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# Soviet Union

## AVIATION & COSMONAUTICS

No 12, December 1989

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[The following are translations of selected articles in the Russian-language monthly journal AVIATSIYA I KOSMONAVTIKA published in Moscow. Refer to the table of contents for a listing of any articles not translated.]

## AVIATION AND COSMONAUTICS

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### Air Force Training Shifts Toward Defensive Mission

*90R10009A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 1-3*

[Article, published under the heading "Anticipating the 28th CPSU Congress," by Col Gen Avn V. Pankin, chief of the Main Staff of the Air Force: "Deepen Perestroyka, Increase Combat Readiness"]

[Text] The process of perestroyka which is taking place in our society, the defense orientation of Soviet military doctrine, and the continuing reduction of the Soviet Armed Forces within the framework of reasonable sufficiency have exerted determining influence during this past training year on the nature of activities of Air Force units.

These and other current objective factors explain in large measure the need for a radical change in the work style and methods of commanders and staffs of air units and combined units, since primary focus is now on matters pertaining to ensuring continuous operational readiness on the part of subordinate units and subunits to repel an aggressor sneak attack, as well as matters pertaining to improving modes of defensive air combat operations.

Analysis of work accomplished in this past training year indicates that we have succeeded in achieving a higher degree of organization, job-related and innovation activeness on the part of personnel, in comparison with the previous year, in accomplishing training plans and schedules with a good performance mark. There has been an appreciable improvement in the level of aircrew flying skills, and leader personnel have shown greater responsibility for steady improvement in the preparedness of air regiments to carry out their assigned missions. The principle of "Teach troops that which is needed in war" was adopted as the basis of Air Force personnel training.

As we know, tactical air exercises constitute the concluding phase and at the same time the highest form of training of air units and subunits. Training exercises test the readiness of men and equipment to perform combat missions. Another reason the tactical air exercise is important is the fact that in peacetime this is the only activity which can provide personnel with an idea of the scope and dynamics of modern combat and is the only activity in which personnel can acquire the experience and know-how of skilled, determined actions.

In this past training year the subject matter and directional thrust of tactical air exercises were adjusted in the direction of air assets working primarily on defensive missions. In the course of tactical air exercises, air unit commanders and staffs improved skills in command and control of aircrews and subunits as a rule within the dynamic environment of combined-arms defensive combat, developed tactical thinking, learned rapid situation assessment, learned to make intelligent decisions, and learned to accomplish close coordination in an operational-tactical environment of conduct of initial defensive operations.

Operating in a complex tactical environment, flight personnel would work on various modes of combat and performance of such missions as repelling an enemy sneak air attack, cover and close air support of defending ground forces, engagement of enemy air assault forces, conduct of air reconnaissance, and jamming.

Commanders and political workers, Aviation Engineer Service, rear services and communications personnel amassed essential experience in the course of training exercises. In addition, tactical air exercises provided the opportunity to test the viability of the points in guideline documents and the realisticness of current tactical-technical performance standards, thoroughly to study the specific features of employment of aircraft armament and combat equipment, and to refine the methods of preparing for and modes of conduct of combat operations aimed at decisively defeating invading hostile air and ground forces.

The best results in the course of training exercises were achieved by the military units led by Communist officers V. Larin, V. Petrov, A. Pelevin, and many others. Of those who displayed excellent performance in flying sorties involving weapons delivery, I would like to name the crews of Lt Col V. Vereskulin, Maj Yu. Gorin, and Capt S. Penzin. These officers are genuine experts at their job; one can learn a great deal from them.

What is it that predetermined the success of tactical air exercises in these units? First of all, high-quality advance preparation of all organizational and methods materials. Second, thoroughly thought-out and comprehensive preparation of personnel. Third, arranging for the most highly-trained officers in the units, as well as representatives of scientific research organizations and service academies to conduct research investigations in the course of training exercises. Such a combination of practice and theory made it possible to conduct research on a high scientific level, to analyze obtained results in a high-quality manner, to prepare recommendations on practical incorporation of all positive results into the operational training of troops and staffs, and to determine problems requiring further study.

Unfortunately we also have units in which commanders and staffs have not yet restructured organization and conduct of tactical air exercises with emphasis on performing missions in conditions of defense. In addition, exercise preparations are made in haste, and frequently the most simple items are practiced and rehearsed as exercises, items which do not require much effort to accomplish. Research plans are at times far from today's urgent problems. What can such training exercises contribute? Nothing other than that vaunted check mark in report documents. As a rule people's labor, time, and material expenditures (and considerable at that) are wasted in such instances. In addition, the absence of apparent results has a negative effect on personnel, dampens the men's enthusiasm, aggravates stagnation, and in no way fosters the development of initiative and innovation. We cannot shut our eyes to this; we must work resolutely to achieve a change in the state of affairs.

Organization of command and control exerts considerable influence on the state of operational readiness and quality of operational training of units and subunits. The responsibility of commanders and staffs for skilled organization of command and control has increased in present-day conditions, due to radical changes in the means and methods of combat operations. Practical experience indicates that if command and control are unreliable, then even if personnel are adequately equipped and trained, the combat capabilities of units and subunits may prove to be not fully utilized, threatening failure to accomplish the mission of repelling aggression.

As we know, the principal and ultimate indicator of effective command and control in combat is achievement of the stated objective on the basis of efficient utilization of the manpower and assets at the commander's disposal. In order to accomplish this, one must have a solid grasp of the operational and tactical environment, one must project situation development in a well-substantiated manner, and one must make optimal decisions and implement them in a persistent manner. These points also apply in full measure to the daily activities of commanders and staffs.

The majority of commanders and staff officers of air units and subunits and support units endeavor to acquire these qualities in the course of their daily training and independent work activities. Such officers as Col R. Bedoyev, Lt Col M. Bulychev, and others are constantly improving the level of their job proficiency. They successfully incorporate advanced methods of planning and scientific organization of labor into staff work activities, actively utilize computer hardware, develop and maintain the command and control system at a high level of readiness. It is essential to disseminate and study their experience and know-how, since we still have a good many deficiencies, and the application of advanced know-how will unquestionably be very useful.

I must note that in the past training year a numerous innovations were adopted in many air units, and experiments of various kinds were conducted. Ground training and preparation of flight personnel was organized in a new manner. It became grounded on instilling greater independence in regimental commanders. They were authorized to determine in a differentiated manner the items to incorporate in training sorties for each pilot, in order to promote more successful pilot mastery of flight maneuver sequences.

Modern automated flight data recording equipment became extensively utilized in grading quality of training sortie performance. Some units have now established automated performance monitoring data centers based on such equipment, facilities which make it possible to determine flight personnel errors quickly and in a well-substantiated manner, as well as comprehensively to analyze aircraft performance.

A fundamentally new system of servicing aircraft has been adopted in the units, cutting the time required to make an aircraft departure-ready without detriment to quality, through efficient distribution of engineer and technician personnel among the duty shifts.

A number of units have proceeded with adoption of an improved logistic support system in order to improve the mobility of air regiments and to develop a uniform theater air forces support structure in defensive operations. It is leading to a substantial increase in the capabilities of air forces rear services units, although it requires their radical reorganization.

The fact that in recent years new and more sophisticated aircraft have been entering operational service with Air Force units is increasing the operational significance of each aircrew during the conduct of combat operations and is imposing higher demands on command, flight and engineer-technician personnel, and on rear services and communications personnel. Persistent search for methods of accomplishing maximum effective utilization of the excellent combat capabilities of modern weapons and equipment, as well as continuous improvement in tactical skills, have become the main tasks in their job-related training.

Successful mastery of fourth-generation aircraft and increased pilot flying proficiency are promoted by modern flight training methods grounded in new combat training programs and in other documents regulating flight activities. The practical daily activities of Air Force units have persuasively confirmed the effectiveness of these methods in improving the quality of flight personnel combat training, in economical aircraft utilization, and in development of independence on the part of air regiment commanders.

Another step has been taken toward ensuring flight safety. Airfield air traffic control centers which have been established have fully proven themselves. They have freed regimental commanders and their deputies from the additional work load of air traffic control and have made it possible to engage in training flight personnel in a more substantive manner. One important advantage of the centers over the former air traffic control groups is that their personnel makeup remains constant, and consequently operations are smoother.

Considerable hopes have been placed on transition to the new system of training frontal aviation pilots according to the principle of interlinked training stages: DOSAAF - pilot school - specialized training center - air regiment. The adopted procedure makes it possible to ensure purposefulness and efficiency of flight personnel training and development from the very outset. In addition, achievement of a fairly high level of flying proficiency at the first stage of training eliminates or at least greatly reduces psychophysiological "washing out" in the process of final pilot development at subsequent stages. Thus we expect more highly-proficient pilots to be coming into the line units.

Good results in combat and political training cannot be achieved without firm military discipline. Constant attention is being devoted to matters pertaining to strengthening discipline and maintaining firm observance of regulations on the part of commanders, staffs, and political agencies of Air Force units. An uncompromising campaign is being waged against violators of military discipline, especially persons whose behavior is at variance with regulations. Efforts at improving the esprit de corps and cohesiveness of multiethnic military units have been stepped up on the basis of the decisions of the September (1989) CPSU Central Committee Plenum, although we must state that there are still many problems in this area and that it will be necessary to work hard in order to achieve the desired results.

Attention continues to be focused on personnel living conditions, facilities and services. Meriting approval, for example, is the initiative of air regiment chief of staff Lt Col A. Krishtop, who has done a great deal to improve living conditions and conditions for rest and recreation for Air Force personnel, to refurbish barracks facilities, and to establish a psychological relaxation room for compulsory-service personnel. I should note that these are not trivial matters. It behooves us to utilize all available possibilities to activate the human factor, which in the final analysis also determines in large measure both progress in perestroyka, our achievements, and our setbacks. It is certainly no revelation that wherever living conditions, rest and recreation conditions are better for the men, training performance results and discipline are also better.

As stated above, on the whole commanders, staffs and political agencies, as well as all Air Force personnel displayed an improved level of operational readiness and proficiency in the past training year. They developed greater capability to perform difficult missions in conditions of defensive operations. Party political work became more effective, and it achieved a stronger linkage to the daily lives of Air Force personnel and to their activities aimed at ensuring combat readiness and flight safety. Many air regiments and support units achieved substantial performance results in their military labors and rose to a qualitative new level of military proficiency.

All these are specific examples of the continuing perestroyka in the Air Force and evidence of development of the process of activation of the human factor, glasnost, and democratization. I want to stress once again that it is very important to see positive changes, to support and encourage advanced know-how, to reinforce and consolidate achieved levels, and to deepen restructuring processes.

In our time, however, which demands of each and every Communist, Komsomol member, and party-unaffiliated member of the Air Force a great deal of personal effort, it is necessary to seek not only objectively to assess achievements but also to concentrate attention on errors of omission, oversights, and unutilized reserve potential for improving the quality of combat training. And we still have plenty of deficiencies. Perestroyka has brought them into good focus. For example, socialist competition is not producing adequate effect in many units. It is being impeded by a lip-service attitude and by poor leadership. Some places they have not yet forgotten echoes of past years, when action for the sake of show was emphasized in training, and the main thing—teaching that which is essential in actual combat—was replaced by a lot of empty talk. Nor can I remain silent about the fact that in some units failure adequately to appreciate the role of operational training, lack of a daily effort to complete the daily schedule of operations and training activities, failure to encompass all personnel in training activities, and poor indoctrinational work adversely affected military discipline. All these and other mistakes, errors and miscalculations should not merely be noted down, but an effort should be made to correct them as quickly as possible, thoroughly to study them, closely to analyze their origins, and to prevent future occurrence of such things.

The new training year, the year of the 28th CPSU Congress, will be an even busier year for the Air Force. This is due to the continuing scheduled reduction in personnel, while maintaining a high degree of operational readiness on the part of air units to perform their missions in any and all situation conditions.

In spite of some relaxation of international tensions, there still remains a possibility of outbreak of wars and military conflicts. As USSR Minister of Defense Army Gen D. T. Yazov, candidate member of the CPSU Central Committee Politburo, noted in his address at the September (1989) CPSU Central Committee Plenum, statements by some NATO military officials attest to the fact that NATO still pursues a strategy of intimidation [ustrasheniye—also translates as deterrence], aimed primarily at the Soviet Union and its allies. The situation requires that air units be maintained in a continuously high state of combat readiness to repel a sneak act of aggression and demands that we prepare staffs, personnel, and particularly flight personnel, for organized, determined actions. Matters pertaining to improving methods of bringing units to various levels of operational readiness, shortening the time required to carry out appropriate measures, increasing vigilance and readiness of alert-duty forces and assets, as well as aircraft survivability continue to be important.

Elaboration and practical mastery of modes of combat operations which make it possible to achieve excellent results in accomplishing assigned missions with the least possible expenditures continue to be a key area in further improving unit combat proficiency. Elaboration of theoretical, technical, and organizational measures is prescribed, aimed at practical implementation of the requirements of Soviet defensive military doctrine.

The attention of Air Force commanders and staffs should be concentrated on seeking ways to achieve further increase in intensity of operational training, on resolutely rooting out a lip-service approach in planning, as well as attempts to organize and conduct combat operations according to standard theoretical schemes, without taking into account the specific situation and the actual capabilities of our forces. Further improvement of methodology of organization and conduct of tactical air exercises and special tactical exercises [e.g. airfield security], training drills, brief tactical drills for officers, and other training activities must form the basis for improving tactical air proficiency. And this is to be accomplished not by quantity but by quality, by doing away with compromises with realism, predictable pattern, and unnecessary relaxation of demands.

Tactical air exercises and air exercises will continue to be conducted jointly with combined-arms field training exercises and air defense forces exercises. This will require thorough organizational coordination, elaboration of safety procedures, and creation of a stable command and control system in conditions of a rapidly-changing ground and air situation. Particular attention is to be devoted to a radical improvement of all types of combat operations support in order to bring it into conformity with today's greatly increased requirements.

We view as no less complex a task for all personnel the mastering of the new military regulations, thorough study of their points and provisions, and their practical adoption in combat training. Measures to accomplish radical restructuring of military life and strengthening of discipline, organization, and orderly procedure, currently being adopted in conformity with CPSU Central Committee demands, should help accomplish higher-quality resolution of the problems connected with maintaining a high level of unit operational readiness.

While fully aware of the importance of the work we shall be doing, it is also necessary to see realistic ways to achieve the stated objectives. The Air Force is equipped with modern aircraft and armament and contains highly-skilled cadres; the majority of Air Force units are led by experienced, demanding, and caring commanders. But that is not all. Attainment of the stated goals will depend in large measure on the political and job-related activeness by party members and all personnel. Today a maximum of competence, responsibility, businesslike efficiency, initiative, and stick-to-itiveness are demanded of each individual. This is a decisive condition for successful accomplishment of the tasks assigned to Air Force units in the new training year.



## Flameout Caused by Air-to-Ground Rocket Wake Turbulence

*90R10009B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 4-5*

[Article, published under the heading "Combat Training Experience," by Military Pilot 1st Class Col I. Artyushenkov: "Method = Science + Practical Experience"]

[Text] Method has a special place within the flight personnel training system. It is grounded on theoretical research and practical experience, and its function is to help achieve the main objectives of all types of training. Effectiveness of flight personnel training, the combat capability and operational readiness of Air Force subunits and units depend in large measure on the degree of sophistication of methods. However, inadequately developed methods recommendations or, in many cases, the total lack of methods recommendations not only have an adverse effect on the training process but also lead to more serious consequences—"method-caused" mishaps. In this connection there is presently a need thoroughly to analyze the reasons for the appearance of methods instructions which have not been thought through in detail, as well as their connection with air mishaps. In our opinion the root of the evil lies in a substantial discrepancy between theory and practice and lack of reliable feedback between them.

Leading scientific research establishments, various centers, and the Air Force Main Staff Combat Training Directorate naturally and logically have the final say in formulating basic points of method. But methods work which is performed in line units and has an unequivocally practical directional thrust is in a secondary role, as it were. It is restricted to the rigorously-defined framework of specifically stated sections and is of an auxiliary, refining and detailing nature. As a result one observes an insufficiently attentive and frequently even skeptical attitude on the part of Air Force scientific circles toward conclusions and recommendations obtained in air units, particularly if they are at variance with generally accepted recommendations.

Accumulated experience and well-reasoned suggestions by flight personnel at methods councils are sometimes ignored when refining the points of existing training methods. In addition, the voice the practical experts in the field quite often simply does not reach the theorists and regulations formulators. What happens is a disruption of feedback as well as violation of the principle "from the general to the particular and from the particular to the general."

Guided by instructions which are not refined in a prompt and timely manner, pilots repeatedly encounter the same situations. I shall cite an instructive example of "method-caused" mishaps. A regimental tactical air exercise was in progress. After a two-ship MiG-27 element fired S-24 rockets at a ground target, the engines on both aircraft experienced compressor stall and flameout.

This is probably the only time this has occurred simultaneously on two aircraft flying together.

The investigation board reached the following conclusion: "The principal cause of flameout of the airplanes' engines was the fact of substandard rocket propellant in the fired munitions." This was a standard conclusion for such cases. The prescribed remedy was also standard: prohibit using three lots of munitions and temporarily halt the firing of S-24 rockets by MiG-27 aircraft.

The members of the board of inquiry seemed to ignore the fact that the rockets had been from different lots, had been stored at different depots and even in different parts of the country, and had been used earlier uneventfully. According to the roughest calculations, the presented conclusion is of very low probability. Nevertheless the findings were approved. The aircraft involved in the incident were grounded, and hundreds of expensive munitions were withdrawn from use. The actual cause of the engine flameout, however, remained undetermined. In addition, nobody remembered the prescribed remedy.

I have fired a great many rockets and missiles from aircraft of various types. I will never forget the sensation of proximity to their wake turbulence. The aircraft, shaking, skims along the surface of this turbulent wake for a certain period of time. When this happens, it is essential immediately to commence dive pullout and to move away from the wake turbulence of the launched missiles or rockets. The most important thing at the initial phase of pullout is to avoid an abrupt increase in angle of attack. High angles of attack reduce the engine air intake's safety margin of resistance to compressor stall.

It is even more important to maintain straightline movement prior to and at the moment of launch. An angle-of-attack increase of even 2-3 degrees and an increase in load factor by 0.1-0.2 g leads to deepening of the aircraft's flight path into the rockets' wake turbulence. This causes the aircraft to roll, one notes a slight rise in engine gas temperature, typical aircraft buffeting occurs, as well as pre-stall "growling" of the engine air intakes, which is easily distinguished from operation of the antisurge system.

A further increase in angle of attack prior to launch worsens the situation. Following missile release the turbulent wake rises and not only gets into the aircraft's path but twice intersects its flight path—upward and downward. The greater the angles of attack, the stronger the impact of hot propellant gases on the engine air intakes. The result is compressor stall and flameout.

The dynamics of development of events in the air mishap mentioned above were analyzed by pilots after the inquiry was completed. They ascertained the following. The element leader was late in spotting the target and fired off his rockets as he turned onto the target, that is, with a G load. His wingman following his maneuver. Both pilots found themselves in the situation we have described above. The element leader was able to air-start his engine, but his wingman was unable to do so, because of lack of altitude.

If we look more closely at the incident, we see that the pilots' mistake was not the cause of the mishap. It was only a consequence, the consequence of a primary cause—failure adequately to detail methods instructions on firing rockets from aircraft of that type as well as repeated erroneous conclusions reached following investigation of similar incidents.

Eight years have passed since then, but the circumstances of the incident have never been communicated to Air Force flight personnel and have not been reflected in methods procedures. Thus they have failed to close the breach on one of the elements of "method-caused" mishaps. I believe that it is not too late to make a detailed analysis and, finally, to reach correct conclusions.

After all, it is possible that precisely the occurrence of G load during missile launch leads to compressor stall, engine overheating and flameout in the stratosphere. It is also entirely possible that ingestion of parts of the fin assembly into aircraft engines when firing a salvo of S-5 and other rockets is not always a consequence of entering the fragment spray pattern but can result from firing rockets during dive pullout or while turning onto the target. Conduct of investigations of this type will help assess the effect on flight safety of the state of affairs in such a training category as weapons delivery, and will help determine the general primary causes of "method-caused" mishaps.



## Pilot Suggests Incentives for Veteran Combat Pilots

*90R10009C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 6-7*

[Article, published under the heading "Combat Training and Flight Safety: Views, Opinions," by Military Pilot 1st Class Maj A. Korotchenko: "You Have Become a Pilot 1st Class. What Next?"]

[Text] Sooner or later each of us comes to a point where it is no longer enough merely to ask oneself questions, without thinking about the matter further. There comes a time when you begin seeking answers to these questions, analyzing for the purpose of determining just why is it you are living and working, what you are striving to attain. You look for clarity but are unable to find it: neither in the speeches of the top brass nor in official documents. But the thought arouses one's consciousness: can it really be that nobody is concerned with the fact that you and hundreds of others like you have come to a halt in your professional growth, with the fact that you and your colleagues no longer have a goal toward which one must strive, overcoming one's own limitations. Why is this happening?

Perhaps because the finer points and nuances of our flying work reach representatives of the "highest echelon of Air Force authority," who themselves no longer fly, only through the subjective reports of their assistants, the inspectors, who, incidentally, are no longer flying at full ability, for understandable reasons. And like it or not, they gradually, due to their advanced age and the fact that they fly only sporadically, become increasingly further removed from the deep-lying problems of their profession. But why is it then that those commanders who fly every day, who regularly encounter these problem-icebergs in their activities, remain silent? They most probably are afraid that they will not be understood or that they will fall into disfavor.

The topic which I would like to discuss is, I am convinced, of concern to the absolute majority of pilots, who are interested in advancing their professional skills. I therefore invite them to engage in a frank discussion.

For a beginning I shall cite the following example. When one of my colleagues was a young captain, with a first-class proficiency rating, he was teaching pilots aerobatic maneuvers in an allied country. For a period of a year he was able to fly only during daylight, since the aircraft being flown permit executing advanced maneuvers, involving extremely low altitudes, only during daylight hours.

But then it became necessary to teach night flying to his charges. This instructor immediately had difficulties. As was later ascertained, these difficulties were more psychological than actually involving flying skills. He could clearly see that stated regulations in the Manual of Flight Operations, pounded into his memory like a rusty nail into a living tree (they say that the manual has a red cover because it is written in the blood of entire generations of airmen—so we were taught), which states that a pilot first class shall not go more than so many months between night flights. And here an entire year had gone by!

What should he do? Fortunately he could put the question to the Soviet military attache. The reply: you have got to instruct them! And then he added with solicitous concern: be very careful, son.

And the captain had a tough time of it! At his age of 26 he was aware that one should not ask for trouble, no matter how important the task at hand. And he was ready and willing to proceed cautiously and intelligently. But his conscience was burdened by those lines from that little book "turned bloody by generations of aviators," a book which for him had the weight of holy writ.

Perhaps the most difficult thing was psychologically to force himself to disavow dogma which he had assimilated in the hothouse conditions of peacetime training.... They began flying just before dusk and gradually "edged" toward full darkness. They successfully completed the entire training sequence, although the airfield did not even have runway-end floodlights or truck-mounted searchlights.

That was more than 10 years ago. My colleague is still a pilot 1st class. Only his rank has advanced by one grade. And yet his flying skill has improved to an incomparable degree. But what tangible recognition is there, and how is this improvement in professional skills doing anybody any good?

It is unpleasant to realize that your experience and know-how mean nothing, that the hundreds of hours spent in the air, in one-on-one gun-camera air-to-air combat, in night air-to-ground strikes, etc, while having taken their toll on your health and nerves, have given nothing in exchange other than some gray hair at the temples, giving neither moral nor material compensation. And material benefits are the least of one's concerns! It is much more important to create a system which enables one to feel that one is a genuine pilot, not some kind of a serf-aviator, who is limited and restricted in his professional advance by anybody who feels like doing so. As if he had not spent long years flying and improving himself. It seems that the pilot's badge bearing the number "1" brings us all—from captain to colonel—back to a common level. And yet this is the worst kind of profanation. The people in the line units are well aware of this fact. Here is some confirmation.

We were to demonstrate to visitors from Moscow the combat capabilities of the MiG-29. All the pilots in our regiment have a high proficiency rating. However... everybody has a high rating, but varying experience. We knew in advance who would be flying to the air-to-ground range, and we were right. Within seconds Lt Col A. Tolubayev executed his maneuver and took out the targets. The members of the inspection team were delighted. Aleksandr Petrovich, please accept this watch personally from the Deputy Commander in Chief of the Air Force!

But then summer came to an end. It was now the season for flying in instrument meteorological conditions and in marginal VFR conditions. And Lieutenant Colonel Tolubayev "rejoined" the ranks with the young captains, performing the same training schedule. But how was he to improve his flying skills? Unfortunately, in spite of his level of proficiency and in spite of the requirement of the combat training program that an individualized approach be applied to the pilots, the administrative bureaucracy acts as the great leveler. What happens is the same thing as in KROKODIL: "I won't put up with upstarts! Bellows the Saw, reducing the Forest to Stumps."

What must be done to dismantle this truly antiprogressive, stagnant system? Should we perhaps borrow from the experience of civilian enterprises?

In industry, for example, there are worker categories, and the highest mark of professionalism is the personal stamp, which entitles a person to turn over finished product to the customer, bypassing quality control. That is, the worker is personally responsible for quality. I am convinced that in every air unit there are pilots who are capable of guaranteeing high-quality performance of every training sortie. These are primarily those officers who by virtue of their skill, their serious attitude toward the reasonable requirements of flight safety, and by their specific job performance have earned the right to a certain degree of independence.

Everything is quite logical here. Who better than an expert at his job knows how one should prepare for a given flight? Nobody! Because all of us are individuals, not robots corresponding to the State Standard incorporated into all kinds of regulations and formal instructions!

I am sure that some superior officers will become indignant upon reading the above: "Look what this guy is suggesting! A pilot will decide for himself whether or not he is ready to go up. This will greatly increase the risk involved!" etc, etc. Nevertheless I would not take offense at them. I realize that the upgraded system is not to their advantage, since expanding the limits of independence for experienced pilots will inevitably raise the question of the advisability of the continued existence of a number of positions in the administrative bureaucracy. Therefore the persons occupying these positions would go to any lengths to keep things as they are. As for risk, it is hardly likely that it will increase, for the pilot will be bearing personal responsibility for all mistakes. In addition, to state the obvious, who is going to take to the air if he is unsure about whether he can handle it? Moreover, we are not talking about all pilots, but only the most highly-proficient ones.

I must also mention the combat experience amassed by our airmen in the Republic of Afghanistan. It was gained at a high price. The war frequently placed pilots in conditions which demanded immediate, independent decisions, and decisions which frequently were contrary to regulations. He who could handle this type of situation came through with flying colors, displaying psychological firmness, staunchness, volition, and confidence in himself. While he who was accustomed to being told what to do by somebody else paid with his life for his lack of proficiency. For this reason we simply cannot forget these bitter lessons, taught to us by hard realities. In peacetime conditions as well we must do everything possible to ensure that flight personnel possess a level of proficiency enabling one instantly to assess the situation, to make and execute the decision.

There is also another aspect to this problem. Can we simply accept a situation where a 35-year-old combat pilot (not an "upstart" lieutenant colonel) feels he has no prospects for advance? But that in fact is the case. Not everybody can be promoted to full colonel. There is nothing with which we can provide officers with reward or material incentive for length of service in flight duty. As a result pilots who seem to be stuck in grade and have become sick of wasting their time in the air, flying the same maneuvers over and over, do their utmost to get out of the Air Force. This results in enormous losses, both financial and in terms of morale.

In such a case, how can pilots be given some incentive? I believe that we can offer the opportunity for self-improvement. In connection with this we should perhaps consider introducing a "master" proficiency rating (or something of the sort), which would be a guarantee that a pilot can be given a certain degree of independence: he could fly, for example, not only according to the combat training program, but also the full RLE [expansion unknown], he could teach young pilots using his own methods, he could work on mastering more complex types of flying, etc. Thus the master pilot would be firmly cognizant of the fact that he bears full responsibility for his own personal training, for the quality of execution of the mission assignment, and for flight safety. I feel that this would be a powerful incentive.

In conclusion I would like to discuss in greater detail the professional standards which a military pilot must meet in order to earn a master rating. One could apparently assume that such a rating is deserved by officers who are able to think in a sober manner and who do not succumb to the thrill of taking a risk. Pilots who have logged not less than a certain specific number of hours (for a specific Air Force component [vid aviatsii]). This requirement could be 1500 hours for fighter pilots, for example. Incidentally, it takes at least 17-20 years of continuous flying duty to log this many hours. And this means that a great deal of professional and life experience will be amassed over the course of such an extended period of time, entitling a pilot to bear responsibility for the prestige of military aviation.

Logging flight time is one thing, but a pilot should apparently also have the ability to pass on his skill and knowledge to others, that is, he should be an excellent instructor. An important role is also played by the pilot's state of health and other attributes required in flying.

In my opinion a decision only by the command authority is not enough when advancing a pilot in proficiency rating. In order to avoid subjective judgment it is important to know the opinion of a pilot's colleagues, friends, and certainly the members of his family (and perhaps this is the most important element). In short, information should come from various sources, while the approach to selection of candidates for the master rating should be tough and uncompromising. Otherwise a person could be done a disservice....

I fully realize that it will be difficult psychologically to make the decision to take this step, both for our superiors and for us pilots. It has been too long now that they have been leading us all by the hand, with every step rigorously prescribed in advance. Over the course of decades they have driven out of us the ability to think and make decisions independently. Initiative was a synonym for indiscipline and was ruthlessly punished, right down to permanent grounding. Many would have their "heads lopped off" due to a mistake by a single individual. Thus in place of developing personal discipline, responsibility, and integrity in people, there occurred a persisting process of cultivating secrecy, actions geared to show and pretense, deception, and terror of the new. As a result we gradually became transformed (some more than others) into tin soldiers, to be manipulated at will.

It will of course be difficult to restore the true status of professional pilot. It will be necessary to overcome a great many bureaucratic obstacles. But it must be done. All those of us who have not lost their integrity and honor, who are truly concerned for the future of military aviation, to which we have dedicated our best years, must become involved. I know from my own experience that one person alone cannot carry such a burden, and I am therefore hoping for the support of all flight personnel. Let us use our magazine as one of the means of joining efforts in the fight against bureaucracy, for our professional and service interests. Let us remain silent no longer!

**Editor's Note:** In our opinion Maj A. Korotchenko has presented a number of interesting, although perhaps not undebatable suggestions. We invite our readers to take part in discussing them, because as we know, truth is frequently born in the clash of opinions.



## Listing of Recipients of Honorary Title

*90R10009D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 10-11*

[List of recipients of honorary title: "Their Military Labors Have Been Rewarded by the Homeland"]

[Text] **The Air Force training year is at an end. It took place under the banner of the 19th All-Union CPSU Conference, which focused personnel on qualitative parameters in military affairs. As practical experience has shown, successes by Air Force personnel in combat training are more substantial wherever there is personal example by the leader-Communist, focusing on specific deeds and excellent end results. The homeland greatly appreciates their military labors. By edict of the Presidium of the USSR Supreme Soviet dated 18 August 1989, 18 Air Force officers and general officers were awarded the honorary title "Honored USSR Armed Forces specialist" for outstanding services to the Soviet State in the area of strengthening our national defense capability and for outstanding skill in their professional activities. At the request of our readers, we present these recipients below.**

* * *

**Maj Gen Avn Pavel Tarasovich Bredikhin.** Member of CPSU, graduated Military Air Academy imeni Yu. A. Gagarin in 1971. Military pilot 1st class, during flight career has qualified on four types of aircraft. Has logged a total of approximately 3,000 hours. Awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. He and his men have successfully mastered a new aircraft and are successfully performing complex missions during extended flights.

**Maj Gen Avn Konstantin Vladimirovich Vlasinkevich.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1972. Military pilot 1st class, has qualitied on eight types of aircraft during his flying career. He has logged a total of more than 4,650 hours. Awarded the Order of the Red Star and the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. He serves as commanding officer at the Balashov Higher Military Aviation School for Pilots. He skillfully organizes and supervises pilot training, political, and methods training. His school is one of the Air Force's finest higher educational institutions.

**Col Valeriy Nikolayevich Gnezdilov.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1985. Military pilot 1st class. He has logged more than 2500 hours. He has quaslified on eight types of aircraft. he is currently flying the MiG-29. A standard method for flight personnel to master the most complex types of training has been developed in Col V. Gnezdilov's unit with his direct participation. Awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class.

**Col Aleksandr Nikolayevich Goloshumov.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1975. Military pilot 1st class. He has currently logged more than 2700 hours and has qualified on seven types of aircraft. Awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. A high degree of professional competence as a pilot, competence in methodology and theory, as well as a great deal of experience and know-how enable him to do a good job of organizing and rigorously monitoring observance in air units of orderly procedure and rules and procedures of organization of flight activities, and improvement in flight safety.

**Col Ivan Ivanovich Golubtsov.** Member of CPSU. Graduated Yeysk Higher Military Aviation School for Pilots in 1966. Since then he has logged approximately 3000 hours, for 15 years in a row has annually requalified as a military pilot 1st class. Col I. Golubtsov displayed excellent fighting, moral and psychological qualities while carrying out his international duty in the Republic of Afghanistan. He flew 235 combat missions. In addition, he trained 25 Afghan pilots for combat flying. Awarded the Order of the Red Banner and Order for Service to the Homeland in the USSR Armed Forces, 3rd Class, for exemplary performance of combat missions and for rendering internationalist assistance.

**Lt Col Viktor Nikolayevich Krasilnikov.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1984. He has qualified on eight types of aircraft, military pilot 1st class. He has logged a total of more than 5000 hours, more than half of which were in day and night instrument conditions. Lt Col V. Krasilnikov has made approximately 100 test flights. He has been in emergency situations on several occasions, but he completed these flights safely thanks to his experience, skill, and personal courage. His military labor has been honored with the Order of the Red Star.

**Col Viktor Alekseyevich Larin.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1981. He has qualified on eight types of aircraft and has logged a total of more than 2000 hours. Recipient of the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. Col V. Larin has proven himself to be an energetic, hard-working officer-leader with stick-to-itiveness and an experienced commander-indoctrinator. His men have successfully completed conversion-training over to the fourth-generation MiG-29, and they recently received a mark of excellent in a tactical air exercise involving redeployment and live firing at target drones.

**Maj Gen Mikhail Ivanovich Lipatov.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin, USSR Armed Forces General Staff Academy. He has qualified on six types of aircraft, including the MiG-29, and demonstrates a high degree of flying skill. He also possesses excellent operational-tactical proficiency, displays initiative at command post exercises and tactical air exercises, quickly assesses the situation, makes well-substantiated suggestions, and makes correct decisions. Awarded the Order of the Red Star.

**Col Anatoliy Grigoryevich Morozov.** Member of CPSU. Graduated Military Air Academy imeni Yu. A. Gagarin in 1985. He has qualified on eight types of aircraft and has logged a total of approximately 2500 hours. At the present time he has the proficiency rating of military pilot-expert marksman, and flies the Su-25 aircraft. Awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. Col A. Morozov is distinguished by a strong sense of responsibility for the assigned task, stick-to-itiveness, and initiative. He constantly directs the efforts of his men toward improving their qualitative performance results in combat training.

**Col Leonid Nikolayevich Mokhov.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1983. Military navigator 1st class. He has logged more than 4000 hours. He qualified on the Il-76 aircraft and has flown numerous important missions. For example, he has done an excellent job on airlift operations to the Republic of Afghanistan and to the Transcaucasus, and he took part in earthquake disaster recovery efforts in Armenia. For his military labors he has been awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class.

**Maj Gen Avn Vitaliy Yegorovich Pavlov.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin, USSR Armed Forces General Staff Academy. He has qualified on six types of fixed-wing and rotary-wing aircraft; military pilot-expert marksman. He has logged a total of more than 4000 hours. 292 of these hours were flown in Afghanistan. His qualities as a pilot, commander, and indoctrinator blossomed fully in the harsh combat conditions of that country. His men performed various missions: from close support of ground troops to evacuation of wounded and airlifting of military and civilian supplies. And this commander always displayed an example of staunchness, courage, and skill. Vitaliy Yegorovich holds the Order of Lenin and the Gold Star Medal of the Hero of the Soviet Union, the Order of the Red Star, and the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class.

**Maj Gen Avn Vyacheslav Ivanovich Resnyanskiy.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1970. Awarded the Order of the Red Star and the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. Vyacheslav Ivanovich devoted more than 15 years of military service to training student pilots. Having flown more than 4000 hours and qualifying on four different types of helicopters, he passes on his experience, know-how, and knowledge to young airmen. He sees his task as instilling in personnel devotion to the socialist homeland and a high sense of responsibility for performance of military duty.

**Col Yaroslav Arsentyevich Titov.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1977. He has been flying for 25 years. During this time he has logged almost 4000 hours and has qualified on five types of fixed-wing and rotary-wing aircraft. For 14 years now he has been successfully requalifying each year as a military pilot 1st class. He has been awarded the Order of the Red Star and the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. Col Ya. Titov is trained and prepared for combat operations covering the entire combat training program, flying day or night, and in all weather. He flies with boldness and sureness. He passes on his wealth of experience to the younger pilots.

**Col Georgiy Viktorovich Tikhomirov.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1974. He has logged more than 1700 hours and possesses a military navigator-expert marksman proficiency rating. He took part in rendering internationalist assistance to the Republic of Afghanistan. He flew 22 combat missions. A knowledgeable, experienced expert at his job, he repeatedly carried out his assigned missions in excellent fashion. He has devoted and continues to devote a great deal of attention to improving methods of combat employment of aircraft and to training high proficiency-rating specialist personnel. He has been awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class.

**Col Vyacheslav Mikhaylovich Shvechikhin.** Member of CPSU. Graduated from Military Air Academy imeni

Yu. A. Gagarin in 1974. During his 23 years of flying service he has qualified on 12 types of aircraft and has logged a total of 3600 hours. He possesses a wealth of experience in flying methods work, possesses a high degree of operational-tactical proficiency, as well as solid knowledge of aircraft. Tactical air exercises aimed at improving the quality of pilot flying, weapons, and tactical proficiency have been held under his personal supervision and with his direct participation. He has been awarded the Order for Service to the Homeland in the USSR Armed Forces, 3rd Class.

**Col Vladimir Nikolayevich Shchipunov.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1977. Military pilot 1st class. He has logged a total of approximately 3600 hours, one half of which was flown in instrument meteorological conditions, including at night. Col V. Shchipunov, who holds the Order of the Red Star, is rightly considered to be one of our finest specialists. He makes a large contribution toward preparing materials on flight operations navigation support during tactical air exercises and takes active part in improving flight personnel training methods and increasing the reliability of Military Transport Aviation aircraft navigation gear.

**Maj Gen Avn Pavel Igorevich Ettinger.** Member of CPSU. Graduated from Military Air Academy imeni Yu. A. Gagarin in 1971. Awarded the Order of the Red Star and Order for Service to the Homeland in the USSR Armed Forces, 3rd Class. Military pilot 1st class. He has qualified on nine types of aircraft and has logged a total of more than 3200 hours. Maj Gen Avn P. Ettinger is fully trained for combat operations, and possesses a high degree of flying and methods skills. No mishap-threatening incidents have been charged to him.

**Maj Gen Avn Yakim Ivanovich Yanakov.** Member of CPSU. He has qualified on 10 types of aircraft, including the MiG-29. He has logged a total of more than 4100 hours. He skillfully applies in a practical way the knowledge he acquired at the Military Air Academy imeni Yu. A. Gagarin, from which he graduated in 1972, in the conduct of various exercises and in organizing the process of personnel training and indoctrination. In air units Yakim Ivanovich is known as an experienced pilot and an advocate of unswerving adherence to guideline documents pertaining to ensuring flight safety as well as strengthening discipline and military rule of law.

* * *

This coveted award of the Homeland carries with it considerable obligation. One must continue displaying initiative and stick-to-itiveness in the post to which one has been entrusted, one must have an innovative attitude toward one's job, and take an uncompromising, aggressive position in the campaign against negative phenomena. Today, stresses USSR Minister of Defense Army Gen D. T. Yazov, candidate member of the CPSU Central Committee Politburo, it is very important to consolidate achieved levels, to support and develop advanced know-how in every possible way, and to deepen restructuring processes by persistent, purposeful, and high-quality accomplishment of the practical tasks facing our units and subunits.



## Hind Helicopter Downed by Rebel Missile Over Salang Pass

*90R10009E Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 12-13*

[Article, published under the heading "They Were Decorated by the Homeland," by Maj V. Trusov and Capt V. Mayorov: "Echo of the Salang"]

[Text] **A great deal is being written today about the war in Afghanistan. And various points of view are expressed. In spite of their conflictive nature, however, one thing is unquestioned: the absolute majority of Soviet military personnel displayed examples of selflessness. One example of this is the heroic deed performed by officers A. Golovanov, who in June 1989 was awarded the title Hero of the Soviet Union (posthumously), and S. Peshekhodko, who was awarded the Order of Lenin (posthumously).**

* * *

The weather in Syzran was clear and placid on the day of Col Aleksandr Sergeyevich Golovanov's funeral. A band was playing solemn music. This line officer was accompanied on his final journey by cadets, command personnel and faculty from the Syzran Flight School. It was here where he became acquainted with the skies, where he made his first solo flights. He was to be reassigned here following his tour of duty in Afghanistan. His mother, his wife, and his sons—his elder son, Valeriy, who is a third-year cadet at the school, and his younger son Volodya—walked with heads bowed, inconsolably grief-stricken. Helicopters circled overhead, paying final honors to this combat pilot. Three volleys rang out....

Colonel Golovanov took off on his last mission during the night of 2 February. He was in an almost festive mood. Finally the long-awaited moment had come, when he would be flying home, a moment to which the airmen of the composite regiment stationed at Kabul Airport had long been looking forward. By that time many realized that the "Afghan slaughterhouse" was unlikely to produce any results other than senseless deaths.

For this reason the news about the flight they had been waiting for quickly made the rounds of the prefab housing modules. The airmen began counting the hours remaining before their arrival back in the homeland. Aleksandr Sergeyevich was rejoicing as well. He was all smiles. He even put on a new flight suit for the occasion. He and weapons officer Sergey Peshekhodko were to be first to take off. Such is the honored and responsible privilege of the leader.

Lt Col Anatoliy Nikolayevich Akimov recalls: "I was with the commanding officer right up to his departure. I was to lead out the second element of helicopters. Departure clearance was long in coming. Finally it came. He said to me: 'Akimov, I've got my departure clearance. So proceed according to plan'. A firm handshake, an exchange of wishes for a safe flight—and a few minutes later the Mi-24 was climbing above the field. Judging by the radio communications, everything was going well. The only thing that concerned us was the poor visibility and the buffeting being caused by strong wind gusts. But nobody had any doubt about the regimental commander's skill. And when Golovanov replied to the radioed inquiry from the command post as to whether he was beyond the pass: 'I am approaching the pass. We'll see you across the border,' we felt relieved."

Suddenly he was summoned to the command post by the regimental deputy commander for flight training, Lt Col P. Gushchin. It seems that they had lost radio contact with Golovanov. They immediately sent up a communications relay aircraft, which proceeded to orbit over the Salang Pass. Gushchin and Akimov were nursing the hope that the regimental commander had put down at Bagram Air Base due to bad weather. But why then had there been no response to their radio queries? They stubbornly kept at bay the thought that the worst had come to pass. But the minutes were ticking away, with no answers to their question.

The communications relay aircraft observed no flames on the pass. Akimov reported his thoughts on the incident to the army's commander of air forces, Maj Gen Avn D. Romanyuk. In the meantime the pass had begun to get socked in. A blizzard swept in and raged on for 72 hours. This was followed by above-freezing temperatures and rapid melting, followed by more snow. The regiment did not make it across the border until 6 February.

KRASNAYA ZVEZDA reported during those anxious days: "The incident occurred during the night of 2 February. A helicopter flown by officers A. Golovanov and S. Peshekhodko took off to reconnoiter the route between Kabul and Mary. Communications with the helicopter were lost when the aircraft was in the vicinity of the Salang Pass. The helicopter may have been shot down by a rebel missile, or it may have wandered off course and flown into one of the peaks flanking the pass. Is the crew still alive? All Soviet air assets and manpower in Afghanistan have been mobilized for the search effort.... Everyone is fervently hoping that the helicopter crew is still alive...."

Yes, they were hoping for the best, although pilots—who are realists in flying matters—realized that hopes were faint indeed. It subsequently was learned that the helicopter had been hit by a rebel missile and had exploded in the air.

...In Afghanistan Military Pilot 1st Class Colonel Golovanov was in the air virtually every day. In combat there were no days off. And a commanding officer cannot relax until all his men have returned to base. In war one cannot remove the burden of responsibility even during sleep. Essentially by virtue of his position he could have flown less frequently—nobody would have held it against him. But Golovanov realized that he was the most experienced pilot in the regiment, and therefore the most difficult missions were his. That is a commander's fate, and that is a leader's duty.

The squadron commanders knew that after mission briefings Golovanov would invariably ask whether a mission had been scheduled for him—and God forbid that somebody had failed to do so, for whatever reason! He would fly into the most dangerous areas, where the probability of being shot down seemed so high that one would not even bother considering some other outcome. But nevertheless.... Each and every mission demanded enormous emotional and physical effort. Physical and emotional stress loads were at the limit of human capabilities.

The men would say about him: we have a lucky commanding officer. And he was in fact downright lucky; sometimes he would emerge unharmed from the very flames of hell. But this luck was not mere blind fortune; it was grounded on professional expertise, combat daring, and the highest degree of flying skill, which helped him gain the upper hand over unpredictable circumstances.

On 21 August 1988 an Mi-24 helicopter was crippled while flying out to one of our outposts high in the mountains. It was being flown by Capt Anatoliy Litvinenko and weapons officer Sr Lt Aleksandr Moshkov. By some miracle the pilots succeeded in bailing out of their flame-engulfed helicopter. Their parachute canopies did not have time to deploy, however: if they had been just 15 or 20 meters higher.

Colonel Golovanov immediately took to the air. The mujahideen met his helicopter with heavy barrage fire. Their machineguns were firing practically point-blank. But the commanding officer succeeded in retrieving the bodies of the dead pilots and in taking off. Did it make sense for him to risk his life in a situation where his men were beyond all help? From the standpoint of philistine rationalism, it did not make sense. It did make sense from a standpoint of higher morality. He was awarded the Order of the Red Banner for this mission.

On 30 September the regimental commander was flying wingman in a two-ship element. He watched as a Stinger missile struck the lead helicopter, which blew up in the air. The blood pounded furiously in his temples. His legs turned to jelly, and pain wrenched his heart—the lads who had just perished he had nurtured like his own sons! One would have to be a man of rare self-control to continue and carry out the mission, and on the following day to take off once again and head out to where in the coordinates of time fractions of a second separate life and death.

Once munitions sited alongside the helicopter flight line began exploding following shelling of the airfield. The regiment could have lost a great many aircraft if it had not been for the courage and composure of Colonel Golovanov. He quickly arranged for the aircraft to be dispersed. In spite of the continuous explosions, he himself would climb into the cockpits, fire up the engines, and taxi away to a safe location.

Aleksandr Sergeyevich differed advantageously from some of his fellow regimental commanders in that he occupied the center of attention of the air unit not because of slogans, appeals, or unwarranted demandingness, but rather by virtue of specific deeds and his tireless energy. As they say, his men never lost sight of their beacon light. For example, even acknowledged flying aces marveled at his virtuoso piloting skills.

Military Pilot 1st Class Maj V. Konkov recalls: "Aleksandr Sergeyevich flew the Mi-24 expertly. And yet he had been flying these aircraft only for a year and a half! He flew dual with me after I arrived in Afghanistan. I knew Golovanov from when we had served together in the Transbaikal Military District, when he was 'sedately' flying the Mi-8. But here in Afghanistan he would sometimes fly such violent maneuvers that I would feel nauseous. And he could really hit the target! It is not surprising that they recommended him for the title of pilot-expert marksman. Relatively few earn this honor. But what can I say—the guy could really fly! He was once flying above mountain terrain when engine thrust suddenly dropped off. He instantly shut the engine down, immediately restarted it and continued escorting the Mi-8's he was with."

We would not have the full story of Aleksandr Sergeyevich if we spoke only about his skill as a pilot. He was an outstanding individual. Cordial, cheerful, sociable. This is how those who served with him remember him. Military Pilot 1st Class Col Vladimir Anatolyevich Barinov, a friend who had served with him in the Transbaikal Military District, told us: "He was a rare individual. He was very attentive toward people's needs. He never split personnel up into officers, warrant officers, and enlisted men. For him everybody was the same in the sense of humanity. For this reason people would pour their hearts out to him. When they learned of his death, everybody who had ever served with him took it really hard."

We talked about Colonel Golovanov with many persons who had known him from previous service in the Transbaikal Military District. Here he rose from squadron deputy commander for political affairs to regimental commander. He flew a great deal and with total dedication. He and his colleagues time and again came to the aid of the civilian population, rescuing people and property from natural disasters. In spite of the difficulties of life at remote garrisons, he never became dejected. He raised two sons—heirs to the heavens. During rare moments of relaxation he was an indispensable comrade, loved a good joke, and loved good company. He affected people in a positive way with his sincere humanity and charm.

"We have only the finest memories connected with the name of this man," stated Honored Military Pilot USSR Maj Gen Avn Gennadiy Petrovich Bednov, commander of air forces in the Transbaikal Military District. "A fine, experienced, solicitous commander. On the return from Afghanistan Aleksandr Sergeyevich Golovanov marched at the head of his regiment. By his self-sacrifice he essentially kept his men from getting into a difficult situation. This was a genuine heroic commander exploit!"

...We strolled about the classrooms, headquarters, and the helicopter unit flight line. He had spent several years here. He had solved numerous problems, hurried off on flight operations, and returned home from long flights, his family awaiting him. We had the feeling that the door would open at any moment, and a smiling, cheerful Colonel Golovanov would appear on the threshold. It is hard to believe that he is no longer with us. The echo of the Salang Pass will painfully reverberate in our hearts for a long time to come.



## Officer Pleads For Greater Commander Decision-Making Authority

*90R10009F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) p 14*

[Article, published under the heading "Problems of Training and Indoctrination," by Military Pilot 1st Class Lt Col N. Shilovskiy, holder of the Order of the Red Banner and Order of the Red Star: "'I Am Answerable for Victory'"]

[Text] During my years in military aviation I have become convinced that a contradiction exerts considerable influence on the professional competence of flight personnel (including its moral-psychological aspect): a high degree of combat proficiency as opposed to flight safety. On the one hand higher demands are being placed on combat pilot air, weapons, and tactical proficiency, while on the other hand higher demands are also being placed on ensuring flight safety. Both are essential. These conditions, however, cannot be observed by all persons at all times. For this reason some commanders unnecessarily simplify training missions and are disinclined to accept responsibility for making a given decision.

As a member of the limited Soviet forces in the Republic of Afghanistan, what I saw convinced me of the erroneousness of such an approach to training flight personnel. Prohibitory regulations and unnecessary situation simplifications engendered a low level of proficiency both on the part of certain air unit commanders and of their men, which became the cause of many unpleasant incidents, including tragic occurrences. Our subunit did not take a single casualty during the first two years of intensive air operations. Our superiors gave us a great deal of independence in carrying out assigned missions. But we ourselves held the guilty parties strictly to account for mistakes and departures from prescribed procedures or regulations pertaining to flight operations. Critique and analysis of violations or incorrect actions would as a rule be conducted by commanders in the presence of all personnel. And we should note that it was precisely statements by one's comrades that produced the best results. All of us—both the "guilty" and the "innocent"—learned, ran through a given situation, evaluated a comrade's actions, and reached a conclusion. Initiative, tenacity, and boldness were encouraged, and responsibility and independence were instilled.

The picture was entirely different in subsequent years. There was an appreciable increase in the number of various unpleasant incidents. They were caused most frequently by lack of aircrew proficiency and mistakes by leader personnel in situation assessment and decision making. During that period commander independence and flight personnel initiative were restricted by higher commanders.

I remember the following incident. Once a reconnaissance team we had inserted was spotted by mujahideen and requested immediate extraction. As luck would have it, the weather began deteriorating rapidly. Assessing the situation, the helicopter detachment commander requested permission to make the extraction—he no longer had authorization to make such a decision on his own. Although the weather still permitted the mission to be flown, his superiors refused to authorize it, on the basis of a weather analysis.

During the following 48 hours it was impossible to extract the team due to fog and low cloud cover. Our boys were fighting, taking casualties, and running out of ammunition. We could not simply abandon them to their fate. There was only one solution: go out and get them. At this point I was instructed to go out, regardless of conditions, and pick up the recon party.

Four helicopters took off before dawn. We were lucky: the mountain peaks were sticking through the cloud tops. Descending through the cloud cover and breaking out above the target area, we spotted the reconnaissance team and safely extracted it. Luck is a good thing, but we were not counting on it. We were relying on our experience and skills, because we had experienced such situations in the past.

Or take another incident. Capt V. Goncharov was flying a helicopter carrying air assault troops. A burst of machinegun fire from the ground damaged the hydraulics. After reporting the situation back to the command post, the pilot made a forced landing. The mujahideen, staying out of effective range of assault-rifle fire, proceeded to fire a recoilless gun at the helicopter. After a few rounds an effective hit would be assured.

While clearly aware of the danger, Captain Goncharov did not lose his composure. He instructed the assault troopers to grab the tailboom and swing the helicopter into the direction of the enemy. He proceeded to fire his nose gun, hindering the mujahideen from zeroing in on the target. They held the enemy at bay until help arrived.

It would seem absurd if Captain Goncharov were to call the appropriate command post and, in view of the circumstances, to wait for advice on how to proceed.

But was the weather assessment situation not equally absurd? Can a person who is situated many kilometers away and who bases his decision solely on weather forecast analysis see the situation more clearly than the local commander?

Combat experience, in particular, has shown that victory is won by he who is better prepared professionally and is psychologically prepared to make independent decisions. Of course such qualities cannot be developed with a mania for prohibitory regulation, excessive caution, and unnecessary situation simplification during training. They not only hinder embodiment of our main principle: learn that which will be required in actual combat conditions, but also in my opinion diminish flight safety, for it sometimes happens that an air accident has happened somewhere, and in other units they curtail flight operations or do not allow a certain category of pilots to go up. And then immediately we have a stream of documents aimed at playing it safe, containing another prohibitory regulation, etc.

But if they only provided us with information of occurring violations of flight procedures and regulations and gave us the right, not just in words but in actual fact, to decide for ourselves what measures should be taken, I would do the following. I would determine to what degree the deficiencies described in an incoming document apply to us, and then, of course if it was necessary, I would conduct a classroom training session. But I would place the main emphasis on work on the flight simulator and training drills in the helicopter cockpit. Utilizing our experience and know-how from Afghanistan, I would enlist those pilots who have in one way or another run into similar situations in the past, and I would set up an exchange of views and opinions.

Precisely such group discussions frequently are more beneficial than directives from the higher echelon. I believe that flight safety would genuinely improve. And then every commander, invested with responsibility, independence, and trust, could state with justification: "I am answerable for victory."

## Magazine Photographs Tu-160 Blackjack in Flight

*90R10009G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 21-23*

[Article by AVIATSIYA I KOSMONAVTIKA special correspondent S. Skrynnikov: "Missile-Armed Warjets"]

[Text] It had been foggy and drizzling for days. But this was no hindrance to our departure. The aircraft, with me in the aerial gunner position, broke out of the clouds. We had been climbing through cloud mass since shortly after liftoff, and now, at 4,000 meters, we suddenly broke out on top.

The clouds looked quite different from above. While, pinkish. And the clean, bright sun above them. Whoever has seen this sight at least once is forever captive to the heavens.

...We leveled off at 5,000 meters and went into a holding pattern. I could not even believe it that I was about to photograph for publication in the open press what was until quite recently the highly-classified Tu-160 [Blackjack] strategic bomber.

Prior to this flight I had seen the Tu-160 only on the ground. I was struck by the similarity between this 275-ton aircraft and an elegant fighter. Incidentally, it has a control stick, just like a fighter.

The jet beauty glided up elegantly, smoothly, like a white swan. Why is it that foreign specialists dubbed it Blackjack? To frighten the American public? In order more readily to obtain appropriations for building the B-1B strategic bomber? We might remind the reader that the Tu-160, which is entering operational service with Long-Range Aviation, is a response precisely to development of the B-1.

One of the traditions of the guard regiment, which recently celebrated its 50th anniversary, is to be first in all things. The regiment flew its first combat mission on the night of 23 June 1941, delivering a strike on enemy military-industrial targets. They had to bomb fascist tank columns during daylight and without escort. Before the end of 1941 they flew a bombing raid on military targets in Berlin, as a stern warning of the inevitability of retribution for the Hitlerites' crimes. The regiment's aviators made that long flight toward Victory, losing comrades along the way, and ultimately reached Victory, bringing peace to Europe. Thirteen guardsmen were named Hero of the Soviet Union.

This regiment's pilots were among the first to master aerial refueling. They were also pioneers in bringing the Tu-16 jet bomber [Badger] into operational service. In memory of this, a Tu-16 stands poised on a pedestal by the unit's war museum.

The regimental aviators' accomplishments include bringing the supersonic Tu-22 [Tu-26/Tu-22M Backfire] bomber into service. Now it is the turn of the Tu-160.

Regimental commander Gds Lt Col V. Gorgol briefs his men on a new and important phase in mastering this aircraft. Calm and even-tempered, he gives instructions in a clear and precise fashion, and only his tired eyes give away the presence of difficult thoughts and constant tension. After all, the commanding officer is responsible for everything.

Following tradition, prior to departing on a difficult mission the aviators met with Long-Range Aviation veterans two-time Hero of the Soviet Union Lt Gen Avn (Ret) A. Molodchiy, Hero of the Soviet Union Col Gen Avn (Ret) V. Reshetnikov, and former Long-Range Aviation corps commissar Lt Gen Avn (Ret) S. Fedorov. Commander of Long-Range Aviation Lt Gen Avn P. Deynekin flew in to say a few parting words, to give help and support. Son of a pilot who was killed in the war and an Honored Military Pilot USSR, who qualified on several types of aircraft during his 30 years of active flying, Petr Stepanovich knows how difficult things are right now for the regiment. And he is doing everything he can to help them, endeavoring to help every pilot, every technician, each and every maintenance mechanic in the Long-Range Aviation he loves so dearly. He has already accomplished some things. A lieutenant colonel rather than a major is now prescribed for the T/O position of Tu-160 aircraft commander, although the aircraft technician [ground crew chief], who is now designated aircraft engineer [inzhener korablya], is still a captain. And yet there has been an exponential increase in scope of work and responsibility. I feel that it is high time for not only aviation as a whole but for each individual military aviator to become our country's pride. This will happen; it cannot be otherwise.

...In conformity with the plan worked out on the ground, the Tu-160 approached very close to us. Fine. I have a picture. Now let's get a different angle. I seem to be able to see through the cockpit glass every single drop of perspiration on the face of instructor pilot Col V. Selivanov. During his service career he has qualified on many types of aircraft, and he is an expert at advanced aerobatic maneuvers. Now he is being led to the target not by instruments but rather by a sixth sense—a sensitive feel for the aircraft, which is essentially what makes a pilot a pilot. It is for good reason that they say that whoever has not yet gone through the test of courage is not yet a Long-Range Aviation pilot.

"I imagine Long-Range Aviation pilots would make outstanding cosmonauts," I thought to myself. "After all, manual docking is considered one of the most difficult procedures on a manned space flight."

The two aircraft seemed to merge into a single entity, frozen into a sculptural composition; it was only the clouds slipping past below which brought me back to reality. The altitude and speed were formidable. Not one member of either crew could afford to make a single mistake. And they were performing flawlessly.

Selivanov handed over the controls to Col V. Grebennikov. He has logged extended flights on the Tu-95M [Bear-H] bomber, involving two aerial refuelings. He is one of the most highly-experienced pilots in Long-Range Aviation. Submitting to his will, the aircraft obediently moved into the positions we needed for our photography.

The photo session was over. Finished! The Tu-160 dropped back and initiated a nimble climbing turn, its wings flashing in the sun. It headed off on a training mission.

It was only back on the ground that the realization struck me that this was not an ordinary photography session, but the first time the Tu-160 had been photographed in the air.

...I then went up in a Tu-16 flown by Gds Maj V. Karmazin to take pictures of Tu-22M [photo shows Backfire-C] jet bombers. After that we came back down.

I proceeded to make arrangements for future sessions. I feel that the best pictures are yet to come, that I will be able to photograph bombing runs, missile firing and, most important, the men—hard-working, selfless, true knights of the skies. After all, they are the primary strength of military aviation!



## Helicopter-Helicopter Missile Attack Tactics

*90R10009H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) p 24*

[Article by Military Pilot 1st Class Col V. Smusenok, candidate of military sciences: "'Combined Attack' Tactics"]

[Text] This tactical move presumes attacking with two types of missiles. It can be employed by a two-ship element of helicopters (or single helicopters) in an air-to-air engagement with enemy rotary-wing and fixed-wing aircraft. It is recommended that this tactic be employed in situations in which the element of surprise in the attack is not achieved, particularly in the case of forward-quadrant attacks. The main objective is to force the adversary to maneuver, and thus to increase his thermal signature.

Following target detection and identification, the combat helicopters increase airspeed to close to maximum, and proceed to close on the target following a pursuit curve. Each helicopter aims individually. Upon reaching maximum authorized range of engagement, antitank missiles are fired (by a two-ship element—on the element leader's command; by a single aircraft—independently).

Execution of missile-evasion maneuver by the adversary makes it possible to approach unimpeded to within launch range of air-to-air missiles with a different guidance system and to fire them (sequentially by a two-ship element, and independently by a single aircraft). A high target kill probability is assured.



## Development of Space Shuttle Heat Tiles Spins Off Benefits to Economy

*90R10009I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 26-27*

[Article, published under the heading "The Space Program Serving Science and the Economy," by Candidate of Technical Sciences A. Tarasov, chief designer, Molniya Scientific-Production Association, and Doctor of Technical Sciences B. Petrov, assistant general manager, VIAM Scientific-Production Association: "'Clothing' for Buran"]

[Text] Development of the Buran space shuttle required the development of fundamentally new materials with special strength and thermophysical properties. Without exceeding prescribed weight limits, they were to ensure practical reliability of the orbiter craft at all phases of a mission. Work was conducted on the basis of fundamentally new scientific and organizational concepts, since traditional solutions failed to ensure meeting the prescribed requirements within the specified timetable. How was interaction between designers, materials scientists and process engineers accomplished in practice?

Designing of shuttle craft components and individual assemblies was performed simultaneously with development of materials. It was an integrated creative process. The design engineers took into consideration the specific features of new materials and technologies, while the materials scientists worked on substantial modification of the materials, including changing their chemical composition and conditions of processing.

The orbiter's heat shielding constitutes an amazing symbiosis of scientific thought and technical embodiment. Materials scientists and design engineers have never before been faced with such a complex task.

As much energy as is required to accelerate the space shuttle to orbital velocity is released in the process of orbiter deceleration in dense layers of the atmosphere. Therefore the first and main function of the heat shielding is to prevent accumulation of this energy and to "release" it (95 percent) into the surrounding medium. Otherwise the orbiter, even if fabricated of the most highly-refractory materials, would inevitably burn up upon reentering the atmosphere. A second and no less important function is to retard the inward-proceeding heat flow to such an extent that, with a surface temperature of 1200-1300° C, heating of the fuselage aluminum skin does not exceed 150-170° C. In addition to all these requirements, the heat shielding must also possess high strength, in order to withstand static and particularly dynamic vibration and acoustic stress loads during the boost and deceleration phases. In addition, during subsequent missions it should not undergo any appreciable changes in properties and dimensions within a range from -150 to +1300° C.

The Buran's heat shielding includes a number of specially-developed materials, but the primary item is a heat tile, which is of "air" design in the literal sense of the word, because air (a vacuum at high altitudes) comprises approximately 95 percent of total volume. The remaining 5 percent is uniformly filled with special ultrathin quartz fiber.

We must admit that at first accomplishment of such a task did not appear possible. In the course of theoretical and experimental activities, however, connected with seeking new mechanisms of heat transfer within a porous body, the mechanics of its deformation and failure, we nevertheless succeeded in developing a fiber between and one two microns in diameter and in finding ways to accomplish its uniform distribution within a volume and to accomplish its effective sintering, and in eliminating the harmful effect of impurities and contaminants which cause degradation of the fiber at high temperatures. As a result the Soviet heat tile has proven to be considerably stronger and more resistant to the effect of high temperatures, while the entire heat shielding system is more reliable and lighter in weight than the foreign system.

Each tile is protected by erosion-resistant coatings. "Black" coatings provide stable heat shielding in a plasma flux and reradiate thermal energy into the ambient medium. "White" coatings reduce shuttle craft heating by solar rays by means of a controlled ratio of induced optical characteristics. Between flights the coatings protect the tiles from mechanical damage, contamination, and the effects of moisture.

Repair coatings have also been developed, for restoring tile performance. Use of these coatings makes it possible to eliminate removal of tiles and a new full fabrication cycle.

The technology for manufacturing the erosion-resistant coatings is unique and inexpensive. And in some parameters these coatings are superior not only to other Soviet products but to products on the world market as well.

The tiles are secured to the orbiter's metal skin with a specially-developed silicone adhesive. The unique nature and complexity of its development lay in the fact that, with minimal application (by weight) of adhesive, it was necessary solidly to bond tile to metal through an equally porous felt underlay. A second problem was retaining strength at temperatures up to 300° C, and a third problem was ensuring adhesive elasticity at -150° C. In addition, gluing of the heat sheet tiles to the shuttle craft surface had to be performed at room temperature.

The heat shielding system also includes a large group of new materials, including hydrophobizing agents to protect the tile and felt underlay from moisture, sealing compounds, and special paints. A new class of materials was developed, based on Soviet raw materials, for detachable moving assemblies: thermal sealing agents—cord-type, with an operating temperature of 1250-1650° C; brush-type, to keep the elevons operating and to seal the payload bay doors; elastic tapes to seal hatches. These materials are also the equal of modern foreign products in their properties and reliability, while some of them are even superior in a number of indices.

A new titanium alloy was extensively used in the shuttle craft's primary load-carrying structure. This alloy made it possible to fabricate items of unique size and dimensions (plates, sheets, structural shapes, etc).

Aluminum, the traditional "wing" material of the aircraft industry, was used for the airframe, but aluminum with new properties. It withstands temperature changes in a range from -150 to +160° C in combination with massive vibrational and acoustic stress loads, and it does not become brittle at low temperatures.

In addition to lightweight metals, specialty steels were used for many assemblies. They include carbon-free alloys of iron with nickel, chromium, cobalt, titanium, and other alloying elements, which possess extreme strength, toughness, and hardness characteristics.

Approximately 2,000 parts on the Buran shuttle craft operate in conditions of dry friction without traditional oils and greases. Made of high-strength steels, nickel and titanium alloys, they ensured a high degree of reliability thanks to special antifriction and wear-resistant coatings of complex composition.

A total of 48 new materials were specially developed for the Buran orbital vehicle. Many of these are unique in formulation, manufacturing process, and properties. These products are protected by more than 150 patents.

The material countenance of the Buran orbiter concentrates the latest advances in science and industry. The practical value of these developments also lies in the fact that they will be utilized in various areas of the economy. For example, the manufacture of new kinds of glass, carbon, synthetic, and ceramic fibers as well as new types of bonding agents began with the development of heat shield ceramic tiles, carbon-reinforced structural plastics, adhesives, and synthetic felts. The heat tile material is already being used as highly-effective insulation in high-temperature furnaces, which provides a 30-50 percent savings in electricity. Work has begun on utilizing this material in automotive engine parts and in high-temperature filters for aggressive media. Utilization of erosion-resistant coatings in high-temperature industrial furnaces and heating equipment is providing substantial (up to 30 percent) savings in energy and a 30 to 50 percent increase in furnace lining life. The coatings eliminate refractory dust from furnaces involving the use of heat-insulating materials.

High-temperature polymer composites, adhesives, and synthetic felts can be extensively utilized in the automotive industry, machine tools, medicine, agriculture, and electronics....

Amassed experience in the manufacture of semifinished products of improved aluminum alloys and aluminum alloy parts, the equipment and manufacturing processes are already today being used in the development of new types of civil aircraft.

Reduction of expenditures of raw materials, energy and labor in the production of titanium structural components is a very promising development and can be successfully applied not only for new generations of aircraft and space hardware but in other areas of machinery engineering as well.

The development of carbon-based composite materials has opened up extensive possibilities for their utilization in long-lived electric-furnace reheaters, crucibles for melting and casting refractory metals and thermostable space vehicle structural components, as well as for replacing portions of the human skeleton as elements possessing unique compatibility with living tissue. We should particularly note the utilization of this material in the brakes on Tu-154 and An-124 aircraft, which has extended their service life by a factor of 2.5.

Meeting stringent requirements on accuracy and parameters of new materials for the Buran and the conduct of highly complex manufacturing processes required a sharp improvement in production sophistication and knowledgeability on the part of specialist personnel.

In conclusion we should like to state that utilization of these materials and technologies in the economy will unquestionably help accelerate scientific and technological advance, and therefore will contribute to improving the welfare of the Soviet people.



## Pilot In-Flight Mental and Emotional State Analyzed

*90R10009J Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 28-30*

[Article, published under the heading "Flight Safety: Experience, Analysis, Problems," by Maj Gen Med Serv Prof V. Ponomarenko, doctor of medical sciences, corresponding member, RSFSR Academy of Pedagogic Sciences; Col Med Serv (Res) Prof L. Grimak, doctor of medical sciences; and Lt Col Med Serv V. Kostritsa, candidate of medical sciences: "Psychological and Emotional States and Pilot Reliability During Flight"]

[Text] Flying a modern aircraft demands highly-organized mental activeness on the part of the pilot. The envelope of the fluctuation of pilot working state, mental and emotional tone on either side of the optimal level is narrow, and going beyond these limits is fraught with diminished quality of job performance. For this reason the problem of pilot mental and emotional states is of great relevance and is increasingly more insistently demanding thorough, comprehensive investigation.

Mental and emotional state is the specific manifestation of interaction of mental and emotional processes (attention, thinking, volition, emotions) in the course of performance of current activity. In other words it is an integral psychophysiological reaction by the system, which forms under the influence of conditions of the external environment, the functional peculiarities of the system, and the specific features of the activity involved. In contrast to vegetative reactions, which reflect the energy aspect of the system's adaptation processes, mental and emotional states are determined predominantly by the information factor and organize adaptive behavior at the mental and emotional level, taking into account the characteristic features and general psychological mindset of the individual and a person's specific relationship to what is taking place.

The productive aspect of flying activity is formed through specific states of the mental and emotional makeup. Their specific forms are manifested as so-called predeparture and mission-departure mobilization of the pilot's system, and preaction excitement, which stimulates efficient utilization of physiological reserves in the complex conditions of flight, as well as during combat flying.

It is important to know that the greater the mobilization of psychophysiological functions is required by current activity, the more easily can be disrupted the correspondence between the current mental and emotional state and the current activity. When the level of a pilot's alertness and the specific features of his mental and emotional functions become inadequate to the conditions of current activity, for whatever reason, so-called difficult states arise. This is why these matters should fall within the competence of flight surgeons.

Prompt and timely preflight diagnosis of adverse pilot states is one effective way to prevent problems in the air. Unfortunately analysis of medical support of flight operations, mishap-threatening incidents and the structure of dynamic observation of pilots in the period between flight surgeon medical board sessions indicates that the mental and emotional state of pilots as an object of medical oversight and monitoring is little represented in the activities of flight surgeons.

We endeavored to determine the degree of relevance of problems of difficult mental and emotional states during flight with the aid of a specially-prepared questionnaire in which the subjects were not required to identify themselves. The obtained data were grouped and subjected to mathematical processing. It was borne in mind that a specific feature of mental and emotional states may not be specifically reflected in objective physiological indicators but, encouraging regrouping of the dominant mental and emotional process, distorts an integral quality of the subject—consciousness, from the standpoint of completeness and expediency of reflection of specific conditions of activity.

We surveyed 120 pilots, whom we divided into two groups: young pilots (80 persons, average age 27.7 years, length of service in flight duty 8.4 years), and veterans (40 persons, average age 39.3 years, length of service in flight duty 19 years).

**Table 1. Presence of "Difficult" States in Flight Activities (as a percentage)***

| Flight Conditions | Young Pilots | Veteran Pilots |
|---|---|---|
| Instrument weather | 35.0 | 26.7 |
| VFR weather | 1.25 | 7.1 |
| Combat flying | 10.0 | 19.0 |
| Night flying | 13.7 | 13.0 |
| Flying in conditions of busy radio communications | 42.5 | 34.5 |

*The fact that 100 percent is exceeded within the groups is due to the presence of different states in one and the same pilots.

It follows from Table 1 that the percentage of pilots who noted the occurrence of at least one instance of an unusual ("difficult") state during flying which had an adverse effect on piloting quality proved to be fairly high.

One's attention is drawn to the high percentage of "difficult" states developing when flying in instrument meteorological conditions, as well as in conditions of busy radio communications.

It was noted in the study that certain pilots, when flying in formation in conditions of intensive radio communications, may develop peculiar mental and emotional states characterized by disruption of precision in perceiving things around them, confused thoughts, and the sensation of "inflow" of blood to the head. Occurring in certain flight conditions, they pass when these conditions change. The reason for this is the necessity of performing simultaneously two extremely closely-related mental activities—precisely maintaining one's specified position in formation, and monitoring the content of radio communications.

Analysis of the survey materials indicated at the same time that even when extremely complex flight situations arise, 48.7 percent of young pilots and 62.6 percent of veteran pilots fully monitor the situation and their own actions. In all other instances various disruptions in activity were noted. Pinpointing in the preliminary studies the most frequently occurring deviations from the usual state, we asked all subject pilots to rank those which occur most frequently. The average figures on the ranked assessments determine the place they occupy in flying activities (Table 2). It was ascertained that pilots name direct opposites among the most frequent adverse changes in subjective physical well-being during flight: excessive mental and emotional stress on the one hand, and drowsiness and dozing-off states on the other.

**Table 2. Ranking of Frequency of "Difficult" Mental and Emotional States During Flight**

| States | Young Pilots | Veteran Pilots |
|---|---|---|
| Heavy mental and emotional stress | 2 | 1 |
| Spatial disorientation | 3 | 4 |
| Feeling unwell (flow of blood to the head, etc) | 4 | 2 |
| Drowsiness, Dozing-off phenomena | 1 | 3 |

Drowsiness and Dozing-off states may occur quite infrequently, but the main thing is that they can be dangerous. The following incident can serve as an illustration.

A certain pilot, just prior to night flight operations, had not slept for two days due to the illness of his child. That night he was to fly leader of a two-ship element, with a light gun being used in place of radio communications. He had to hold in position on the runway for some time on the red light, and he happened to doze off. His slumber was interrupted by an irritated voice in his headphones: "0135, get going!"

He does not remember taking off, but after he was airborne he heard a voice in his headset: "0135, pull back on your stick." This revived him somewhat, and he noticed from his instruments that he was flying inverted and descending slightly. He became fully awake at that moment when he pushed the stick forward (a correct stick response for inverted flight), and his head rolled sharply toward the windscreen. Only after this did he become fully cognizant of his situation, roll his aircraft over, and continue the flight.

The situation which occurred at 100 meters above the ground on takeoff was confirmed by his wingman, who saw the lead aircraft flying inverted for a certain period of time, and it was also descending. It remained a mystery to our pilot how he was able unconsciously to make the only correct move (push the stick forward) when the aircraft was descending, while the tower controller's instruction prescribed exactly the opposite.

The exceptional nature of this example arouses natural interest in the psychophysiological mechanisms which ensured adequacy of pilot reaction in such an unusual situation. We can point only to the fact that in certain instances regulation of relatively complex elements of job-related activity, including such as assessment of spatial attitude, can occur at the level of the subconscious.

Returning to the figures pertaining to ranking of "difficult" states, we should note the following feature. Veteran pilots more frequently deal with a state of excessive in-flight work activity, while the younger pilots most frequently encounter drowsy and dozing-off states. Apparently with young pilots there are more factors involving off-duty activities which disrupt normal sleep patterns, while reliability of the psychophysiological mechanisms of activation of job-related activity is not yet as high as in veteran pilots.

Thus the importance of adequate, full-value sleep for pilots is reconfirmed. The difficulty in meeting this condition lies in the fact that the training schedule includes flights both at night and in the early morning hours. This means that the pilot commences vigorous job-related activity with varying psychophysiological state and level of wakeful alertness. In addition, it has now been established that complex processes take place in the "sleeping" brain, the function of which processes consists not only in energy preparation of the system for subsequent activity but also, and this is very important, in informational preparation of the system as well: in particular, in forming an individual's mental and emotional preparedness for a specific type of activity in which he will be engaging upon awakening. Research has shown that organization of full and adequate rest and sleep is not the sole aspect of effective efforts to prevent adverse states during flight.

One should bear in mind that the triggering mechanisms which promote the forming of "difficult" in-flight states frequently "trigger" during the period preceding a flight. These can include psychological factors pertaining to performance of duties, relating to one's job or profession, or pertaining to one's off-duty life and activities. It is precisely these factors (Table 3) which cause depressed mood (64 percent), mental or emotional exhaustion (12.5 percent), and loss of interest in flying (22.5 percent).

**Table 3. Correlation of Negative Factors Diminishing a Pilot's Working Mood Prior to a Flight (as a percentage)**

| Psychological Factors | Young Pilots | Veteran Pilots |
|---|---|---|
| Unkindness by a superior | 32.5 | 36.0 |
| Job-related foul-ups | 28.7 | 14.2 |
| Dissatisfaction with organization of flight operations | 7.5 | 10.7 |
| Bad weather | 8.7 | — |
| Awareness of inadequate preparation | — | 8.3 |
| Problems in one's personal and family life | 13.7 | 18.4 |
| Tiredness, indisposition | 5.0 | 5.9 |

As we see, the problem of "difficult" pilot in-flight states should be considered highly relevant, particularly since in 20 percent of cases they cause slight concern (a suspicious attitude toward one's own state of health), and in 17.5 percent of cases cause strong concern, behind which lies concealed a distrust of one's professional and psychophysiological abilities. We must assume that precisely these two latter groups comprise that contingent among which repeated occurrence of "difficult" in-flight states can lead to the forming of basic reactions with elements of illness, and in particularly adverse cases can also cause true neurosis and can lead to actual illness.

This aspect of the problem also requires special attention on the part of all medical service elements because, as has been ascertained, instances of transferred "difficult" in-flight states are reported least frequently to unit medical officers (only 15 percent). As a rule negative elements are discussed among friends and communicated to command personnel.

The existing state of affairs attests to the fact that flight personnel are continuing to assess "difficult" in-flight mental and emotional states as manifestations of illness and for this reason are very disinclined to inform flight surgeons of this fact. Doctors in turn devote insufficient attention to dissemination of appropriate mental-health knowledge among personnel.

In conclusion we should state that psychophysiological analysis and review of deviations in the mental and emotional states of pilots in the process of job-related activity reflects a desirable prevention-achieving trend within aviation medicine. For the flight surgeon the need for such analysis is also dictated by his job-related duties, which prescribe regular conduct of psychophysiological preparation of pilots for flight operations.



## Loading Aircraft Ordnance Without Ground Equipment

*90R10009K Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 34-35*

[Article, published under the heading "For a High Degree of Combat Readiness," by Col Docent A. Vasilyev, candidate of technical sciences; Col Docent A. Kuzmin, candidate of technical sciences; and Sr Lt S. Rodnykh: "Saving Time"]

[Text] Personnel have long been faced with acute problems of increasing the operational readiness and combat capability of air units. Unfortunately, however, these problems are not resolved as rapidly as one would wish. While in the recent past one could cope with such problems with organizational measures and by increasing the aggregate of knowledge, abilities and skills of Air Force specialist personnel, today and in the near future they can be resolved primarily by means of an aggregate of organizational and engineering innovations. In our opinion the fundamental direction of approach to this matter is scientific validation of the need, expediency, and possibility of placing aboard aircraft equipment, assemblies and systems which would be used only for the purpose of reducing expenditures of time, labor, and resources on accelerated preparation of fixed-wing and rotary-wing aircraft for combat missions.

At our Kharkov Higher Military Aviation Engineering School the subject matter of senior theses for cadets in the aircraft faculty is filled with topics dealing with engineering possibilities of improving the processes of servicing aircraft. Particular attention is focused on the problem of optimizing the process of loading aircraft with ordnance.

This is the most labor-intensive and time-requiring process involved in mission-readying aircraft. The duration of this process determines on the whole the time required to mission-ready an aircraft, the actual value of which greatly exceeds present-day requirements. In addition to time, most frequently loading ordnance requires considerable expenditure of physical energy. And this occurs at the busiest time for engineer-technician personnel, working conditions for whom are extremely unfavorable and complex for performing these operations. Frequently loading ordnance takes place away from base, which imposes considerable commands on self-sufficiency in performing these procedures. Attempts to solve this servicing problem by improving only the ground equipment have over the last several decades failed to produce any substantial results.

The search for highly-efficient methods and means of mounting bombs, etc have led senior-year cadets at the Kharkov Higher Military Aviation Engineering School to formulation of the following methodological aspect. The task of radically reducing time, labor, and resource expenditure can be accomplished only by engineering means, by improving and facilitating the servicing of aircraft. We are convinced that this is the only way to solve the problem of achieving self-sufficiency for the process of loading aircraft with ordnance. Thus a difficult and complicated engineering task has arisen, consisting in developing an onboard highly-mechanized device with independent power drive unit, providing capability to mount ordnance "from the ramp" without precise alignment of mated components.

The result is development of three basic types of built-in ordnance loading systems. One has a common power drive unit and cable lines to external stores pylons. One has individual power drive units in each pylon. One features cable lines on the aircraft and a common power drive unit as part of the aircraft servicing equipment package.

Figures 1 and 2 show a built-in system for pylon-mounting ordnance, following the second of the three design variations.

**Figure 1. Built-in Ordnance-Loading System. Top View.**

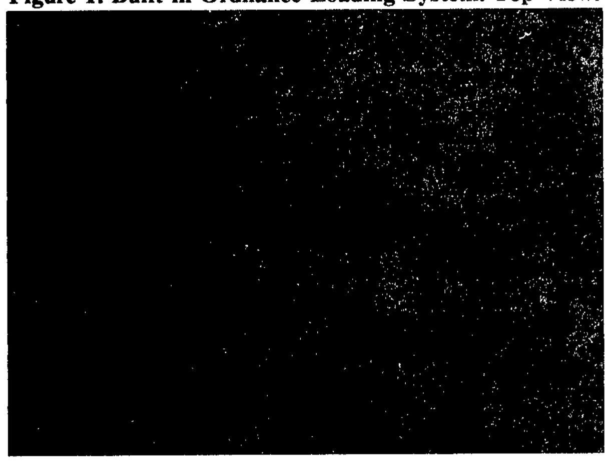
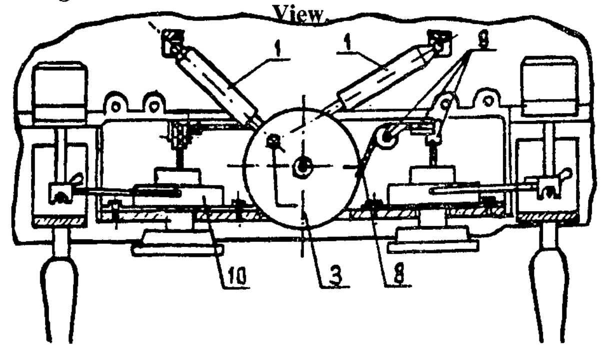


**Figure 2. Built-in Ordnance-Loading System. Side View.**




The system is driven by two hydraulic cylinders (1), connected by pin (2), which is connected to disks (3). The pin and disks comprise a crankshaft, which converts the rotational-translational motion of the hydraulic cylinder rods into rotational motion of cable drum (4), shaft (5) of which turns in bearing (6), which is attached to the body (7) of the ordnance mounting pylon or stores rack.

Cable (8), wound on drum (4), is connected to automatic ordnance securing and release shackles (10).

This system is designed for mechanized-automated loading of ordnance onto aircraft external stores pylons. It is designed to lower munitions to the ground, to accomplish accelerated attachment of munitions to and release from the pylon mounting system, to perform automatic placement of munitions onto the bomb rack or pylon release shackles, to pick up aircraft bombs, missiles, etc "from the ramp" within a radius of two meters from a point directly below the stores pylon. This provides capability to load aircraft without ground carts which, incidentally, are very unwieldy and inconvenient.

Calculations have shown that this device increases aircraft efficiency (in comparison with analogous standard-issue devices) by a factor of 2.5-3, depending on type. It will not take more than 10 minutes to load out any type of aircraft.

The high efficiency figures for the proposed ordnance loading system are achieved by substantially increasing the probability of on-schedule mission departure by a fixed-wing or rotary-wing aircraft as well as a fundamental shortening of the "mission - turnaround - mission" cycle. In addition we obtain total self-sufficiency of the aircraft ordnance loading process, since the built-in loading system provides capability to take a munition directly "from the ramp."

At the present time a team of cadets at this school is working up two preliminary designs of a built-in system in alternative design variations. The main question remains unanswered: how can we get the finished product adopted? Naturally we are unable to accomplish this without the help of interested organizations.

**The editors would like to address this question to the Air Force Aviation Engineer Service and to the Ministry of Aviation Industry. Replies will be printed in subsequent issues of this magazine.**



## Developments in Aviation Abroad

*90R10009L Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 38-39*

[Article: "Foreign Aviation Briefs"; based on materials appearing in foreign publications]

[Text] **Rockwell/MBB X-31A Experimental High-Maneuverability Fighter**

The concept of combat beyond visual range has recently been subjected to increasing doubts in the West. Since air-to-air adversaries close at a relative speed in excess of Mach 2, each must be prepared within seconds to engage in close-in-combat with short-range missiles, followed by gun employment. Development of the latest generation of short-range missiles with an infrared homing guidance system makes it possible to accomplish effective forward-quarter attacks on the first pass. Even in these conditions, however, maneuverability exceeding that possessed by modern fighters will provide substantial advantages to the combat pilot.

The X-31A fighter is designed for effective conduct of close-in combat (without detriment to its beyond-visual-range combat capabilities). Two experimental prototypes will initially be used to investigate a safe maneuvering envelope positioned beyond the limits imposed by modern aerodynamics, powerplant, structural design, and pilot.

The main purpose of the X-31 project is to provide for the conduct of air-to-air combat within an operating envelope into which pilots have not dared venture up to the present time. Maneuvering at high angles of attack and low airspeeds, the new fighter will feature very high rates of turn, and will thus secure a tactical advantage.

In order to prevent slow-speed stall, the X-31 will integrate aerodynamic control and vectored thrust. This will enable the pilot to fly the aircraft in post-stall conditions for short periods of time, in order to have a missile-firing advantage on the first pass. Within certain limits the pilot, when aiming, will be able to turn his aircraft like a gun turret.

The X-31 project differs fundamentally from preceding X-designation projects. In the opinion of experts it is the first project intended to research new flight conditions, while promising technologies were tested on previous experimental aircraft. In addition, the X-31 project is the first international experimental program.

MBB [Messerschmitt-Boelkow-Blohm] is considered a pioneer developer of the concept of maneuvering in post-stall conditions, which involves maneuvering flight following normal stall while maintaining a high rate of turn, decreasing turn radius, and rapidly turning the aircraft's nose. Back in 1983 Rockwell proposed buildign a demonstration aircraft with an abnormal increase in kinetic energy—the Snake. This design featured vectored thrust, integration of flight and engine control, and improved pilot protection against linear and transverse load factors. In June 1986 the United States and West Germany signed a memorandum of agreement on a high-maneuverability fighter project. At the present preliminary design stage, Rockwell is responsible for the configuration, aerodynamics, and structural design of the X-31 aircraft, while MBB is developing the aircraft's control system and engine air intake design. Experts are of the opinion that control system development is the most important technical problem. Later MBB will fabricate wings of carbon-reinforced plastic and vectored-thrust nozzles for the two planned X-31 demonstration aircraft.

The total cost of the project, including a year of flight testing of both aircraft by pilots from Rockwell, MBB, the U.S. Navy and the West German Air Force, is estimated at 75 million dollars. Twenty percent of the amount will be provided by the FRG.

The X-31 has a configuration suited to supersonic flight, but in order to reduce costs, flights will be limited to transonic speeds. "We are building demonstration aircraft distinguished by a low degree of risk, but we shall test them in flight conditions characterized by an exceptionally high degree of risk, in which nobody has ever flown before," commented one of the project executives.

In order to reduce costs, existing equipment will be used wherever possible. The General Electric F404 engine has been chosen as powerplant, which provides the 5,400 kg X-31 a rated thrust-to-weight ratio of greater than 1.3 to 1. Vectored thrust will be produced by using panels or vanes mounted on the airframe to deflect the F404 engine's exhaust up to 10° in pitch and yaw. Canard-type projections forward, a belly air intake, and a double-delta type wing will enable the X-31 to fly at high angles of attack.

The purpose of the X-31 project is to demonstrate high maneuverability in prestall and poststall configurations and to accomplish this quickly and at low cost. This is to result in development of an aircraft design with excellent performance characteristics in close-in combat without detriment to beyond-visual-range combat capabilities.

The U.S. Navy is interested not only in improving maneuverability but also in reducing carrier-landing approach speed. Experts believe that the controls of an aircraft with enhanced response reaction beyond normal limits of lift should ensure its maneuverability throughout the entire flight envelope, including during steep-angle landing approaches.

**Cameras on a Helicopter**

As we know, icing of helicopter main rotor blades leads to loss of aerodynamic efficiency, and engine air intakes can become clogged with ice. Specialists from the British Royal Navy have recently been conducting intensive studies in this area. They are simulating some icing conditions with a special ground blower unit, and are also conducting test flights in Canada and Norway. Special helicopter-mounted cameras have been developed for these studies.

The British Royal Navy Wessex helicopter shown in the accompanying photograph [not reproduced] is equipped with such cameras. One is mounted on the main rotor hub and can simultaneously photograph all four blades to record rate of ice buildup. Cameras are also mounted in the helicopter's nose section. These cameras monitor ice buildup on the engine air intake.

**Aircraft Engine For Japanese Air Force**

Japan's Defense Agency has announced plans to develop Japanese capability and facilities to build an advanced aircraft engine for modern supersonic combat aircraft. The Japan Defense Agency (JDA) intends to request a government appropriation in Fiscal Year 1990 for development of the first three such engines. According to JDA calculations, "several billion yen" will be required just for the initial phase of the project.

According to project officials, this engine will incorporate the latest advances in the U.S. and West European aircraft industry. It is to power Japan Air Self-Defense Force aircraft entering operational service at the end of the 1990's. Japanese military circles link this new project with development of a Japanese military aircraft industry. At the present time a number of Japanese plants are building modern fighters for Japan's Air Force, but they are being built under U.S. license. Development of an engine for a supersonic aircraft will be a Japanese first. This ambitious project will cost the Japanese taxpayers several hundred billion yen.



## New Mir Orbital Mission Described

*90R10009M Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 42-43*

[Article, published under the heading "The Space Program Serving Science and the Economy," by Hero of the Soviet Union Col V. Zudov, Pilot-Cosmonaut USSR: "Fifth Primary"]

[Text] Over the last three years there have been four resident crews and five visiting crews aboard the Mir orbital scientific research complex; four of the visiting crews were international in makeup. A total of 19 cosmonauts have worked aboard the space station. Over a period of six months the new crew will receive two new modules and will perform testing, adjustment and organization of regular operation of their onboard systems, equipment and scientific apparatus. This will mark the beginning of implementation of the modular design principle embodied in the Mir Station basic work module. This means a substantial broadening of the capabilities of the orbital scientific research complex for performing economic tasks, scientific research, and multiple-aspect experiments.

During its stay in orbit the crew will perform several EVAs and will test the cosmonaut manned maneuvering unit, which is today simply essential for assembling, operating and maintaining large structures in space and for working with space shuttle systems.

Two crews were trained for this mission. The first—mission commander: Hero of the Soviet Union Col Aleksandr Stepanovich Viktorenko, Pilot-Cosmonaut USSR. In 1987 he flew a manned mission as commander of a Soviet-Syrian crew. Flight engineer: Hero of the Soviet Union Aleksandr Aleksandrovich Serebrov, Pilot-Cosmonaut USSR. He has flown two manned orbital missions, in 1982 and 1983.

Backup crew—commander: Hero of the Soviet Union Col Anatoliy Yakovlevich Solovyev, Pilot-Cosmonaut USSR. Last year he flew a mission as commander of a Soviet-Bulgarian crew. Flight engineer Aleksandr Nikolayevich Balandin is a manned mission crew newcomer and for this reason the reader is not acquainted with him. A. Balandin was born on 30 July 1959 in the town of Fryazino, Moscow Oblast, to a family of white-collar workers. He has been a member of the CPSU since 1981.

Upon graduation from the Moscow Higher Technical School imeni N. E. Bauman in 1976, he worked at the design office of the Energiya Scientific-Production Association. He joined the Cosmonaut Corps in 1978, went through the full training program, and successfully passed the final examination in 1986. In 1988 he commenced training as a flight engineer for a mission to the Mir orbital complex. He has made 25 parachute jumps. He is married and has a daughter.

As we see, most of the crewmembers have space flight experience and had previously studied the transport spacecraft, the space station, and the Kvant module. Specific features of the training of the fifth, primary crew include postponement of the launch date due to the fact that the modules were not ready. For example, the additional equipment module was to arrive at the Mir space station at the beginning of this year. As a consequence of this there were changes in the composition of the crews, which caused certain difficulties. Nevertheless, and this must be particularly emphasized, an atmosphere of complete mutual understanding, trust and comradeship was maintained by the crews. Their high degree of professionalism and proficiency enabled A. Viktorenko and A. Serebrov to accomplish manual docking of the Soyuz TM-8 spacecraft with the orbital complex in the middle of the night on 8 September.

Demothballing the life-support and heat-regulation systems, checking the radio and TV communications equipment, other equipment and apparatus, the "Vityazi" [Champions] proceeded to carry out the program connected with unloading the Progress M spacecraft and preparations to receive the first D—additional equipment—module.

Many new innovations are incorporated into its design. A fundamentally new cosmonaut life-support system will undergo testing, for soon a large-volume structure will be assembled in orbit, which places new demands on the orbital station's internal atmosphere, its composition, purity, and ventilation system. When an orbital "factory" is built, cosmonauts will also have occasion to work on the exterior surface of the orbital complex. For this reason the diameter of the egress hatch on the module has been increased. While in the past a cosmonaut would travel across the orbital station exterior surface hand over hand, protected by a special safety tether, now, seated in a special chair equipped with a maneuvering propulsion unit, he can travel up to 60 meters from the station, and even further in the future.

We should state that the manned maneuvering unit, jokingly dubbed a "space motorcycle," possesses fairly good maneuvering capabilities. The fact that the maneuvering unit is equipped with two compressed-air cylinders gives the unit a speed capability of up to 35 m/s. It is a pity that, having begun development of such a manned maneuvering system much sooner than the Americans, and testing this system at the beginning of the 1970's, we abandoned work on the project because of somebody's stupidity. Only now are we once again returning to it.

The manned maneuvering unit will still have a safety-tether cable, which the cosmonaut can use to return to the station if necessary. The fact is that the Mir complex cannot "pick up" a space traveler in distress. This requires special devices and capability to maneuver the entire complex in orbit. The Buran space shuttle orbiter, which is capable of picking up a cosmonaut who has wandered to some distance in the manned maneuvering unit, will help resolve this problem.

The current mission program calls for the cosmonauts to deploy a truss frame platform on the station exterior and to mount various antennas and television devices on this platform. This will be the first such complex structure, which will respond to earth commands, to be deployed exposed in space. It will provide specialist personnel at Mission Control with capability not only to observe and analyze the state of the earth's atmosphere, degree of pollution and presence of harmful pollutants above a target area or region, but also to photograph a target object, that is, to contribute to the environmental protection effort.

A large volume of medical and biological research will also be performed during this mission. Research will include study of the state of the cardiovascular and respiratory systems in conditions of rest and during functional stress-load tests, investigation of the state of central and regional blood circulation, as well as hematological investigations. The crew will also perform a number of biological experiments involving study of the peculiarities of the embryonal and postembryonal development of birds in conditions of space. All this will make it possible to amass experience in conducting experiments and to improve the system of preventing the adverse factors of space flight.

Arrival at the Mir orbital station of the third module—the T technical module—is anticipated in February 1990. This module is a small shop for producing in conditions of weightlessness alloys possessing unique properties. In short, difficult work lies ahead.



## Computers and the Space Program

*90R10009N Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 12, Dec 89 (signed to press 2 Nov 89) pp 44-45*

[Article, published under the heading "Spaceflight Support," by Yu. Zaytsev, department head, USSR Academy of Sciences Institute for Space Research: "Computer Systems in the Space Program"]

[Text] Alongside atomic and subatomic physics, molecular biology, cybernetics, and nuclear energy, the beginning of space exploration constitutes one of the major achievements of the 20th century, comprising an entire era in science. The space program has become a separate field of science and technology. It is performing major economic tasks: establishment of satellite systems: communications, television, weather, navigation, geodesy, and earth resources. In the last few decades we have learned hundreds of times as much about the earth, the moon, and the planets of the solar system than during the entire history of civilization.

Reassessment and reevaluation of traditional notions on development of the corresponding sciences are taking place on the basis of space research, in particular the correlation between theoretical, applied, and computer methods. It was previously believed that a scientific problem was essentially solved if a mathematical model had been constructed which describes the physical phenomenon and a closed analytical solution of this model had been found. Difficulties of a computational nature were minor.

In space exploration computational problems are so complex that they require the development of qualitatively new methods of calculation and the creation of increasingly more powerful computer hardware. Incidentally, we observe an analogous situation in cognition of the world of the atom and subatomic particles. There is also an increasing number of various problems which in most instances can be successfully solved only by numerical method, utilizing electronic computers.

At the same time, while in the past electronic computers were viewed merely as high-grade calculating devices, in recent years it has become obvious that computers are capable of creating qualitatively new mathematical models of target processes and phenomena and of investigating parameters which are not accessible to direct measurement. For example, now we can answer even the following hypothetical question: how would the earth's orbital path change if Mars did not exist?

Here is another example. Specialists know that the motion of an airborne or spaceborne vehicle traveling at high velocity is described well within the framework of a continuous medium by the well-known Euler equations for an ideal incompressible liquid. Complex configurations of the craft proper, however, as well as differences in flight configurations make it difficult to obtain a complete solution to such a mathematical model. In addition, at velocities in the order of the speed of sound, one must take gas compressibility into account. For flights at high altitudes it is necessary to examine motion in a rarefied gas. And these classic models can become even more complex when solving practical problems. When a space vehicle enters into dense layers of the atmosphere, for example, its surface reaches a temperature of several thousand degrees. Consequently problems involving study of its heat shielding require that one take into consideration the physical and chemical reactions taking place, radiation, etc.

Thus not only investigation and solution of the mathematical model proper, but also "designing" the model so that it adequately reflects the principal properties of the target phenomenon presents considerable difficulties. And this task can be accomplished only with the aid of modern computers capable of performing hundreds of millions of operations per second.

We should note that computer simulation or modeling is much cheaper than full-scale investigation, and in many cases is the only possible method of investigation. At hypersonic speeds, for example, temperatures are so high that they lead to effects of dissociation and ionization, and in many cases even gas glow occurs. Modeling such phenomena in laboratory conditions is technically very complex. In many cases experimental measurement data are of a highly approximate nature, not to mention the high cost of the experiment.

Or, for example, manned space flight is an extremely complex and bold undertaking. The harsh conditions of space are unforgiving of the slightest mistake. Understandably each space flight is preceded by an extensive series of simulation experiments. They help us predict, for example, the effect of various factors of flight on the cosmonaut's system. Efficient spacecraft shapes and optimal structures of propulsion unit nozzles and shuttle craft wing sections are today also determined in most cases with the aid of numeric modeling.

In recent years a number of projects have been undertaken to develop various mathematical models of near space which are adequate to physical reality, particularly the interaction of the solar wind with a planet possessing its own magnetic field, such as the earth, for example. For the first time indications were obtained which point to the existence of secondary shock waves, which were subsequently detected during the conduct of direct measurements in space. Interaction between the solar wind and the ionosphere of a planet lacking its own magnetic field, such as Venus, was also modeled. Thus success in studying space is connected to a large degree with utilization of computers. With a correctly formulated problem and proper mathematical modeling, the volume of information obtained from calculations is more complete and considerably less expensive than corresponding experimental investigations.

Extensive and reasonable practical adoption of systems of automating design and experimentation is a task of great national importance, and its successful accomplishment depends in large measure on success in developing powerful computers. Further increase in computer capability, however, is being increasingly impeded by the very mode of operation of computers and their internal organization. Qualitatively new approaches are require.

We can attain high rates of information processing by utilizing a limited form of parallel processing, called conveyer-type processing. A conveyer-type computer, also called a vector computer, can begin processing one set of data before it has completed processing the preceding set. By overlapping operations, the computer spends less time on performing long sequential calculations.

Typical conveyer-type computers contain eight or more processors, interconnected in such a manner that results from one processor are fed directly to the next. Only the first and last processors have access to the computer's RAM. The computer uses these processors, taking data from memory element by element and "pumping" them through its "processor tube." Each processor performs an elementary operation on the data, and the end result is returned to memory.

Speed is achieved by the fact that the processors can operate simultaneously. There are difficulties here as well, however. The conveyer cannot work faster than its slowest component.

Utilization of parallel-processing computers provides a qualitative leap forward in solving the problem of further increasing computer processing power. Imagine that you are directing the construction of a building and have assigned the entire job to a single workman. He will unquestionably apply a sequential approach, that is, he will perform the work prescribed by the plans (laying brick, installing plumbing, electrical wiring) stage by stage, performing each action of a given stage in a specific order.

But many stages, such as laying brick, can be performed considerably faster if the work is divided among several bricklayers working simultaneously. Other operations, such as installing plumbing and electrical wiring, are independent of one another and could be performed simultaneously by different crews of workers. This principle forms the basis of the approach to designing high-output computer systems using parallel processors linked to a central processor.

Usually some general-purpose computer with an input/output system is used as central processor. A matrix processor consists of a high-speed computer from a family of linked processors. The term "linked" is defined as connection of this processor to another computer which forms the function of task distributor.

Parallel computers can be subdivided into two principal types: the first type, in which all processors simultaneously work on different data, is a parallel data computer; the second type, in which each process runs its own program, is a parallel processes computer.

A typical application of parallel data computers is processing of satellite photographic imagery. The electronic circuitry frequently distorts these photographs, creating bright or dark spots on the image. Most of this interference can be removed by calculating the average brightness of several adjacent picture elements (points). Since a parallel data computer can process hundreds if not thousands of points simultaneously, it can produce an "enhanced" image much faster than a traditional computer.

In a parallel processes computer, on analogy with division of labor in building a house, a computation problem is broken down into sub-problems, which are independent of one another and can be solved simultaneously by several separate processors. For example, if the computer is doing a space shuttle orbiter flight simulation, computation of simulated conditions, such as, for example, gliding, is performed on several processors, while others will produce as output the view from the flight deck or will convert crew commands.

One example of a high-output computer system using parallel matrix processors is the system developed by joint efforts on the part of Soviet and Bulgarian scientists and specialist personnel. The system includes a YeS1037 general-purpose computer (central processor)—jointly developed by the USSR Academy of Sciences Institute for Space Research and Bulgaria's IZOT Association, plus four Bulgarian-built YeS2706 matrix processors.

Utilization of modern electronic components and new design and engineering solutions has made it possible to build an operationally reliable small computer system with excellent performance characteristics. Central processor output runs as high as 2 million operations per second when running various test programs. The computer has 16 megabytes of RAM. The matrix processor has a peak output of 12 million floating-point operations per second and has up to 4 megabytes of local RAM.

In the future new technologies will unquestionably influence the development of parallel-processing systems. Advances in the semiconductor industry and also possibly the utilization of new high-temperature superconducting materials will naturally lead to new technical solutions in hardware development. It is apparent that new hybrid machines will be developed, in which optical channels will link extremely high-speed digital processors.

One can expect even more radical changes from using purely optical computer systems, which can perform high-speed analog calculations using various algorithms. At the present time it is true that it is not entirely clear whether the use of optical computers will be limited only to certain areas of simple processing or whether general-purpose computer systems will be developed on the basis of optical techniques.

And, finally, we should mention recent efforts to develop so-called "neuron network models," which make a computer model comparable in some ways to the human brain. A computer with such a structure potentially possesses superiority in logic, but it is also considerably weaker in conventional calculations. Scientists have succeeded in creating several neuronlike systems, and it is anticipated that this model will experience rapid evolution, both in terms of hardware and algorithms.

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