.

A second conclusion is that Soviet tank design is the result of a mix of individual initiative by talented designers, technological constraints, and perception of the role of and threat to armored forces. These are all factors in any nation's armor R&D program. What distinguishes the Soviets are peculiarities in emphasis and tone. First and foremost, tanks were selected by military planners and political authority as one of a handful of critical areas where the Soviet Union must compete successfully with foreign nations. It was this high national priority that gave KBs the resources they needed and allowed them sufficient initiative to overcome a Western technological lead in little more than a decade of concerted effort. The Soviets were ambivalent to foreign threat, but faithful to a consistent doctrinal requirement. Designers used threat data when it suited them and foreign technology when it assisted them, but they seem genuinely to have been bound by requirements that go back to tank theory of the 20s: large numbers and high speed. Together with an industrial base pushed even farther to the limits than Western industry by the special demands of tank building, a fast tank in enormous quantity determined much of how Soviet armor R&D would go.

A third conclusion is that Soviet tank development was neither as rapid nor as single-minded as is sometimes supposed. We have seen confusion in specific requirements and confusion in fulfilling them. The tank builders operated in a perpetual state of crisis, and often at odds with one another. The highly centralized decision making machinery at times demanded the impossible, at times rejected the essential, and at times seemed caught in its own coils and decided nothing. Similarly, we have seen that within the overall success of Soviet tank building through World War II there were many failures. While there are positive features to Soviet armor R&D, there are also many reasons not to imitate it. It may be said to have succeeded because of its priority and the resources piled into tank building rather than any rational management of those resources. The history we have seen recommends itself only to a few, critical, national programs. Finally, we have seen that it is possible to approach Soviet armor R&D from Soviet historical sources. These sources at different times have tried to stress different aspects of the past, or even to distort the past to answer the needs of the present. Thus, under Khrushchev, blame could be laid on Stalin and (some) Stalinists, scandals of poor judgment, the purges, and failures of materiel development programs. If Brezhnev era historians have muted such discussion of past failures, they have not erased the past. Surprisingly, for a censored, centrally controlled press, there is a fair amount of diversity among Soviet writers on the history of tank building. One has only to compare Kotin's autobiographical statements with historical articles, or the Kirov Plant history with Kartovenko's more subtle (and balanced) preference for Koshkin and the Kharkov designers, to get the flavor of contention. And from contention, truth can emerge.

Tanks are the most visible of ground force weapons, as well as one of the continued highest priority programs in the Soviet Union. For these reasons, tank building is often selected as representative of how Soviet ground combat R&D works, and of how well it works. If this is so, it is important to see the peculiarities and paradoxes of tank building, to understand the ground from which it sprang, and to see the successes and failures of its efforts during years when primary sources allow us to do more than argue probable design philosophy from finished hardware. For if we argue only from hardware, we must remember that many mistakes in tank building have been buried; only the successes are in plain view. We have seen some of the failures in the past and we have seen the overall process operate at times in spite of itself. We should appreciate the key role that has been played by KBs, and especially by talented individuals within them, who broke from strict production orientation to give unwilling customers much more than was wanted, but what was eventually to prove vital. This history is important to remember, to set alongside the overall success of the Soviet Union's quantitative and qualitative competition with Nazi Germany. This history has relevance for today. The tank builders of the pre-war years are dead or retired, but the saga of Soviet tank building goes on.

FOOTNOTES

(BSE=Bol'shaya Sovetskaya Entsiklopediya; SVE=Sovestskaya Voyennaya Entsiklopediya; IVOVSS=Istoriya Velikoy Otechestvennoy Voyny Sovestkogo Soyuza 1941-1945; Vizh=Voyennoistoricheskiy zhurnal)

1. The Soviet Union has produced only one historian of the epic of its tank builders, V. D. Mostovenko. Others, notably Chief Marshal of Armored Forces P. A. Rotmistrov and the late Chief of Armored Troops Marshal A. Kh. Babadrzhanyan, have published valuable works, but the detailed history of tank R&D is subordinated to the history of tank forces and their combat employment. Nor has anyone documented and defended his position with quite the vigor and academic discipline of Mostovenko. Mostovenko's works include one book, Tanki (2d ed)(Moscow: Voyenizdat, 1958); this was revised from a 1954 edition with an apparent Khrushchevian mandate to be critical of past errors. There are also four articles during the early and mid 60s in much the same spirit. These are, "K voprosu o razvitii sovetskikh tankov", Vizh nr. 7 (1965), pp. 114-116; "Pervyye tanki nashey strany", Krasnaya zvezda, 8 August 1967, p. 4; "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", Vizh nr. 9 (1961), pp. 33-45; and "Tank, vremya, konstruktor", Krasnaya zvezda, 30 June 1965, p. 3. A fifth article was not available; it appeared in Tekhnika-Molodezhi nr. 9 (1963), pp. 18-19. Rotmistrov's chief work is a book, Vremya i tanki (Moscow: Voyenizdat, 1972). Babadzhanyan's chief work is under his editorship, Tanki i tankovyye voyska (Moscow: Voyenizdat, 1970). Babadzhanyan is also the author of articles in Vizh and BSE on tank subjects.

2. For example, see Arthur J. Alexander, Armor Development in the Soviet Union and the United States (R-1860-NA)(Santa Monica, Calif.: Rand, 1976); Ronald Amann, et al., The Technological Level of Soviet Industry (New Haven: Yale University Press, 1977); John Milsom, Russian Tanks 1900-1970 (Harrisburg, Pa.: Stackpole Books, 1971).

3. The summary is based primarily on Mostovenko, Tanki and Rotmistrov. The most comprehensive treatment of this period in English is by John Milsom. Unfortunately, this work is chaotic in organization and method, and often wildly inaccurate, treating all data as simply addative without interpretation or analysis (Milsom thus comes up with two tank plants on the lower Volga, one at Volgograd and one at Stalingrad; they are the same plant in one city that changed names.) Milsom is a treasure trove of photography, however, and where he only quotes from difficult-to-obtain sources, he is fairly reliable.

4. Voprosy taktiki v sovetskikh voyennykh trudakh (1917-1940 gg)(Moscow: Voyenizdat, 1970), p. 239.

5. A. Ryzhakove, "K voprosu o stroitel'stve bronetankovykh voysk krasnoy armii v 30-e gody", Vizh nr. 8 (1968), p. 105. Inventory and production figures present special problems; even Rotmistrov used inaccurate data on German production according to a review of his book (see Vizh nr. 2 (1973), p. 116). I have tried to use only figures cited by Soviet sources as derived from archival materials.

6. Mostovenko, "Pervyye tanki nashey strany". Ryzhakove, p. 106 gives the figure 900.

7. The five plants are mentioned only by V. Tarasov, "Tank", BSE (1st ed), vol. 53 (1946), col. 561.

8. This is going somewhat beyond Soviet sources. Mostovenko acknowledges the similarity only to dispute it (Tanki, p. 115). Specific identification of the Western models and a chance to compare them with their look-alike Soviet counterparts is from Kenneth Macksey and John H. Batchelor, Tank (New York: Charles Scribner's Sons, 1970), pp. 56-57, 64-67, 69, 70, 72-73. Macksey and Batchelor do not use Soviet sources and do not cite sources in the body of their work; they do appear to be faithful to the better Western materials.

9. For production rates, Istoriya vtoroy mirovoy voyny 1939-1945, vol. 1 (Moscow: Voyenizdat, 1973), p. 214, citing archival sources. For inventories, M. Zakharov, "Kommunisticheskaya partiya i tekhnicheskoye perevooruzheniye armii i flota v gody predvoyennykh pyatiletok", Vizh nr. 2 (1971), p. 6.

10. Zakharov, p. 11 gives 24% of production 1931-1936 as medium or heavy tanks. This would be the T-28 and T-35, neither of which carried more than 30 mm of armor before 1939. Other production was about 6,780 T-26 tanks by 1937 and about 5,000 BT tanks by the same year: Rotmistrov, p. 46. The remainder, about 1200, would be T-27 and T-37 tankettes.

11. No KV or T-34 were produced in 1939; for 1940 the figures are 243 KV and 115 T-34; for the first half of 1941, 393 and 1110, respectively: IVOVSS, vol. 1 (1961), p. 415.

12. It is difficult to sort out just what organizations were responsible for the development of Soviet armor. Some of the material has been deliberately obscured, since it involves persons who were purged in the 30s. Part of the confusion results from shifts in responsibility as a new state tried to find a place for old as well as new problems. And finally, with the close interlocking of Party and government under Stalin it is difficult to say whether officials acted as Party members or government officials.

13. V. A. Vishnyakov, Tank na p'edestale (Moscow: Voyenizdat, 1970), p. 28. Stanislav Alekseyevich Kostyuchenko, et al., Istoriya Kirovskogo zavoda 1917-1945 (Moscow: Iz-vo "Mysl'", 1966), p. 427. Both these books are unusual sources, rich in personal details and anecdotal materials. Kostyuchenko is partisan to the Kirov plant to the point of chauvinism, but does give a lively history of tank building there--not the only concern of the book or of the Putilov/Kirov complex. Vishnyakov is listed as the main source for A. A. Morozov following Morozov's entry in SVE, vol. 5 (1978), p. 395. The author is a Colonel-engineer and kandidat of technical sciences; in 1944 he was a student at the Academy of the Armored Forces: see Vishnyakov, "Samyye moshchnyye tanki", Znamenosets nr. 5 (1975), p. 19. Vishnyakov's book is the best biography of M. I. Koshkin, although not cited in Koshkin's entry in SVE, vol. 4 (1977), p. 413.

14. A. S. Magid, Korabely delayut tanki (2d ed.)(Moscow: Iz-vo "Znaniye", 1977), p. 70.

15. Vishnyakov, Tank na p'edestale, p. 36; SVE, vol. 3 (1977), pp. 311-312.

16. Vishnyakov, loc. cit.; Kostyuchenko, et al., loc. cit.

17. Zakharov, pp. 3-4.

18. Sovetskiye vooruzhennyye sily (Moscow: Voyenizdat, 1978), p. 229.

19. See below on Revvoyensovet and Defense Council.

20. Kostyuchenko, et al., p. 387.

21. Zakharov, p. 5.

22. Vishnyakov, Tank na p'edestale, p. 22; Mostovenko, Tanki, p. 78n. See also E. A. Kosyrev, et al., Tanki (Moscow: Iz-vo DOSAAF, 1973), pp. 26-27; Mostovenko, "Tank, vremya, konstruktor"; Rotmistrov, p. 25; SVE, vol. 2 (1976), p. 347.

23 Sovetskiye vooruzhennyye sily, p. 89; Zakharov, pp. 5-6; Ryzhakoye, pp. 107-108.

24. John Erickson, The Soviet High Command (London: Macmillan & Co. Ltd., 1962), pp. 305-306.

25. SVE, vol. 4 (1977), p. 266; SVE, vol. 2 (1976), p. 349.

26. SVE, vol. 5 (1978), pp. 295-296; Vishnyakov, Tank na p'edestale, p. 24; Ryzhakoye, p. 106; Mostovenko, "Pervyye tanki nashey strany".

27. Zakharov, p. 6n; Vishnyakov, Tank na p'edestale, pp. 35, 48-50; Rotmistrov, pp. 85-87; Mostovenko, Tanki, p. 108, and "Tank, vremya, konstruktor". The "tracks only" debate was whether to allow development of a replacement for the BT fast tank that did not have dual propulsion, tracks and wheels (with the tracks removed). See also, on the Voyensovet, SVE, vol. 2 (1976), pp. 366-367.

28. SVE, vol. 2 (1976), p. 347.

29. Mostovenko, Tanki, p. 78, and "Pervyye tanki nashey strany". Erickson, p. 184 also corroborates the role of the GUVP.

30. Zakharov, p. 4.

31. Idem.

32. A. Kh. Babadzhanyan, "Tankovyye Voyska", BSE (3d ed.), vol. 25 (1976), pp. 265-267; Vishnyakov, Tank na p'edestale, p. 19.

33. Rotmistrov, p. 45. For the tsarist GVTU, see Mostovenko, Tanki, p. 51.

34. Vishnyakov, Tank na p'edestale, p. 24; Rotmistrov, p. 45; Sovetskiye vooruzhennyye sily, p. 186; SVE, vol. 5 (1978), p. 270.

35. Babadzhanyan, "Tankovyye Voyska", loc. cit.

36. For the duties of Main and Central Directorates, see SVE, vol. 2 (1976), p. 365.

37. Babadzhanyan, "Tankovyye Voyska", loc. cit.; A. Babadzhanyan, "Marshal bronetankovykh voysk Ya. N. Fedorenko", Vizh nr. 10 (1976), p. 127; Magid,

p.106; P. Maslov, "Formirovaniye i podgotovka tankovykh rezervov", Vizh nr. 1 (1972), p. 24n; Rotmistrov, p. 86; V. Syropyatov, "Razvitiye tanko-tekhnicheskogo obespecheniya v gody voyny", Vizh nr. 9 (1978), p. 40.

38. Rotmistrov, pp. 47-48; Mostovenko, Tanki, p. 114; Zh. Ya. Kotin, "Ogon'. Manevr i bronya", Vovennyy Vestnik nr. 9 (1977), p. 23.

39. Kotin, loc. cit.: SVE, vol. 4 (1977), p. 409; BSE (3d ed.), vol. 13 (1973), p. 846. Both encyclopedias specify Kotin's position as with a design bureau.

40. SVE, vol. 2 (1976), p. 172.

41. Magid, p. 104.

42. I. Krupchenko, "Novyy trud o tankovykh voyskakh", Vizh nr. 2 (1973), p. 115.

43. Kostyuchenko, et al., p. 390.

44. M. A. Vodolagin, "Stalingradskiy Arsenal" in Kuznitsa Pobedy OMoscow: Politizdat, 1974), p. 117; SSSR v Velikoy Otechestvennoy voyne 1941-1945: kratkaya khronika (Moscow: Voyenizdat, 1970), p. 82; Vishnyakov, Tank na p'edestale, p. 91; Magid, pp. 39, 104.

45. Vishnyakov, Tank na p'edestale, pp. 95-96; G. P. Frezerov, "Boyevoye zadaniye vypolneno" in Bitva za Moskvu (Moscow: Iz-vo Moskovskiy Rabochiy, 1968), p. 585. Paton is mentioned frequently in passing elsewhere; one interesting story about the introduction of automatic welding (and other matters) is contained in Khrushchev Remembers (trans. Strobe Talbott)(Boston: Little, Brown and Company, 1970), pp. 116-119.

46. Also often konstruktorskiy kollektiv (design collective), gruppa konstruktorov (group of designers), kollektiv konstruktorov (collective of designers), or konstruktorskiy otdel (design branch). Although sources use the terms loosely, the otdel and byuro seem to designate offices, whereas the other terms are used to denote several designers who may be a KB or may be part of a KB working on some sub-project. KB in this paper will denote a bureau, that is, an organizational entity, which may or may not have collective task-organized within it.

47. Mostovenko, "Pervyye tanki nashey strany"; Rotmistrov, p. 51; Mostovenko, Tanki, p. 78.

48. Mostovenko, Tanki, pp. 75ff; Kosyrev, et al., p. 25. Admiralty refers to the Izhorsk Plant in Leningrad, which formerly made armor plate for the tsarist navy; AMO was the predecessor of the ZIL plant in Moscow.

49. Mostovenko, "Pervyye tanki nashey strany"; BSE (1st ed.), vol. 53 (1946), col. 560.

50. The Polish sources, all from the biweekly magazine Zolnierz Polski, 9 Jul, 13 Aug, 27 Aug, and 10 Sep 72, are cited in a letter dated 14 May 1979 to the author from Dr. Arthur Volz, Murnau, Germany. Professor Zaslavskiy (to use the Russian spelling) is mentioned twice by Mostovenko: Tanki, p. 89, where he is credited with a brake design incorporated on the BT-7 (corroborated by Kosyrev, et al., p. 36); and "K voprosu o razvitii sovetskikh tankov", where he is mentioned as a victim of the purges.

51. Rotmistrov, p. 51, mentions splitting up the original KB.

52. The T-24 project can be placed at Kharkov by association with the designers who worked on it, then later on the BT: Kosyrev, et al., p. 29. This is confirmed by BSE (1st ed.), vol. 53 (1946), col. 560, which identifies Kharkov Locomotive as the production facility for the T-24. Zolnierz Polski, 10 Sep 72 specifies the plant and Zaslavsky's involvement.

53. BSE, loc. cit.

54. MS-1, or T-18, variants are known from Mostovenko, "Pervyye tanki nashey strany" and Tanki, pp. 79-83. Since the T-18 was in production at Bolshevik, it is reasonable that the KB there worked on the modifications. Putilov did some work in mounting a locally manufactuted, regimental gun on the MS-1 (Kostyuchenko, et al., p. 387). The other tanks and tankettes are known from Mostovenko and Rotmistrov, and are associated with Bolshevik by Polish sources (fn 50).

55. Polish sources (fn 50) imply that the OKMO was associated with but distinct from Bolshevik; they assign a name of Factory imeni S. M. Kirov, nr. 185, not to be confused with the Plant imeni Kirov (formerly Putilov), also in Leningrad: Janusz Magnuski, "Nadano mu imie KW", Zolnierz Polski, 30 Oct 77. Rotmistrov, p. 51, and Vishnyakov, Tank na p'edestale, p. 28 identify the KB as the OKMO of Barykov. Rotmistrov does not provide an expansion of the unusual abbreviation; Vishnyakov offers opytnokonstruktorskiy otdel, not accounting for the "M". The expansion given in the text is from G. I. Reznichenko, Mashiny, stavshiye pamyatnikami (Moscow: Iz-vo DOSAAF, 1977), p. 21. Polish sources describe a separate department formed out of Bolshevik; an experimental design-mechanical section would thus be a reasonable title. Polish sources confirm designers and models from Soviet writers, but, working with what must be unique materials, are able to identify the plant number and specify the relationship to Bolshevik. Vishnyakov, Tank na p'edestale, p. 29 does offer that the OKMO had employees who formerly worked at the Obukhov Plant, Obukhov being the pre-revolutionary name of Bolshevik.

56. BSE (1st ed.), vol. 53 (1946), col. 561.

57. Rotmistrov, p. 51.

58. Kharkov is firmly tied to the BT by the biographies of its designers, especially Morozov. See also Vishnyakov, loc. cit., where Koshkin goes to Kharkov, which was then (1937) producing the BT-7.

59. Apart from the Polish material (Zolnierz Polski, 15 Oct 72, 3 Dec 72, 18 Feb 73), locating the light tank plant and KB in Moscow is conjectural. It is not unreasonable conjecture, however, since a light tank plant was evacuated from Moscow in 1941, along with a plant, supplying light tank hulls, from the Moscow suburb of Podol'sk: Frezerov, pp. 576, 580. The Podol'skiy zavod imeni S. Ordzhonikidze may correspond to the Moscow plant identified by Polish materials as Plant Nr. 37 imeni S. Ordzhonikidze, where Kozyrev and Astrov worked.

60. BSE (1st ed.), vol. 53 (1946), col. 560.

61. Kostyuchenko, et al., pp. 388-389.

62. See fn 10.

63. Mostovenko, Tanki, p. 91; Rotmistrov, p. 51; Kosyrev, et al., p. 40; Vishnyakov, Tank na p'edestale, p. 30.

64. See fn 10. For T-26 modifications, see Mostovenko, Tanki, p. 92; Ryzhadoye, p. 106.

65. Tseyts is identified as designer of both the T-28 and T-35 by Rotmistrov, p. 51. Involvement of the OKMO is established through Barykov (Rotmistrov, loc. cit., and Vishnyakov, Tank na p'edestale, p. 28; this is confirmed by Zolnierz Polski, 30 Oct 77 (see fn 55).

66. For the T-35, see Mostovenko, Tanki, pp. 97-98, where production 1933-1939 is given as "several tens"; Polish materials (see fn 55) sepcify 61 produced 1934-1939 at the Kharkov Plant.

67. Vishnyakov, Tank no p'edestale, pp. 28-29.

68. The KB is identified with amphibious tanks and tankettes by Rotmistrov, p. 51. See also Mostovenko, Tanki, pp. 99-101. Polish materials (see fn 59) specify the involvement of the OKMO with the first tankette designs.

69. Kostyuchenko, et al., pp. 426-428.

70. Vishnyakov, Tank na p'edestale, pp. 30-35, 42-45. Essential elements of the story presented by Vishnyakov are confirmed by almost everyone writing about the T-34; see especially Rotmistrov, pp. 51-52, 63; Mostovenko, Tanki, p. 108; Mostovenko, "Tank, vremya, konstruktor"; and Reznichenko, pp. 21-24.

71. See fn 68. One source of continuity may well have been the desire to have a vehicle making extensive use of automotive components (engine and drive train) so as not to compete for critical engines with the medium and heavy tanks, or the T-26 light tank. These automotive components would have been readily available at the AMO/ZIS/ZIL in Moscow and GAZ in Gorky, locations frequently associated with light tank production.

72. Barykov is associated with the T-100 by Rotmistrov, p. 51, where Troyanov is also named chief designer of the T-50. Troyanov's later role as heavy tank designer is specified by Vishnyakov, Tank na p'edestale, p. 101; Mostovenko, "Tank, vremya, konstruktor"; and IVOVSS, vol. 3 (1962), p. 170. OKMO involvement is by association with Barykov: Rotmistrov, loc. cit.

73. Kostyuchenko, et al., pp. 556-561; see also Kotin, p. 24. Kosyrev, et al., p. 39 are the only authors to associate Kotin, Dukhov, and Yermolayev with the T-100 as well as with the SMK. The Kirov Plant history makes no mention of T-100, and Polish material (fn 55) has T-100 made by Plant 185, i.e., OKMO. Barykov is mentioned with T-100 by Rotmistrov, p. 51. It is reasonable to conclude that Kosyrev, et al. are in error. SMK participated in competitive trials, but T-100 is not mentioned: Vishnyakov, Tank na p'edestale, p. 40.

74. Vishnyakov, Tank na p'edestale, p. 58; Rotmistrov, p. 93; the status of Ural'skiy tankovyy zavod Nr. 183 imeni Kominterna as lead plant for T-34 production is mentioned in Vishnyakov, Tank na p'edestale, p. 95 and Magid, p. 106.

75. See fn 72.

76. Chelyabinsk, or Tankograd (Tank City), as it was called, is the most-discussed wartime tank facility. The plant was based on the Chelyabinsk Tractor Plant and evacuated personnel and equipment from the Leningrad Kirov Plant, Kharkov Diesel Engine Plant, and others. There is no doubt that the Kirov KB went to Chelyabinsk: see Kostyuchenko, et al., pp. 593, 616; Vishnyakov, Tank na p'edestale, p. 94; "Dni i nochi tankograda", Pravda 15 February 1975, p. 6 (interview with Kotin). It is tempting to speculate that what was left of OKMO (Trofimov, e.g.) may have joined the evacuation from Leningrad to Chelyabinsk.

77. Frezerov, pp. 575-576, 585; Rotmistrov, pp. 51, 266; Magid, p. 55.

78. A good description of the growth of a production KB is given in Frezerov, p. 586; and Magid, pp. 46ff. As an example of some of the changes, Chelyabinsk, when it began production of the T-34 (May 1942), added a five-speed transmission (Vishnyakov, Tank na p'edestale, pp. 94-95). Krasnoye Sormovo designed a new turret for the T-34, at first to eliminate a ballistic vulnerability, but also to permit upgunning (Ye. E. Rubinchik, "Sormovskiye 'T-34'" in Kuznitsa pobedy (Moscow: Politizdat, 1974), p. 279). Other local improvements included new cast turrets, cast road wheels, larger fuel tanks, and unspecified simplifications of parts (Mostovenko, Tanki, pp. 141, 150).

79. Frezerov, loc. cit. The self-propelled antiaircraft weapon was not accepted into the inventory: N. Popov, "Razvitiye samokhodnoy artillerii", Vizh nr. 1 (1977), pp. 27-28.

80. Uralmashzavod was one of the Urals "Big Three" tank producers, the others being Plant 183 and Chelyabinsk (Vishnyakov, Tank na p'edestale, p. 89). Petrov is named by Rotmistrov, p. 266, as Chief Designer of a plant building SAUs. This may be the same F. F. Petrov who designed artillery weapons for the central artillery KB before the war. Gorlitskiy headed the design collective (not necessarily the entire KB) that built SAUs on T-34 chassis (Rotmistrov, p. 52), and worked on a joint Uralmash-Kirov team according to IVOVSS, vol. 3 (1962), p. 170.

81. The production mobilization order was GKO Order 1, delivered to the plant in person by Malyshev the night of 2-3 July 1941 (magid, p. 39). It is an interesting sidelight that initially Krasnoye Sormovo (or Plant 112), failed to meet its mobilization commitment, leading to the sacking of the director and Party chief (Magid, p. 66). Krylov is identified from Vishnyakov, Tank na p'edestale, pp. 46, 106; Magid, p. 46; and Rubinchik, p. 278. The new design, the T-34-85, was also first put into production at Plant 112: Magid, p. 106. Production started 15 December 1943 (Mostovenko: "Tank, vermya, konstruktor").

82. Morozov was elected to the Supreme Soviet from Kharkov (not necessarily an indication that he lived there), and was identified as a designer at a Kharkov plant (which is more convincing)(Notes from the Radio Liberty Biographic Files).

83. For the T-43 and T-44, see Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 40 and Vishnyakov, Tank na p'edestale, p. 106. On improvement of the T-44 see A. Sidorenko, "Razvitiye vooruzheniya Sukhoputnykh voysk v 1945-1953 gg", Vizh nr. 3 (1973), p. 96. Morozov is

is identified as the head of the T-54 designers by Kosyrev, et al., p. 58.

84. SVE, vol. 5 (1978), p. 395. Morozov also holds two awards of the Hero of Socialist Labor; the first, 1942, can be associated with his work on production of the T-34; the second is undoubtedly connected with his 70th birthday in 1974, honoris causad.

85. SVE, vol. 3 (1977), p. 273; obituary, Krasnaya Zvezda, 5 May 1964, p. 4. Dukhov was awarded the Hero of Socialist Labor three times, last in 1954 (for his 50th birthday?). The Lenin prize, at the age of 56, probably represents recognition for undisclosed work done at the military KB.

86. SVE, vol. 4 (1977), p. 409. For his position as deputy to Malyshev, see "Dni i nochi tankograda". His post-war history is summarized in SVE cited and covered well in Kotin, pp. 22-26. Kotin, even from the scant material, emerges as the most political of the designers. There is also something vaguely repellant about him. Morozov and Dukhov were his contemporaries, to be sure, but there is not the same uneasiness about them with regard to rapid upward mobility during the Purge and close association with Stalin. Perhaps it is just the toadyism of his design names, or perhaps it is the ghosts of Zaslavskiy and the OKMO that flit in the background, but Kotin is my least favorite of the tank builders.

87. Magid, p. 126. Maybe the return was not completely to civilian tasks, but only the cessation of tank building. Krasnoye Sormovo builds air cushion vehicles, which are openly military, and probably is involved with other naval construction. One of the interesting questions I have not pursued is the long-term influence of demobilized tank builders on the Soviet bureaucracy. Malyshev went on to head the Soviet nuclear ministry. An engineer at Krasnoye Sormovo during the war was, in 1977, assistant Minister of Foreign Trade. Is there a dispersed tank lobby, or at least a group of alleged civilians sympathetic to tank building and the sacrifices from other sectors of the economy necessary to support it?

88. Mostovenko, "K voprosu o razvitii sovetskikh tankov", p. 115 and Tanki, p. 95.

89. Vishnyakov, Tank na p'edestale, p. 24. "In order to create finished combat vehicles in the shortest possible time, technological achievements, both in our country and abroad, were studied." (Rotmistrov, p. 46).

90. Mostovenko, "K voprosu o razvitii sovetskikh tankov", p. 115.

91. The basic source is Erickson, pp. 155, 251, 256-258, 264-282.

92. Ibid., p. 270. Erickson characteristically gives both sides of the issue.

93. Mostovenko, Tanki, p. 87 and "K voprosu o razvitii sovetskikh tankov", p. 116.

94. Kostyuchenko, et al., pp. 565-566.

95. According to Kotin, Ustinov called him at Tankograd in the spring of 1943. "He informed us that new tanks with strong armor had appeared with the Hitlerites. 'Self-propelled mounts are necessary to penetrate this armor,' he explained. 'Think it over.'" The next day Ustinov called back to order a crash program to get the new SAU. Kotin, p. 25.

96. On the T-VI, see Vishnyakov, Tank na p'edestale, p. 86, where surprise is expressed at the dribbling commitment of the new weapon; also, Popov, pp. 28-29. For other conclusions, see Vishnyakov, "Samyye moshchnyye tanki", pp. 18-19 and Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy

Otechestvennoy voyny", pp. 40, 41, 43. Significantly, the only foreign developments that spurred the Soviets were those of the enemy, Germany. Writers are almost wholly contemptuous of British and American Lend Lease tanks; allegedly there was nothing to learn from them.

97. Zakharov, p. 3, citing archives.

98. The interested reader can compare any of the tank descriptions by Mostovenko or Rotmistrov and note the weapons used in ballistic proof testing (see below).

99. B. L. Vannikov, "Vyigrannyye srazheniya" in Kuznitsa pobedy (Moscow: Politizdat, 1974), pp. 144-146.

100. Vishnyakov, Tank na p'edestale, p. 42.

101. Kostyuchenko, et al., pp. 565-566.

102. Vishnyakov, Tank na p'edestale, p. 96 mentions the poor visibility from the new T-34-85, quoting, interestingly enough, from a German author who cites battlefield S&TI that German tankers exploited. Soviet designers then corrected the problem with a commander's cupola. The history may be a bit garbled here, since the Soviets introduced a cupola on the modified T-34 before it underwent major modification to accept the 85-mm gun. Kotin, characteristically, alleges to have discovered the JS-2 problem himself: Kotin, p. 26.

103. Kostyuchenko, et al., p. 393.

104. Popov, p. 29.

105. Vishnyakov, Tank na p'edestale, p. 96.

106. The story is told in Ibid., pp. 50-51.

107. Ibid., p. 31.

108. Ballistic test by actual firing is an accepted, necessary component of any tank R&D program. What distinguishes the Soviets is the degree to which they apparently relied on firing tests. Someone familiar with Western practice may, indeed, see nothing strange in this. As the T-34 with the keyed turret makes clear, however, and as is born out by recurrent Soviet modification of equipment already in service whose faults did not become known until combat or maneuvers uncovered them, it seems to be part of a pattern of dealing best with hardware rather than blueprints.

109. Vishnyakov, Tank na p'edestale, p. 32.

110. Ibid., pp. 46-47, 55.

111. Ibid., pp. 53-54.

112. Mostovenko, Tanki, p. 102.

113. The tests are described in Vishnyakov, Tank na p'edestale, pp. 40-42.

114. Mostovenko, Tanki, pp. 21-54 passim. While valid, the tsarist achievements are almost irrelevant, since there is nothing to show that Soviet tank builders made use of any of them. This rich heritage was almost certainly discovered as history rather than exploited as technology, and the attempt to create a historical Russian and Soviet preeminence in tank building is Mostovenko's most unfortunate lapse as a scholar.

115. Vishnyakov, Tank na p'edestale, and Mostovenko, Tanki, both passim.

116. Mostovenko, Tanki, p. 78; Rotmistrov, p. 26; Mostovenko, "Kvoprosu o razvitii sovetskikh tankov", p. 114. The contest was announced in the Izvestiya Narodnogo Komissariata po Voyennym delam on 2 November 1919 (Kosyrev, et al., p. 27); it is one of the most novel approaches to military R&D since the Athenians consulted the Delphic oracle and were told to defend their city with a wooden wall.

117. Vishnyakov, Tank na p'edestale, p. 33.

118. Kostyuchenko, et al., pp. 393, 557, 566, 570.

119. Vishnyakov, Tank na p'edestale is the source for this interpretation of Koshkin and Morozov as innovators; see p. 29 (for T-46-5 (cp. Mostovenko, Tanki, p. 103)), p. 35 (for A-20 versus the T-32), p. 51 (the 100-mm armor tank), and p. 106 (for the realization of the transverse-engine tank). T-43 is mentioned in Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 40; the T-43 did not quite make 100 mm of frontal armor, carrying only 75 and 90 mm on the hull and turret, respectively.

120. Vishnyakov, Tank na p'edestale, p. 56.

121. Magid, pp. 105-106.

122. Frezerov, p. 586; Kostyuchenko, et. al., pp. 560, 566; Vishnyakov, Tank na p'edestale, p. 31.

123. Vishnyakov, Tank na p'edestale, p. 46 mentions the role of the "tank aces" as advocates.

124. There are two versions of a single story about Kotin, Stalin, and a mockup of a multi-turreted heavy tank. In one version, "Suddenly, Stalin walked up to the model, took away one of the turrets and said, 'And why make a tank into a department store? Leave two turrets.' After a silence he added, 'And it is necessary to consider a supply of drinking water for the crew. It is hot and stifling in a tank.'" (Kotin, p. 24). The second version has Kotin make the suggestion that one turret be removed; Stalin agreed, provided the weight saved be added to the overall armor. (Kostyuchenko, et al., p. 558). In both cases, the model was an early design for the SMK that had three turrets; such a design had apparently been approved earlier by the government, and Stalin was indulging in some last-minute, high-level design changes.

125. The meeting is described in Vishnyakov, Tank na p'edestale, pp. 48-50. Interestingly enough, Stalin plays a personal role here, as well. Silent through all the debate, he suddenly says, "'Well, now, let's not interfere with the designers. Let them build the vehicle they propose themselves, and then we'll see whether it is actually as good as they say." End of debate....

126. Ibid., p. 48.

127. Ibid., pp. 33, 91. When the clutches went out on the two prototype T-34s being driven to Moscow, Koshkin discovered that a designer had "simplified" them, and the author was able to note that Koshkin favored the kind of simplicity that increased, rather than lowered, component reliability Ibid., p. 47). It is an interesting comment on the Soviet approach, that one does not define simplicity in terms of fewer components or cheaper construction. It is also somewhat amazing that the Chief Designer discovers that there has been a departure from drawings for the first time when he takes his tanks out on a long march to show them to the head of state.

128. The diesel engine was tested first in BT-5s, then installed in the first production tank with a diesel engine, the BT-7M; tests were in 1938, production started in 1939 (Mostovenko, Tanki, p. 91). For the assault guns, see, inter alia, Popov, pp. 27-31. One memoir records an order by GKO dated 23 October 1942 that required the Armaments and Tank production Commissariats to come up with SAUs in the shortest possible time, based on all tanks then in production matched with various types of artillery. It is apparent that gun production was not so high as to allow SAUs and tanks to compete for the same models and calibers. See N. E. Nosovskiy, Bog Voyny" in Kuznitsa pobedy (Moscow: Politizdat, 1974), p. 173.

129. The components and characteristics can be traced out with the help of any of the standard Soviet or Western works.

130. Kostyuchenko, et al., pp. 424, 426. The designers at Kirov, after a month of testing, allegedly had to make 600 changes to the OKMO design of the T-28.

131. Ibid., pp. 570, 688.

132. Rotmistrov, p. 63 makes the case that Soviet tanks of the 30s met the requirements of the time and only the late development of antitank artillery necessitated their improvement. Mostovenko, Tanki, pp. 101-102 states, "The exclusive employment of bulletproof armor (on Soviet tanks, 1931-1936, GGG) is explained by the absence at that time of antitank artillery in the armies of probable enemies." Elsewhere, Mostovenko is even more specific: "at the beginning of the 30s probable enemies' armies had, in practice, no antitank artillery," but in 1936-1937 introduced calibers of 37-47 mm with penetration capabilities of 55-58 mm ("Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny," p. 34). Nevertheless, the threat potential was always there, and why ignore the obvious point that the Soviet tanks themselves were carrying 45-mm cannon which were more than a match for bulletproof armor?

133. Vishnyakov, Tank na p'edestale, pp. 44-45 summarizes the arguments. Mostovenko, "Tank, vremya, konstruktor" considers this as one of the two major decisions of the 30s (single-turreted heavy tanks being the other).

134. See text at fn 43.

135. Mostovenko, "Pervyye tanki nahsey strany".

136. Mostovenko, who does not rush to elaborate the Party role in tank building, does note that it was that organization that diverted young engineers from aviation and tractor building to the fledgling tank builders. These other

sectors can certainly be called "critical". ("pervyye tanki nashey strany").

137. The plan was part of the first five-year plan for development of the RKKA, approved 30 July 1928 with nothing on tanks, then revised, 15 June 1929, making tanks one of the three basic categories for qualitative superiority (with aviation and artillery; chemical made a brief appearance, then dropped by the wayside). Initial plans were for 1075 tanks by 1932, later revised to 3500. See Ryzhakoye, pp. 105-106. Mostovenko, "Pervyye tanki nashey strany", after enumerating all the types of vehicles to be developed and the short times facing industry to make the experimental models and get them into production, then deadpans that it became obvious more time was required. In point of fact, military planners had taken about as much time to come up with the plan as they were giving a brand new industry to come up with the tanks.

138. The Kirov Plant history makes this clear. The crash program atmosphere and short (or non-existent) deadlines made it seem like the most desperate of wartime activities throughout the 30s.

139. The haste is documented by sources already cited, especially Popov, Kotin, and Nosovskiy. The nine separate models, from Popov's chart (p. 29) do not include other, limited-production vehicles he mentions, such as the 57-mm antitank gun on a Komsomolets tractor chassis and the SAUs based on captured German T-III and T-IV chassis.

140. Mostovenko, Tanki, p. 93.

141. Ibid., p. 113; Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 36.

142. Magid, pp. 107-108 has the intervention of Moscow; Rubinchik, p. 279 has everyone work it out in Gorky. See text at fn 183.

143. For a good discussion, see Sella Amnon, "Red Army Doctrine and Training on the Eve of the Second World War", Soviet Studies, vol. 27, nr. 2 (April 1975), pp. 245-264. This work has full citation of Soviet sources. From Amnon, especially p. 254, is derived the idea that PU-29 was running ahead of equipment capabilities. Mostovenko's view is in Tanki, p. 83; he adds the proviso that magazine articles contained other possible roles and opinions not necessarily constrained by existing equipment. The ambivalent viewpoint of the anthology is contained in Voprosy strategii i operativnogo iskusstva v sovetskikh voyennykh trudakh (1917-1940 gg)(Moscow: Voyenizdat, 1965), pp. 552 and 759-760n.

144. Amnon, p. 246; Erickson, chapters X-XI; Mostovenko, "Pervyye tanki nashey strany".

145. Amnon, p. 248 (unfortunately, without citation) has Khalepskiy, together with defense industry representatives, set out on 30 December 1929 for Europe and the United States to inspect and purchase armored vehicles. Erickson paints a favorable portrait of Khalepskiy, as impressing foreign observers with his abilities. A member of the "Tukhachevskiy Group", and heavily involved with the Kazan tank school, Khalepskiy fell in the Purge: see Erickson, pp. 327, 333, 347, 436-437. Another luminary of the time was K. B. Kalinovskiy, who was Khalepskiy's assistant at the Mechanization and Motorization Directorate and commander of the first experimental tank units. Kalinovskiy died about 1931, before his genius could make him

suspect in the Great Terror. Of Kalinovskiy, Rotmistrov says, "He may with confidence be called one of the foundation builders of the Soviet theory of employment of tank forces in maneuver war" (Rotmistrov, p. 55). Mostovenko cites Kalinovskiy's articles as the most significant theoretical work in the field during the 20s (Tanki, p. 83).

146. Vishnyakov, Tank na p'edestale, p. 33. The speed requirement for a BT follow-on was set so high that it could be satisfied only by a wheel-track, Christie-type vehicle. This is a classic case of writing requirements with a satisfactory solution already in mind.

147. Mostovenko, Tanki, p. 38.

148. Ibid., p. 157.

149. Ibid., p. 112. Vishnyakov also makes clear that better mobility was behind improvement of the KV series with the KV-1S ("Samyye moshchnyye tanki", p. 18). KV-1S is one of the few examples of a tank lighter than its predecessor. This was achieved by thinning out the armor. Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 41 hints that the heavy tank KB had, with KV-1S (or KV-1s, as it is sometimes written) worked backwards, and in essence built a medium tank. The KV-1S was in production for only about one year, giving way to the JS series of incontestably heavy tanks.

150. Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", pp. 34, 42.

151. Mostovenko, Tanki, pp. 155-156; also Vishnyakov, Tank na p'edestale, p. 45; Kosyrev, et al., p. 48.

152. Mostovenko, Tanki, p. 158.

153. The BT-IS was an experimental modification of the BT with the stated purpose of testing raked, or sloping armor as a means of increasing protection: Mostovenko, Tanki, p. 106.

154. As usual, Mostovenko, in his more careful moments, is the exception, specifying thickness and obliquities in the excellent tables of World War II tanks in "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny".

155. Vishnyakov, Tank na p'edestale, p. 112.

156. Mostovenko, Tanki, p. 110; "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 35.

157. Smaller caliber, more effective weapons were the SU-85 vice SU-122, the substitution of a high-velocity antiaircraft gun for a howitzer; and the introduction of the JSU-122 while the JSU-152 was still in production, although this was more a matter of gun availability than of outright replacement. The SU-100 can be considered either an upgunning of the SU-85, which it replaced in production, or a smaller but more effective weapon than the JSU-122, which it outperformed. See Popov, for details. It is also useful to note that the Soviet tendency to compare calibers obscures this idea of superior performance from a smaller weapon. This is true, even based on Mostovenko's tables (fn 154), where German tanks,

with smaller cannon calibers, have a firepower advantage in muzzle velocity, a subcaliber kinetic energy round, and more ammunition in the on-board load. Some indicator of terminal ballistics, such as how much armor each type tank gun could penetrate at what range, is not given, except for such outstanding designs as the 100-mm gun on the SU-100.

158. Rotmistrov, p. 88.

159. 21,587 SAUs were built during the war (Popov, p. 30). The inventory in May 1945 was "more than 7500" (IVOVSS, vol. 6 (1965), p. 55).

160. The inventory is from IVOVSS, vol. 3 (1962), p. 258. Production for 1942 is from Maslov, p. 22. The prewar inventory could have been as high as 20,000 or more (most of which were obsolescent). Losses do not account for Lend Lease tanks, which were about ten per cent of the Soviet Inventory (Maslov, p. 22). The 1941-1942 total losses are somewhere between 25,000 and 40,000.

161. Production from Maslov, p. 21; inventory from IVOVSS, vol. 4 (1962), p. 20. There may be a slight inaccuracy here, because the inventory data are for active fronts and reserve; there may be a few thousand vehicles unaccounted for in inactive fronts.

162. IVOVSS, vol. 4 (1962), pp. 108 (production for the first half of 1944 was about 14,000), 125 (inventory on 1 July 1944 was 7753 in active fronts, 2232 in reserve). Compare p. 20, where active fronts had 5357, reserve 271. The caution with respect to unspecified inactive fronts (if any) applies (see previous fn).

163. As an appreciation of crew comfort, note Kotin's discovery of the need for power assist to help load the JS-2's 122-mm gun (Kotin, p. 24) and Stalin's concern for the thirst of tankers (see fn 124).

164. Mostovenko, "Tank, vremya, konstruktor" and Tanki, pp. 188-189.

165. See fn 132.

166. Kotin, p. 24.

167. Vishnyakov, Tank na p'edestale, p. 50.

168. Mostovenko, "K voprosu o razvitii sovetskikh tankov", p. 115.

169. Vishnyakov, Tank na p'edestale, pp. 32, 35, 47.

170. Mostovenko, Tanki, p. 93 for the T-46; BSE (1st ed.), vol. 53 (1946), col. 560 for the T-24. BSE is not clear whether the "significant tactical and technical shortcomings" were unreliability or insufficiency of design. Mostovenko leaves no doubt about the T-46: "After a small number of T-46 tanks were built, the vehicle was taken out of production. It was distinguished by a more complicated design and less reliability than our other tanks of that period."

171. Mostovenko, Tanki, p. 104. This may be thinly veiled criticism of the Kirov Plant KB. The comment was directed against the multi-turreted heavy tank. If in the past the essence of a heavy tank had been a lot of armament

arrayed in independent turrets, this concept was clearly not going to work when one tried to put shell-proof armor over the whole vehicle. Mostovenko confirms that the 1938 heavy tank designs started off with three turrets and then got down to two, but does not mention any stories of Stalin plucking turrets off scale models.

172. Rotmistrov, pp. 62-63.

173. Mostovenko, Tanki, p. 193.

174. Vishnyakov, Tank na p'edestale, p. 30 for Morozov; SVE, vol. 3 (1977), p. 273 for Duknov.

175. Erickson, pp. 502-503: "there is no evidence to suggest excessive interference with the corps of tank designers, and the improvements in tank design projected in 1938 were to lead to some excellent machines."

176. Voprosy strategii was published in 1965 and is a bit freer with comments about the purges; it is the source of the statement about repression of proponents of tactical ideas (p. 553). Voprosy taktiki is more reticent about Stalin's excesses, published as it was in 1970. It still cannot hide the fact that a number of prominent military writers do not have biographies after 1938, although it offers no comment.

177. Mostovenko, "K voprosu o razvitii sovetskikh tankov". We are much indebted to the author of a previous article, which was so bad that Mostovenko felt compelled to send in this letter to the editor of Vizh.

178. Some delay in deciding on KV and T-34 has been sketched out. KV and T-32 were tested in September 1939, and in June 1940 production of the T-34 was supposed to have begun. There was apparently a considerable amount of hand wringing all that winter about accepting both new tanks. 1938 itself was an unsettled year that yielded only some archaic throwbacks (T-100, SMK) and much uncertainty about what to do with the BT. Industry was certainly affected by something. Mostovenko notes that only one-third of the government tank orders were filled in 1940-1941 ("Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 33). IVOVSS, vol. 1 (1961) observes that the Defense Commissariat had no clear idea about KV and T-34, even though they already had been accepted for production; as a result, "industrial mastery of new ytpe tanks was retarded" (p. 416). Both sources date from a time when one could be candid about the errors at the top that left the Soviet Union poorly prepared for war. By 1971 Marshal Zakharov is setting out a different interpretation in Vizh: the sytem and Stalin did not err and everything that needed to be done was done. It is this attitude toward history and historiography that makes Mostovenko and other writers of the early 60s so valuable. Perhaps they only were quoting facts to attack Stalin, but at least they quoted facts and archives.

179. Mostovenko, "Razvitiye sovetskikh tankov v gody Velikoy Otechestvennoy voyny", p. 36.

180. The officer was Artillery Chief of Staff General F. A. Samsonov. His statement, that "experience has shown that self-propelled weapons are required, since no other type of artillery had such an effect in directly accompanying the attack of infantry and tanks and in coordinated action with them in close combat" is remembered by Kotin, p. 25; Popov, p. 28

adds: "The material damage inflicted on the enemy by self-propelled weapons, and the results of battle, compensate for the losses." It sounds almost like damning with faint praise a weapon that was to account for over one-fifth the armored vehicle production in the Soviet Union during the war.

181. Rotmistrov, pp. 266-267 contains a description of the meeting in the GKO that led to Stalin's assigning SAUs to the tankers.

182. See text at fn 101.

183. Vishnyakov, Tank na p'edestale, p. 99 and Kotin, p. 25 both attest to the 0300 calls from the Kremlin to the plant directors at 183 and Tankograd, respectively, both of whom had assembeled their section chiefs and their data. Neither source identifies the caller: "One and the same calm voice asked how many tanks had been loaded out in the previous 24 hours" (Vishnyakov). There is little doubt that it was Stalin himself. Who else would tie up whole plants' worth of engineers and managers at three in the morning?

184. P. Batov, "Marshal bronetankovykh voysk P. P. Poluboyarov", Vizh nr. 6 (1971), p. 125.

185. Vishnyakov, Tank na p'edestale, especially pp. 45-46.

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