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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.]

CinC Air Force Shaposhnikov Interviewed

91UM0064A Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 2-3

[Interview with Colonel General of Aviation Yevgeniy Ivanovich Shaposhnikov, CinC Air Force, by AVIATSIYA I KOSMONAVTIKA correspondent, under rubric "For USSR Air Fleet Day: "The Air Force Today and Tomorrow"; uncaptioned photograph of Colonel General of Aviation Shaposhnikov included]

[Text] **The readers' mail is troubling. The struggle between the new and old has dragged on and become fiercer. Statements by the oracles of perestroyka that real results of society's renewal will appear 2-3 years after its beginning have not been borne out. The sixth year is here and only the clouds of problems and the haze of uncertainty are on the horizon. The needle of the sociopolitical barometer just has not shifted toward "clear"; to the contrary, now and then it swings from the "cloudy" toward the "storm" mark. People succumb more and more to moods of depression, and their pessimism is growing.**

All this concerns aviation collectives as well. What awaits us? Perhaps we look at tomorrow so gloomily for nothing? CinC Air Force Colonel General of Aviation Yevgeniy Ivanovich Shaposhnikov answers these and other questions put by our correspondent.

[Correspondent] Comrade Colonel General, how would you generally characterize the state of affairs in the Air Force today?

[Shaposhnikov] The situation in the Armed Forces is determined by processes occurring in society. This stage is natural and we must go through it with minimum losses.

This year has been especially difficult for the Air Force. Accomplishment of our traditional missions involving combat readiness and flight safety has been complicated by the withdrawal of forces from Eastern Europe. Therefore the situation immediately became aggravated in the social-everyday sphere. Judge for yourself: 6,000 pilots now have no apartments, and a total of some 40,000 aviators have not been provided housing. There will be even more homeless defenders of the homeland with the relocation of forces.

[Correspondent] What is the Main Commissariat of the Air Force doing in this respect?

[Shaposhnikov] Above all, we intend to invest funds according to the principle of the priority of general human interests. While appropriations previously were allocated with 30 percent for housing and 70 percent for upkeep of airfields, now it is 65 and 35 percent respectively. Improving aviators' working and living conditions is job number one.

[Correspondent] Yes, the shift in emphasis in activity by military aviation leaders is felt. You will agree that some one and a half years ago we invariably would have begun the conversation with purely professional problems, with combat readiness. But today it is with general human problems...

[Shaposhnikov] Life demands this. Our society has tested people's patience for too long. Moreover, a well-built apartment for the pilot, engineer, technician or other air specialist is a substantial contribution toward improving Air Force combat readiness!

I wish to say the following with respect to professional tasks. Military reform is beginning. The Ministry of Defense has developed a concept for Armed Forces development up to the year 2000. How will it concern us aviators? We will significantly reduce so-called "standard types" of aircraft equipment. Our different types of aircraft and helicopters with significant differences in servicing have multiplied very greatly, complicating the maneuver of personnel and equipment even in one air arm.

The second direction is an improvement in the table of organization structure of front and army aviation. Special emphasis here is placed on reforming the structure of support units. We are preparing to shift to a base system. There essentially will not be a great difference for ground specialists as to which regiment to service, inasmuch as the support equipment will be identical for all types of aircraft.

The next direction is to establish a healthy moral-psychological climate in collectives. The following ideological ruses are being studied as a result of a considerable spread of opinions and aggressive attacks on the Army by some of the mass media. The officer is told that officers will not follow the generals; it is impressed on the enlisted man that enlisted men will not follow the officers... That is to say, what we have are attempts to break down the Armed Forces into categories of servicemen and set them in opposition to each other. These are very dangerous games in political pluralism for the country.

What kind of social elitism can there be if all of us generals, officers and enlisted men are of the same dough, so to speak, came from the people and must serve them? It is something else that all of us should display greater concern for our subordinates and be more tolerant and kinder to each other. A general who is rude toward an officer, as well as an officer who scolds a soldier with swear words, are socially painted with the same brush: these are thugs who have no place in our Armed Forces.

Now about combat training. Many different tactical air exercises were held this year, with the vigilant eye of the Ministry of Defense Chief Inspectorate carefully observing the majority of them, figuratively speaking. It inspected three large strategic formations and nine air schools. There were no major failures or disruptions during the inspection. Subordinates of lieutenant generals of aviation Konstantinov and Zarudnev demonstrated good proficiency. Crews worked under very adverse weather conditions, but they successfully performed missile launches and accomplished other missions with quality. Now it is important to reinforce this positive experience.

[Correspondent] How do you regard the fact that Army Aviation again is being transferred to the Ground Forces? Will not the urgings of dilettantes affect combat readiness, and especially flight safety? Will aviators be protected from absurd instructions? Will they not again end up in the category of pariahs who get everything—housing, clothing, and food—last?

[Shaposhnikov] This is a rather complicated question, and the answer is equivocal. My personal position is as follows. In case of war, Army Aviation will be directed by combined-arms commanders. There is no alternative here. Helicopters are a powerful antitank weapon—an effective weapon of the FEBA, if it can be so expressed. Therefore, following the principle of "teaching troops what is necessary in war," it is logical to rearrange the structure right now, and not wait for the storm to break.

Of course, pilots had greater opportunities for professional improvement when Army Aviation was part of the Air Force, but a gap gradually began to appear between Aviation and Ground Forces. Fewer joint exercises were held, coordination deteriorated somewhat, and so on. Such discrepancies must be eliminated immediately.

I believe there will be no unqualified intervention by combined-arms commanders in aviators' professional affairs under the new structure. Controls have been provided against arbitrary rule. For example, the CinC Ground Forces will decide everything concerning aviation through the commander in chief of Army Aviation, i.e., he assigns the mission, but the air staff works out the procedure for accomplishing it. The very same also can be said about providing aviators with everything necessary for productive activity.

[Correspondent] Addressing the editors, progressively thinking commanders and innovative pilots grieve that the existing combat training system is ineffective inasmuch as it does not stimulate a growth of aviators' military proficiency and extinguishes the personnel's creativeness and initiative. I would like to learn your opinion about what has to be changed for the system to begin to work at full capacity.

[Shaposhnikov] I became firmly convinced long ago that we need to revise very, very much in the combat training system, for you see that one and the same deficiencies are repeated from year to year. What is the matter? Are unqualified commanders at fault? For a long while it was considered to be that very thing, and so reprimands fell on the commanders' heads and officers in charge were removed from positions, but matters still did not move forward strongly. This means the system itself provides no opportunity to overcome barriers along the path to stable quality of combat proficiency.

Having realized this, we now have recommended that commanders of large strategic formations hold meetings with aviators of all categories—pilots, navigators, engineers and technicians—during which all sensible suggestions from the troops are to be collected. In order for reform not to turn into a child of the apparat, it must proceed both from below and from above. At the same time, some of our generals have to get rid of ideas that they know everything, and in particular how to do what in an air regiment situation. Diktat even in minor things and tutorship through and through on their part will lead to nothing good, since it deprives commanders of elementary independence.

I know for myself that as you advance along the career ladder you lose keenness in perceiving those matters which you handled in the previous position. For example, when I was a regimental commander I had a very precise idea of details hindering combat training. I became a division commander, the scale of missions changed, and in time the acuteness of regimental problems dulled in my awareness. This is a natural process. Therefore it is said that everyone should deal with matters at his own level. All of us must learn this art regardless of official position.

Now it is necessary to change the combat training system so that a pilot can constantly improve as a professional. We have officers who have flown combat training program exercises several times each. And then what? Perhaps it makes sense to divide them according to some kind of professional categories or groups into "a," "b," "c," "d" and so on. When someone reaches the final group this will mean in fact and not on paper that he is capable of everything, he is a master, an ace! Otherwise we all hasten and hurry to get pilots to the first class, but in so doing we do not achieve a stable level of proficiency.

In my view, it is difficult to logically explain the presently existing principle when we give first, second and third class pilots strictly defined annual flying hours, for here is what happens. Let's say a first class pilot has flown 70 hours for one year, a second year, a third year, and begins to become disqualified. We grieve with surprise: Why is it, we ask, that first class pilots do not always accurately bomb and fire and allow many near-accident situations in the air? Well, because they do not have high-time as they should and do not have optimum flying hours!

Meanwhile, reserves contained in execution, exactingness and responsibility are far from exhausted. They are the reason for 60 percent of air mishaps. In other words, it is a matter of military discipline, the question of which unfortunately has not been resolved in the Air Force.

[Correspondent] What do you think, can an experienced first class pilot who has flown a certain number of hours,

let's say 1,500, be given independence in selecting flying exercises according to complexity, in preparing for flying, and so on?

[Shaposhnikov] It is early to speak about this today, and not because there are few high-class pilots—they are in each regiment. But you understand, this is impossible to do with the present obsolete organizational structure inasmuch as a pilot (regardless of position) constantly is in a hierarchic pyramid: either he has his head on the line for someone or someone is responsible for him. The entire system has to be changed here. First we evidently will determine the combat readiness categories which pilots should pass through and then will work out the degrees of independence both legally and methodologically.

I will explain what I have in mind in somewhat more detail. For example, we say a pilot is ready to work against ground targets, but the fact is, there are numerous targets: area, small, mobile and so on. Can one and the same person really be ready for actions against all these targets? Meanwhile, here is how it is for us: a crew has flown back and forth to the range a couple of times and we hasten to report that the pilots are ready to destroy, let's say, air defense weapons, and then two weeks later some other kind of typical targets. No, that does not happen. Well now, if our squadron henceforth has, for example, a flight of masters at knocking out airfields, a flight for destroying Hawk SAM systems and so on, then the combat readiness level can be characterized without stretching a point. By the way, professional differentiation also is being studied here. For example, area targets are included in group "a." Then the smaller and more difficult targets are to engage, the higher the category. You see that a pilot working, let us say, according to group "d" standards really can do a great deal, i.e., we have to depart from leveling and primitive standardization of aviator proficiency in combat training. There also has to be an economic incentive.

[Correspondent] Good aircraft are needed to maintain high combat readiness. The situation now exists, however, where the Air Force is forced to take into the inventory that imposed by the Ministry of the Aviation Industry. What has to be done to eliminate industrial diktat?

[Shaposhnikov] It is necessary to use economic factors to avoid industrial diktat. The Cinc Air Force must have all funds allocated for upgrading the air fleet. Crudely speaking, the money has to be placed in his safe. If industry has made a good aircraft, it will receive it in full. But if the Ministry of the Aviation Industry proposes a very necessary but "raw" aircraft requiring phased modifications, payment then is made according to a lower price. That may happen once or twice, and the third time the Ministry of the Aviation Industry will begin to think about what should be done to avoid economic losses.

[Correspondent] Comrade Colonel General, your special intelligence, self-control and tact in contact with people have not gone unnoticed for the overwhelming majority of aviators. Tell us, are you from an aristocratic family?

[Shaposhnikov] Thank you for the kind words. Yes, I came from the aristocracy, from His Majesty the Working Class. I was born in Rostov Oblast in 1942. My father died at the front in 1945. We had a large family, so that, as much as I recall myself in childhood, we were accomplishing one task—survival. Mother brought us four children up alone. I well remember the "ration" of 400 grams of bread which was given per family per day. Our generation did not know what free pastimes were. Beginning with first grade, all vacations were dedicated to working at the construction site or on the kolkhoz, or unloading railcars.

I entered aviation in the footsteps of my older brother, who entered the Kharkov School, at that time still a school for navigators, but I chose the profession of pilot. After finishing school I served in various garrisons and went through all positions. At one time I was in political work, which gave me a very great deal with respect to interworking with people. I finished the General Staff Academy...

About my family. My wife is a physician, an Ossete by nationality, so that we are internationalists and our ethnic problems have been solved. I have three children. The older daughter is a nurse living in Odessa. This year my son finished school and intends to become a physician. My younger daughter likes to study foreign languages. That is how we live...

At the conclusion of our conversation, I wish to congratulate aviators with all my heart on the professional holiday and wish them happiness, health, and all the very best. I believe that the Air Force will survive the difficult times and emerge at a qualitatively new level. The important thing for all of us now is not to give in to pessimistic sentiments.

Soviet, U.S. Combat Helicopter Battlefield Tactics Compared

91UM0064B Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 4-5

[Article by Colonel V. Sporykhin, candidate of technical sciences, and Colonel (Reserve) G. Kuznetsov, candidate of technical sciences, under rubric "For High Combat Readiness": "Opposition Over the Battlefield"; first paragraph is box insert]

[Text] **A strengthening of Ground Forces air defense compels improving tactics of employing combat helicopters. Just what is new in concepts of employing our own and foreign army aviation?**

Helicopter crews can perform various missions during combat operations: destroy small targets, above all mobile ones (self-propelled artillery, tanks, IFV's); engage personnel; combat enemy army aviation and so on. With air defense opposition, tactics of the sides' use of the same type of helicopters have much in common, but there also are fundamental differences connected with the use of technical innovations. Let us examine this in the example of our own Mi-24 and Mi-28 and the U.S.-made AH-64 Apache.

Mi-28 and AH-64 helicopters are outwardly similar, have similar performance characteristics and ranges of employing ATGM's, free-flight rockets and guns, and have approximately equal capabilities in searching for targets during the day. The Mi-24 and Mi-28 crews consist of two persons: a pilot who does the flying and employs the free-flight rockets and fixed machinegun-cannon armament (the Mi-28 has a free-swinging gun mount using a helmet control system); and a navigator-operator, responsible for performing navigational tasks as well as searching for ground targets and employing ATGM's, a free-swinging machinegun and a cannon against them. The AH-64 crew includes two pilots who can fly the helicopter and employ all weapons to an equal extent. It would appear that these craft are capable of accomplishing their assigned missions with air defense opposition equally successfully, but this is not quite so.

Motorized and mechanized subunits presently are protected from air attack by barrelled antiaircraft [AA] systems and surface-to-air missile [SAM] systems. A characterization of the kill zone of Ground Forces air defense weapons is shown in general form in Fig. 1.

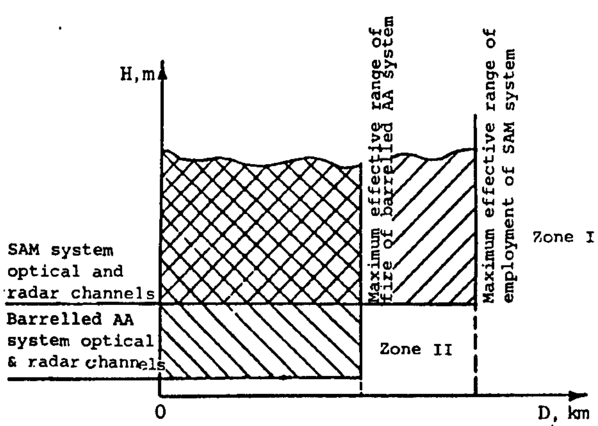

Fig. 1. Characterization of kill zones of Ground Forces air defense weapons

Within the zones hachured in the diagram, enemy helicopters are destroyed with a probability near unity if their presence here exceeds the barrelled AA system and SAM system reaction time, which includes search, preparation of weapons for use, and flight of the projectile or missile to impact with the target. According to foreign specialists' assessments, search and preparation time is around 10 seconds for barrelled AA systems and up to 15 seconds for SAM systems. The former engage helicopters beginning from the height of the barrels, and the latter from 15 m.

To air defense, flying craft represent targets with a radar signature, which facilitates their timely detection. Conversely, camouflaged tanks and other equipment blend with the terrain. This complicates identification and increases search time. The conclusion can be drawn that the helicopter essentially always will lose to air defense weapons in a duel and so it is advisable to operate from outside the limits of their kill zones.

With a meteorological visibility of 10 km or more the resolution of the surveillance-aiming systems of the Mi-24, Mi-28 and AH-64 permits acquiring and identifying ground targets from zone I (see Fig. 1). Search time here is unlimited, and the flight altitude is chosen from conditions most conducive to detection. The probability of a target's line-of-sight visibility P_{lv} depends on distance to it (D), absolute altitude (h) and terrain relief:

$$P_{1v} = \frac{1}{k_1 D} \sum_{i=1}^{D} \frac{1}{1 + \frac{i-1}{k_2 h}},$$

where k_1 and k_2 are factors characterizing the terrain. The greater the altitude and the less the distance, the higher the probability of the target being visible.

It remains to accomplish the important thing, employ weapons, but neither the AH-64 nor the Mi-28, not to mention the Mi-24, is capable of this outside the limits of the SAM system kill zone, since maximum ATGM launch range is less than that of the SAM. Thus an attack on ground targets is impossible from zone I.

Search time in zone II also is unlimited. Based on specifications and performance characteristics of ATGM's, helicopters in this zone can attack ground targets. The flight altitude, no more than 15 m, becomes a serious limitation. Use of extremely low altitudes of 5-15 m at great distances from the target (zone II) has been made the basis of Mi-28 employment tactics by specialists of the Experimental Design Bureau imeni M. I. Mil.

The target's line-of-sight visibility at great ranges is improbable under such conditions according to the cited formula relationship, and this is confirmed by the experience of exercises and of Mi-24 helicopter participation in combat operations. The recommended height for searching and for employing weapons at distances of from 1,500 to 5,000 m is 50-250 m. The Mi-28 and AH-64 are no different from the Mi-24 in this regard.

Taking the mean vertical rate of climb from 10 to 50-250 m and the subsequent descent as equal to 10 m/sec, then the time required just to execute this maneuver in the air defense engagement zone (not counting a time reserve for searching and for employing weapons) will be 8-48 seconds. It follows from this that combat helicopters also are incapable of effectively engaging ground targets from zone II when there is opposition.

But crews can covertly approach the search and attack area by taking advantage of protective properties of terrain relief. It is in this stage of combat employment of a rotary-wing craft that its remarkable quality—the capability of relatively safe flight at extremely low altitude—is revealed to the full extent. Fig. 2 shows a fragment of the employment of the Mi-24, Mi-28 and AH-64 in such a situation.

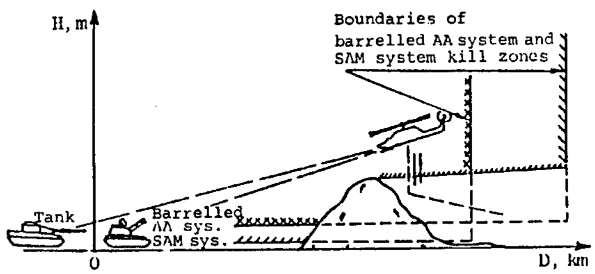

Fig. 2. Use of terrain relief for covert approach to target area

After approaching the search area, the helicopter ascends to the minimum necessary height above cover to ensure direct optical contact with the target. In this case the climb and descent within the zone of visibility of air defense will be done considerably faster than when attacking from zone II. Nevertheless, on emerging from behind cover, limited time remains for searching and for employing weapons, which is determined by the difference between reaction time of the barrelled AA system or SAM system and the time spent maneuvering within limits of visibility of air defense weapons.

The Mi-28 presumes use of such familiar methods as autonomous search and ground vectoring. In the first instance the helicopter uses terrain relief to covertly approach the presumed disposition area of targets to be engaged. Appearing briefly from behind cover, the crew searches for the enemy using a special system within limits of a corridor approximately 2 km wide. After detecting and identifying a target, the pilots aim and engage on the next emergence, and then leave the zone of visibility of air defense systems again.

The method of searching in coordination with a forward air controller is distinguished from autonomous search by the fact that the crew is informed prior to a sortie or in flight of the coordinates of the quadrant in which targets to be engaged are located. It is believed that with consideration of inaccuracies of tying in targets to a map as well as the targets' mobility, the crew of a combat helicopter can detect targets with equal probability in a 2x2 km quadrant by the moment it approaches the search area. In this case the depth of territory subject to scrutiny beyond the line of contact is reduced substantially compared with the first method.

If the AH-64 operates as does the Mi-28, then its chances of engaging targets are no greater, but according to published materials it will be employed in close coordination with reconnaissance helicopters (see Fig. 3). The functions of detecting and identifying targets and determining their coordinates are given to an OH-58D reconnaissance helicopter operating with the ground troops. This helicopter is small and has a small optical, infrared and radar signature, which substantially hampers its detection by barrelled AA system and SAM system crews. It makes the target search just as does a combat helicopter crew using the autonomous method.

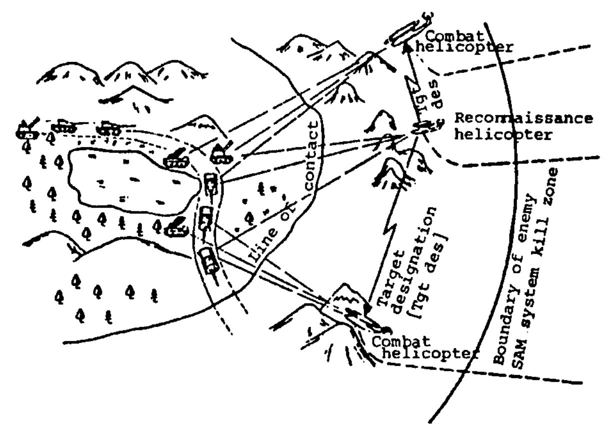

Fig. 3. Coordination of AH-64 Apache combat helicopters with an OH-58D reconnaissance helicopter

The surveillance system and gear for tying in the reconnaissance helicopter to the terrain support the determination and transmission of data to the combat helicopter with an accuracy to 100 m.

On receiving a target designation by azimuth and range in the form of a mark on the sight, the AH-64 crew functions in accordance with the fragment depicted in Fig. 2. Before emerging from cover the pilot lines up the sight line-of-sight with the mark in azimuth. Final aiming, launching the ATGM or free-flight rocket or firing the gun and the helicopter's subsequent departure behind cover in time periods not exceeding the reaction time of air defense systems are carried out in the process of establishing direct contact with the target to be engaged.

Foreign specialists believe that successful use of the AH-64 is ensured in the case where one reconnaissance helicopter interworks with a pair of combat helicopters. Herein lies the superiority of the OH-58D/AH-64 system over independent actions of the Mi-24 and Mi-28, which have only autonomous search or target designation from a forward air controller in their arsenal.

In an autonomous search or with target designation from a forward air controller, the AH-64 crew uses a surveillance-aiming system like the Mi-24 and Mi-28, but at the same time it makes a video recording of the terrain. It looks over the recording calmly and in detail after taking cover. In case a target of engagement is detected, the pilot lines up the sight line-of-sight with the target image before emerging from cover for an attack and subsequently functions as with target designation from a reconnaissance helicopter.

Suggested Improvements in Staff Planning Detailed

91UM0064C Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 6-7

[Article by Colonel Ye. Kislyakov, candidate of military sciences, under rubric "Combat Training: Discussions and Suggestions": "Take a Nonstereotyped, Creative Approach"; first paragraph is box insert]

[Text] **The modern concept of a "method of combat operations" does not fully reflect changes which have occurred in equipment and armament or in conditions of combat operations and needs improvement.**

The content of the method of combat operations has evolved substantially from the moment strike aviation appeared. Basic bomber attack methods were formulated in the late 1930's: concentrated strikes delivered by major forces (several subunits or a unit) in a short time interval; and actions by small groups or subunits staggered in time. During the Great Patriotic War they began to be termed methods of operations of ground attack and bomber aviation. Guidance documents pointed out that in addition to staggered and concentrated strikes, when ground attack aircraft, for example, perform assigned missions when the enemy has been insufficiently reconnoitered they carry out missions in pairs and small groups in target-of-opportunity roving.

The term "methods of combat operations" appeared in the 1950's. The following began to be regarded as basic methods for the air regiment: concentrated strike; staggered operations; denial; target-of-opportunity roving; and others which can ensure successful combat mission performance.

In the 1960's the method of combat operations was understood to mean the delivery of strikes on request, against preassigned targets, and their independent search and destruction (target-of-opportunity roving). Different distinguishing signs were made the basis of this concept's development: distribution of efforts over time; requisite urgency of operations; completeness of information about strike targets and so on.

In the late 1970's the method of combat operations came to be defined as the procedure for employing personnel and equipment in performance of the combat mission by air formations, units and subunits. That which previously was known as "methods" began to be called procedures of operations: simultaneous; successive; against preassigned targets; against targets identified during battles; against independently located targets; by plan; on request and so on.

In accordance with modern views, the method of combat operations represents a set of procedures depending on situational conditions, enemy behavior, and combat capabilities of air formations, units and subunits. The opposition of air defense weapons will influence the character of planned air operations to a considerable extent, but existing procedures do not fully take this important circumstance into account, since the majority of them were formulated back during the 1940's and 1950's when there was not such a multilayered, deeply echeloned system of protection.

There is no question that combat capabilities of air formations, units and subunits largely determine procedures of operations characterizing the number of participating forces and distribution of efforts over time. The requisite detail of aircraft for destroying targets is reduced with an upgrading of weapons. At first glance this inevitably should lead to a change in such procedures, but the necessary number of forces does not always differ appreciably from that used in the past to perform similar missions because of increased air defense effectiveness. Therefore procedures for employing aircraft also remain unchanged and as a result the wording of the method of combat operations does not change although operating tactics have substantial differences.

For example, in destroying enemy aircraft at airfields during the Great Patriotic War, a bomber regiment often delivered a simultaneous strike at full strength against a preassigned target at a designated time. The requisite number of aircraft for delivering desired damage has not reduced substantially under present conditions with intensified opposition to aircraft along their flight route and in the target area and with the accommodation of aircraft in reinforced-concrete shelters. Therefore despite the fact that bombers employ new tactics for penetrating air defense and delivering the strike, the method of combat operations frequently remains the same: a simultaneous strike by the regiment at full strength against a preassigned target at a designated time.

The fact is that the content of the method, which includes only procedures of operations, is insufficiently receptive to changes in the situation and in weapons. In order for this concept to conform to such changes, it is advisable to supplement it with the most characteristic tactical procedures and features of coordination, support, and command and control.

How important is this for practical work? In drawing up documents, commanders and staffs indicate the method of combat operations in the form of an element of the concept of combat operations. Often it is determined by choosing one of 3-5 standard wordings which presented in such a general form that they satisfy the majority of tactical situations. Such a circumstance reduces the practical value of the method of combat operations being planned and of the entire concept as a whole, leads to stereotype, and precludes the possibility of displaying creativeness. But broadening this concept by including new elements in it at the commander's discretion on the one hand will continue to reflect the procedure for employing personnel and equipment, and on the other hand will include information defining the basic content of the variant of combat operations more specifically. With this approach, the number of methods of combat operations can be as large as you like.

If the content of a method includes basic tactical procedures which most fully take into account the capabilities of weapons and conditions of combat operations, this gives the commander a chance to formulate in the concept an original approach to mission performance and demonstrate the tactical "spice" of the variant of combat operations. The advisability of saturating it with questions of coordination, support, and command and control stems from the fact that they dictate the procedure for employing personnel and equipment to an ever greater extent. For example, this procedure becomes more specific in delivering a strike based on final reconnaissance data or in making an approach to a target based on commands of a forward air controller, under cover of jamming from zones or from a combat formation, in coordination with other air arms and so on.

The need for expanding a method's content also stems from the structure of the decision for combat operations. In accordance with this structure, the concept includes information that specifies its elements (concentration of efforts, distribution of personnel and equipment and so on) in a general form, while the other elements of the decision detail them. Thus, the variants of a concentration of main efforts and of a distribution of personnel and equipment are clarified in the section of the decision revealing missions for units and subunits.

The method of combat operations indicated in the form of a variant of the employment of distributed personnel and equipment is detailed in the section of the decision setting forth the procedure for combat mission performance and for coordination. It would be logical that questions of coordination, support, and command and control also are reflected in a general form in the concept as elements of the method and are only specified in appropriate sections of the decision.

The specific content of the method of combat operations and the need for its detailed statement in the concept are determined by the commander with consideration of the number of participating forces, nature of the mission, level of training and experience of staff officers, and time available for coming up with the decision.

An expansion in the content of the method of combat operations as part of the concept increases the commander's role in producing a decision and reduces the length of planning time, since the staff and services are detailing a procedure for employing personnel and equipment that already has been specified to a certain extent. Meanwhile, the commander's responsibility grows and demands on his professional training increase: a mistake he makes in determining the method of combat operations subsequently will substantially complicate the work of staff and services and increase the time for producing a decision.

The proposed approach to the concept of a "method of combat operations" as a procedure for employing personnel and equipment which includes general information reflecting the basic content of variants of combat operations permits scientifically implementing requirements placed on the work of the commander and staff to improve it.

Changes Urged in Obsolete Pilot Training System

91UM0064D Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 10-12

[Article by Lieutenant Colonel of Medical Service V. Kozlov, candidate of medical sciences, and Lieutenant Colonel A. Zhilin, flight safety department editor, under rubric "Flight Safety: Experience, Analysis, Problems": "The Pilot in the Combat Training System"; first paragraph is box insert]

[Text] **One would like to write the following most of all on the threshold of our air holiday: "Perestroyka of combat training is in full swing in Air Force units and subunits, and all conditions are being created for the personnel's full-fledged activity!" But alas, the desired changes are hardly looming on the long-term horizon, and to keep them from being only a mirage it is necessary to speak about what torments the awareness even in a holiday issue. And so the subject is the pilot in the combat training system.**

It was Trotsky who laid down the abc's of organizing and monitoring Red Army combat training, and then they were thoroughly "improved" by Stalin. The principle of "looking for reasons for particular failures not in the combat training system and not in provisions of military doctrine, but in the activity of individuals" became predominant. The important thing was to find the "culprit" and send him "to the scaffold." There was no difficulty in doing this, and the "enemies" in tunics extended in a long line to the wall...

Much water has flowed under the bridge since that time, but to this day the combat training system unfortunately is based on the old foundation. Its fundamentals have remained firm. Figuratively speaking, only its face, disfigured by "Stalinist pock-marks," was made up from time to time, depending on the conjuncture of the moment. The only thing that changed was that physical reprisal against "pointsmen" gave way to moral-psychological reprisal: a relative humanization of our Army reality. Nevertheless, the command-administrative moral lash strikes no less painfully (or perhaps even more painfully) than the ordinary whip. The chief flaw is that the social-legal lack of protection of aviators (as of all servicemen) creates favorable conditions for unlimited humiliation of the self-esteem and worth of people in military uniform. Formed over decades, the psychology of the little person who can be trampled at any moment—removed from flight duty, relieved of position, discharged—has become part of our flesh and blood; hence the broadening scale of people's infantility, skepticism, and bitter sarcasm. Judging from everything, this is a dead end. Is there a way out? We will attempt to look into this, but first let us examine in more detail what we have today.

We frequently say that combat training is a system, i.e., a set of specific elements which have relationships and ties with each other and which form a certain wholeness and unity. Since that is so, then the goal should act as a system-forming factor, in this case to form a pilot as a high-class professional in the broadest sense of this word, as well as a harmoniously developed individual possessing firm health and substantial functional reserves.

This is the goal to which accomplishment of individual tasks by each component which is part of the structure of the system called combat training (whether it be flight, engineering-technical, support, medical service or other training) is subordinated. It is well known that feedback is an important condition for any system's full-fledged functioning. Unfortunately, surveys of aviators show that this vitally determining condition in the organism of combat training is barely glimmering. In our view, the reason lies in the infringed-upon situation of a pilot without rights in the system which has been created.

We will be frank. Throughout all the time the present organization of combat training activity has existed (with the exception of wars and local conflicts), flight personnel have been and remain a little cog in it. They are only passive executors of another's will, with their every step written out in instructions and manuals. Any practical objection or attempt to find the truth by open discussion are viewed as disobedience or lack of execution. Well, forget about objection or discussion. Things have come down to where in some places "ideologues" stuffed with political dogmas attempt to force the "human factor" not only to speak identically, but also think uniformly.

Such an unenviable position of the aviator does colossal harm to the quality of military training and the effectiveness and safety of flight work. Do not expect a person to do his utmost if he becomes a slave of circumstances which he is incapable of changing. In such a situation he simply has no appropriate conditions for full-fledged revelation of his spiritual, professional and moral potential. Alas, this truth is stubbornly ignored and is camouflaged by demagogic appeals to "strengthen," "improve" and "raise" (how?) and by endless appeals to an abstract conscience of an abstract "human factor" separated from the realities of life.

It is by no means accidental that one presently sees that means and methods of training flight personnel are clearly lagging behind the level of development of aviation equipment, and that combat training is oversimplified. Strictly speaking, what is there to be surprised at?! Instructions generous in volume that fall abundantly "from above" on decrepit regiments (from the standpoint of training facility and aviators' everyday life) have no material basis. The fact is, even in high commanders' orders you will not find specifics such as the following: it is necessary to do thus-and-so, and such-and-such assets (monetary or in the form of computers and so on) have been allocated for this, which must be obtained at such-and-such a place. And it turns out that many papers with declarative statements come to the regiment but, for example, there is no trace of equipment for presenting information necessary for training, simulating flights, performing calculations and making out flight documentation (calculators, personal computers).

How can we correlate, understand, appraise and explain this poverty and primitivism which irritates the eyes against the background of the supermodern winged craft being operated in line units? The gap between means and methods of preparing for flights and the fourth-generation aircraft systems has reached such proportions that it no longer can be negotiated using command-administrative methods and demagogic slogans. It has turned into a powerful obstacle in the path of professional expertise. This naturally increases the number of air mishaps. And so it turns out that in saving several tens of millions at the most on microcalculators and computers, the state pays out billions, annually losing dozens of modern aircraft plus the invaluable lives of pilots buried beneath the aircraft fragments. That is how it was, is and will be until we take a comprehensive approach to solving the problem. But alas, no clear improvements are sensed.

Along with other reasons, it is probably also because no leaders responsible for the status of means and methods of training flight personnel have been or are held liable, and this is not reflected on their personal well-being. Then is it worthwhile for them to argue heatedly? Or perhaps they are simply impotent, inasmuch as they themselves do not have what is necessary? Possibly. Then why are they silent? Why do they not sound the alarm? Why do they not turn to higher echelons right up to the government? For it is a matter of state importance! In addition, there is probably not one instance where it was openly written in the findings of an air mishap analysis that the catastrophe occurred as a result of the training facility's crying backwardness compared to today's demands, lack of supply of modern simulators, an absence of normal everyday conditions and so on.

Since a situation has formed in which the physical, psychological and intellectual loads on flight personnel are growing and the social situation of the homeland's winged defenders is worsening, it is not worth playing at hypocritical delicacy. If a pilot who lived with his family under horrible conditions has died, it is necessary to honestly write that our society is at fault.

Hypocrisy is not a chance phenomenon. If honest, objective recorded data appear, specific steps must be taken: allocate funds, seek some kind of additional capabilities and so on. But in some places people apparently reason otherwise. Why make life harder for oneself, especially as the existing system will not "excessively" fuss over a person? It is simpler to heap all the blame on the deceased: he erred, did not finish learning, became confused... And that's it: no person, no questions. The problems are buried with the deceased. A very convenient move for bureaucrats. Do you perceive the echoes of Stalinist philosophy? It is tenacious, oh how tenacious! And its hardiness lies not in the fact that it has a mass of conscious supporters, but in the fact that a system constructed at the turn of the century is still alive. Pilots often "automatically" act in it in the unenviable role of performers without rights.

There is one other point of no small importance here. When an air mishap occurs in a unit, the superiors who arrive to look into it are the ones to whom, strictly speaking, the pilot is supposed to levy claims about poor concern for him. What I have in mind is the contradictoriness of documents regulating flight activity, the imperfection of principles of organizing aviators' labor, and the backwardness of the training facility. The inspectors understand this perfectly well and so they hasten to launch an attack from the threshold, as the saying goes, dumbfound the pilots with accusations, and crush them morally. First-strike tactics and the antidemocratic principle of "he who has more rights is right" enter into force. What feedback can there be after this?

Backwardness in developing the means and methods of flight personnel training in our view is the main reason for the extensiveness of combat training, manifested in increased time, economic, physical and moral inputs. All this is to the detriment of the quality of military proficiency, inasmuch as with this approach to things His Majesty, Gross Numbers triumphs and effectiveness remains as it was before, a poor stepdaughter.

For long years a pernicious practice has existed in units: various activities are conducted not so much for a training purpose as for a legal purpose, for the procurator and inspectors. In violation of elementary logic, regimental commanders often are forced to arrange the training process based not on the collective's urgent problems, but on conjunctural considerations of personal safety under conditions of command-administrative tyranny. After this, need one wonder that despite the fact that biological protective mechanisms aimed at ensuring flight safety are of enormous importance, aviators nevertheless are trained to rely not on them, but on higher (often superficial) control over the level of professional training and unthinkingly have more faith in it than in themselves?

The imperfection of the system which has formed is confirmed by the fact that gaps in pilot training have existed for decades and the number of air mishaps remains very stably at the same level. It is not enough that negative points are harmful in themselves, they engender an answering reaction of the leadership not in the form of a striving to improve the means and methods of pilot training or forms of its organization, but in the form of endless duplication of those measures which essentially have exhausted themselves. That approach to organizing aviators' work completely demolishes the internal mechanisms of a person's control over his own training and places pilots in full dependence on the system.

It will not be simple to radically change the existing state of affairs even if, for example, an order appears tomorrow guaranteeing unit commanders full independence. The old approaches to organizing combat training engendered a deficit of initiative, creativeness, and ability to assume responsibility. There is for now only enough boldness for slogans. Therefore it would appear that rates of changes largely will depend on how quickly we begin to rid ourselves of serf psychology. Many of us have not been enlightened as Individuals.

Immanuel Kant wrote back in 1784 that "laziness and cowardice are the reasons why people whom nature long ago freed of another's leadership nevertheless willingly remain minors all their lives. And others so easily appropriate for themselves the right to be their guardians for these same reasons. For it is so convenient to be minors! If I have a book that thinks for me, if I have a pastor' whose conscience can replace mine . . . then is it worthwhile for me to trouble myself?" In Kant's words, enlightenment is "a person's emergence from the state of his minority in which he is present through his own will," but this requires "freedom, the most inoffensive freedom, and specifically, freedom to publicly use one's own reason in all instances." For now, however, we are only approaching this.

Shortcomings in the organization of professional training comprise the main (although not the only) reason for a violation of the personnel's labor and leisure time. The workday usually lasts for 11 or more hours and is characterized by a pronounced intellectual load and just as pronounced hypodynamia. Far from every month has days off. Physical training is conducted rarely. Often the time set aside for it serves as a reserve for additional activities, conferences and meetings. With no opportunity to oppose this tyranny, aviators fall into apathy.

Unfortunately, negative phenomena also have penetrated the midst of flight personnel, who always were distinguished by brotherhood, comradeship and mutual help. This is attested in particular by the fact that in flight messes rank-and-file pilots and unit command personnel eat in different rooms. Despite the fact that meal standards do not depend on position, in the command messes both the quality and assortment of food and the layout are better.

Today pilots also find themselves under the powerful press of social problems. The colossal shortage of housing, well-arranged garrisons and preschool establishments, unemployment of wives, lack of legal protection for servicemen and their families, and social injustice (low pay for difficult labor, delayed career growth even for conscientious officers and so on) are the real anti-incentives that cruelly wound the people's consciousness and soul. Just what does the state, in the form of the government, set in opposition to them to improve the situation of their winged defenders? Calls to work better and more and to be conscientious (read: be tolerant toward infringements). This is strange opposition, to put it mildly! But it is not without results. The pilot essentially is constantly in a "recruit's" dependence on the system: he is always damaged by waiting either for an apartment or for a rank or for a position or for a pension... In such enslavement it is difficult to preserve dignity and allegiance to higher moral principles, but aviation cannot have a full-fledged existence without these categories. Confirmation of this again is the stability of the fatal number of annual catastrophes, which we stubbornly attempt to reduce by oversimplifications, restrictions, and reduced intensity of flights, but only not by an improvement of the system.

The most unpleasant situation involving realization of the feedback principle in the combat training system probably is seen in analyzing problems connected with flight safety. Knowing that truth uttered publicly at a meeting or face-to-face to a superior will bring nothing except unpleasantness, since the mechanism of social-economic suppression of the individual instantaneously will be switched into operation, the pilot is placed under conditions where he must dodge, lie and degrade himself. And that is just the pilot! The regimental commander is forced to fawn and contrive to organize subordinates' work in the flow of contradictory documents all the time in such a way that "the wolves are full and the sheep are safe." Alas, far from everyone succeeds in doing this.

The existing situation leads to where it is practically impossible to receive timely, objective information about the essence of what happened from the pilot. Naturally in this case it is difficult to talk about any kind of effective and efficient prevention of air mishaps. The fact is that the "pilot is always guilty" principle preemptively forms the image of thinking of persons looking into an emergency incident. As a result, distorted initial flight safety information which goes from the unit to higher organizations engenders preventive recommendations that are just as distorted and separated from life, which again boomerangs against the pilot. The vicious circle closes, generously accumulating within itself all the absurdity of the existing system.

It is also impossible to ignore the problem of aviation equipment operation by flight personnel. Despite supervision by appropriate Air Force research establishments over the physiological-hygienic and engineering-psychological characteristics of the pilot's workstation, one must admit that for a number of parameters aircraft cockpits conform far from fully to the demands being placed on them. Pilots speak about this openly, but what is their opinion worth in comparison with the unlimited dictatorship of the Ministry of the Aviation Industry? Line unit pilots have the right only to express their opinion about the aircraft cockpit to higher echelons in writing, but nothing comes of this as a rule. The Ministry of the Aviation Industry long ago learned the rule that no matter what aircraft is shoved at the Air Force, the pilots still will be forced to fly in it. It is a fact that you would not purchase such aircraft abroad, but in the Union there is almost no competition between firms.

In our opinion, there can be the following solution to the bondage. Legislatively obligate a firm developing an aircraft to pay the flight personnel monetary compensation, with the amount to depend on the degree of nonfulfillment of the client's corresponding demands. We believe that at least to a certain extent this approach will force the heads of the Ministry of the Aviation Industry to take a more attentive attitude toward pilots' critical comments about the quality of their aircraft.

With the existing system, a pilot fit for work but not desiring to fly for a particular reason is in a special situation. How can one "peacefully" leave flight work at the present time? Only by "stamping" oneself with a diagnosis and being written off for medical indicators. In this manner an officer knowingly is placed under conditions which prompt him to commit an antisocial infraction. Why not officially introduce an honest way by which a pilot can leave the Army? Well because then it will be necessary to admit officially that the state is incapable of keeping its winged defenders inasmuch as there will be many aviators who have become sick of being beggarly recruits without rights. Referring to the crying disorder, they naturally will replace flight suits for workers' coveralls, as the saying goes. It must be borne in mind that far from the worst officers are or will be going into the reserve...

And so it is absolutely clear that the existing organization of combat training needs radical change. Meanwhile, as a recent experiment in individual units attests, this is impossible to do if the pilot's situation in the existing system is not fundamentally changed. The chief question remains open: Specifically what must be done to dismantle the dead-end system? The answer is not simple. Judging from everything, a collective brainstorming by commanders and scientists on problems of flight activities is necessary.

Therefore we invite everyone who has specific suggestions to take part in the discussion.

Need for Study of Human Factor in Aviation Stressed

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[Article by A. Akimenkov under rubric "Notes of a Test Pilot": "The Human Factor in Combat Aviation"; first paragraph is box insert]

[Text] **I will stipulate right off that I am not a professional psychologist and lay no claim to the role of an opponent to specialists in this area. I wish to express my opinion, which formed during years of work as a test pilot.**

Today there is pluralism. An attempt is being made to dismantle the administrative-bureaucratic system. This is an objectively natural process, but it absorbs a great deal from conjunctural sentiments. In particular, criticism presently is expressed most of all against Armed Forces political entities and suggestions are made for their dissolution. Meanwhile, there are not now nor have there ever been any deideologized armies. The misfortune of our political entities lies in the fact that ideology was separated from knowledge of man's role in the "man-machine-environment" and "collective-equipment-environment" systems.

While we were writing synopses of primary sources from year to year, people in the armies of developed countries were dealing with man as the leading link of these systems. Specialized structures were created and developed for managing the human factor. We too have a prepared and well-developed structure—political entities. It remained to combine it with those tasks which to this day have been paid no heed or have been ignored as strictly medical, psychological, sociological and so on. It stands to reason that in becoming a service of the human factor, they should include appropriate specialists; specifically which ones will be determined by the tasks which my notes are devoted to revealing.

A person in flight now is under constant pressure of an "information explosion." For convenience of use, an attempt is made to generalize information, process it beforehand and symbolize it to the maximum extent. But in my view the principal trouble is that the number of channels of interaction with onboard systems is increasing while human awareness, as before, remains a single channel. Previously a person would glance at the instrument panel and understand everything, but now it is necessary to understand what goes with what on the indicator screen, and there are more and more of them in the cockpit.

We fought so actively against Freudianism that to this day we cannot understand the simple fact that incomprehensible information can be read only with a certain distance between its sources, and it has to be "information of positions," i.e., of pointers. The instrument panel previously was one general channel of interaction with the pilot. Now, when it represents an indicator screen to an ever greater extent, each digit has become a separate channel. The problem of choosing between a "direct" and "inverse" indication of the artificial horizon is in the same category. Respect for the ability to think has gone so far that an attempt is made to impose a "flight image" on the pilot as an additional operation in determining spatial attitude. But the fact is, nothing could be simpler: Earth is big and I am small on it. A small symbol of an aircraft rotates with respect to a large cockpit. Otherwise it is one more channel for the pilot. But he works more or less successfully in two channels, and then it is with information of different meaning, switching from one to the other. If information values come close together or a third channel appears, troubles begin, right down to a loss of awareness of one's activity.

Stress mobilizes a pilot, especially in a combat situation, and he preserves working ability because of the transition of the greater part of control functions into subconscious thought processes, leaving only the function of guardian of flight safety for the conscious "I." But in parallel with his adaptation, cockpit ergonomics also must be adapted to this, and we have to consider and appraise the deep shifts of attention in channels and understand the nature of troubles in them and of high energy inputs which today have become the reason for much unpleasantness in the air. A point in time may come when we generally will not be able to fly. Even now the question arises: Will we be able to fight effectively?

At one time I studied an instrument in flights which registered such shifts based on EEG indicators of a pilot's brain, but alas, no one took an interest in it. We are waiting for suggestions from abroad. Is it worthwhile? The fact is, here is where the service of the human factor could prove itself. In my opinion, there also should be other problems within its competence, of which many have accumulated.

The operative space of information coordination and combat coordination in flight has increased by an order of magnitude over the last 15 years. The growth trend continues, but after the "stagnant" bans on aerobatic maneuvers we have not yet sensibly learned to master close-combat space, especially on the verticals. The dynamics and intensity of information change with a mutual combat maneuver by large groups of aircraft generally remains unstudied. In performing stereotyped intercept flights where the target plays up to the interceptor, pilots convince themselves that they are able to fight. In fact, however, they have missed a qualitative leap in the development of combat aviation which still has to be comprehended and only then made up. It seems that in the spontaneous combination of elements and factors which we have, the "pilot-aircraft-environment" system can break down under the effect of the most primitive situation, let alone group combat.

The growth in effectiveness and diversity of combat factors considerably paralyzes pilot initiative. Missile launch range, maneuverability characteristics, and homing accuracy and reliability have grown. The enemy becomes realistically dangerous and omnipresent while remaining invisible and unreachable. Not long ago pilots set hopes on visual detection of the foe. Keenness of vision increased 2-3 times under the effect of stress of a combat situation, although the adaptation itself took around a year. Much now depends on technical systems which fail even in peacetime, and rather often. The fact is, it will be necessary to detect such small targets as missiles. Of course, the enemy also is in that situation, but this is no cause for self-complacency. The environment for accomplishing combat operations has changed qualitatively and contains new dangers. The future promises laser, beam and other kinds of weapons. The one who will win is the one who masters the environment of their employment. The impression I am getting is that for now we do not perceive that necessity.

Flight range has increased considerably, even for front aviation aircraft. Increased engine economy contributes to this in particular, although increased flight duration led to a growth in the number of equipment failures. The Americans took a number of steps which allowed them to reach a level guaranteeing dependable, continuous flight for 25 hours. We also need a special program for solving this problem, but such a program is needed for man to an even greater extent. Energy resources and reserves of biologically active substances are distributed in him by organs. Such "jurisdiction" is the reason for the unevenness of their expenditure and fluctuations in the body's working capacity with monotonic loads.

Its special stimulation is required to coordinate energy inputs and increase general working capacity. For this it is necessary to study the nature of biorhythms and determine means of monitoring them. One can be an instrument for monitoring a pilot's working capacity based on his EEG indicators. It must be emphasized that the mismatch of energy expenditures shows up especially insidiously during transitions from monotonous flight to high g-loads. In combination with a large flight range, such a change of conditions leads to an unexpected loss of working capacity, but such flights are what lies ahead for combat aviation and this means we must prepare for them.

The background of high g-loads in flight provokes and aggravates both human as well as all technical weaknesses. Seven g's for over 20 seconds qualitatively changes a pilot's very functionality. The combination of the information overload and flight overload leads to deformation of an adequate perception of reality, which has become a latent cause of many accidents and catastrophes. Hypoxia (oxygen starvation) of the brain menacingly made itself known at high gradients (over 3 g's per second) of moving to g-loads of 5 or more. The brain does not have time to mobilize its protective mechanisms, and a person loses consciousness without the customary warning from the "gray shroud" in the eyes. In anonymous surveys around 20 percent of the pilots of maneuverable U.S. aircraft admitted facts of a loss of consciousness.

One must prepare seriously ahead of time for modern air-to-air combat, which extremely aggravated the problem of social and physiological insurance of flight personnel, since g-loads intensively break down the human body in the course of day-to-day training. For example, disturbances in the heart's electrical activity form and gradually become fixed when going into high g's. Vessels burst and the body is covered with bruises under the blood's weight. After high negative g's the eyes become such as to shock an outsider: there have been cases where pilots have held them in the eye-sockets with their hands.

Moreover, there is a disturbance of the fundus of the eye and blindness develops due to sharp fluctuations of intraocular pressure. The diaphragm distends under the weight of the viscera and the lungs' respiratory rhythm changes. Deformation of cartilages and discs of the backbone disturbs its flexibility and pinches nerves, which produces an entire set of illnesses.

In attempting to transfer the g-load to the "chest-back" direction, the Americans laid the pilot back by making the seat back tilted. As a result it was learned that the accumulation of blood in the area of the pelvis leads to impotency, and the inclination of the neck to paralysis. The cervical section of the backbone functions under rigid conditions. During a landing on a carrier deck, the head tilts forward with a g-load up to 3-5 at the initial moment of braking. With consideration of these nuances, the American Pilots' Association demanded such economic compensation from its government that flight g-loads were limited by directive there to 7. But our pilots demonstrate g-loads of 9, and not just at foreign air shows...

The training of a 1st class military pilot costs several million rubles. His length of service with us is half that in the United States, for example. We thereby lose R20 billion to the United States just on rotation of flight personnel. The fact is, however, the meaning of the arms race lies in just such losses and wins. But our overall loss is not limited to this; it transfers into the social and moral spheres. The USSR government is protected against unpleasantness, of which there is enough even without this, only by the fact that former and presently operating military pilots are very tolerant and selfless. Moreover, they are organizationally helpless, and in the legal and medical sense are illiterate, but this cannot last forever. The Americans also did not become literate at once. They have a start of ten years. This will have enormously more radical consequences if ferment begins with us as well in the present situation. This is why the problem must not be hushed up. It will not resolve itself. It can be removed only by an effective service of the human factor.

In what way? It still is necessary to fly with g-loads. Moreover, a pilot's proficiency lies in walking on the edge of an aircraft's limitations, figuratively speaking. Therefore first of all it is necessary to know precisely what price he is paying for this. Domestic science passed a mass of testers from among soldiers through high g-loads back on captured centrifuges, but no one is taking an interest in their present health. It is even more improper to transfer this experience to people who are not young.

Secondly, it is not understood what age qualification is optimum. "The eye of the eagle sees further, but man sees more"—this thought of Engels contains the systems nature of human reserves. The "eye of the eagle" can be broken, but the system contains backup and reliability. Consequently, the optimum flight age is shifted much beyond the figure at which we ground people from flight duty, but this optimum is considerably closer to that limit beyond which the "breakages" of the body surface, and that is the entire point.

Thirdly, there not only must be a selection, but also a purposeful preparation of the pilot for g-loads, which must begin from childhood and become the content of his entire life. That is done in the United States, by the way. There is simply no other solution for now.

Fourthly, there must be a set of equipment for preparing for a flight with g-loads and for rehabilitation afterwards, a most important component of which must be instruments for monitoring a person's working capacity. Means of stimulating the body by precisely commensurating the end and the consequences can be used for this. And those stresses and fatigue which could not be relieved during rehabilitation must be compensated by social insurance. But this requires income and expenditure statistics if one takes a practical approach to the concept of "labor force."

Fifthly, it is necessary to gain an understanding of how to help a pilot during the g-load itself. I believe that variable seat geometry, an anti-g suit with oxygen charging of the lungs, and other kinds of stimulation in the aircraft cockpit will be able to alleviate the pilot's lot only when they are directed at the same point, as the saying goes. For this the organization of flight tests must include a subunit for psychophysiological and ergonomic accompaniment of tests, a complex of psychophysiological preparation for flight and for rehabilitation after a flight, a flight psychophysiology laboratory, a half-scale simulation center and an operational-tactical and systems evaluation subunit. Measures for line air units must be developed on the basis of their activity, but we do not even have a trace of such a thing.

The combination of capabilities of man and equipment must be calculated for work near operational limitations, i.e., where it is both difficult for a person and where victory over the enemy is strived for. But all of our cockpits are made for straightforward flying and ergonomics of maneuverable flight is absent even as a concept. The very control of an aircraft near the limitations has the worst characteristics. Information, warning and limiting systems are lumped together in an unnatural hybrid. The dynamic properties of the aviation system and aiming systems also are the worst here, although it is specifically in this area of flight modes that, judging from everything, we plan to seek our advantages over the enemy inasmuch as for now we have not succeeded in finding anything else. Alas, there is no one to monitor this problem.

In the hierarchy of man's interaction with the surrounding world, the social-moral aim is not only the most complex one based on conditions of its formation, but also the most preeminent among others. Responsibility to society acts no less effectively than fear for one's life and well-being. This is a kind of realization of the instinct of social self-preservation in the individual. Social-moral orientation forms up the entire structure of aims as it were, without whose psychophysiological automatism flight would be entirely impossible. It cannot be forgotten that emotion is a separate system duplicating nervosity; it is a system that combines with the nervous system's reaction specifically within the framework of the aim.

There exists a theory which states that the body responds to the effect of the environment by shifting from one level of reactivity to another, in each of which there may be a weak, medium or stress reaction. There are some ten such levels and each reaction has three stages. That is how the body's quantitative adequacy of response is organized.

Its qualitative aspect is supported by the aim, where the body's psychophysiological qualities are realized on the basis of an intersystem organization of complex reaction.

Thus the aim is the track of movement by levels of reactivity. The instinct of self-preservation is the motive force. Emotion is the regulator. The social-moral aim is the most integral self-regulation system. If we wish to attain the most complete effect of elevating a person's functionality in the "pilot-aircraft-environment" system it is necessary to begin with the social-moral aim and gradually descend to upgrading of skills and primitive psychophysiological reactions.

On the other hand, the professional psychology of a pilot's perception and training has a sensory, subjective side. The pilot is accustomed to operate with images, each of which is only a symbol, but behind it is the powerful, subconscious basis of experience of operator activity reinforced by the stress of professional risk. A pilot is accustomed to the pressure of stress, which flattens out complex social concepts (including also the meaning of life) to the scope of a specific flight situation, where it is already impossible to separate the personal and the social. Stress here is not an ailment, but a working tool with which an external stimulus pierces the entire hierarchy of aims through and through, realizing instantaneous action in response. This is a subconscious thought process where the pilot thinks with his body as it were.

Therefore slogan propaganda and traditional techniques of education do not work here. The entire hierarchy of aims must be smoothed out by practical activity: official, party, social, flight, on the simulation stands, in the transition from the simple to the complex, and in working out and making decisions, i.e., in acts. This must be a unified system that combines with the service of the human factor. There is simply no other way. Enormous reserves of the human body's adaptation to combat flight of the modern aircraft complex are contained specifically in this system. It is not the equipment, but man with its help who performs his mission against the background of a specific operational-tactical situation in the system of employment of the Armed Forces and of military collectives.

The "collective-aircraft-environment" system is formed by social relationships, which are what link its elements into a single whole, but this is an almost unknown system. The hushing up of its problems stems from difficulties of elaborating concepts of the conscious and unconscious in the collective, concepts through which the aforementioned social relationships are realized. The situation is complicated by the fact that functionality of the Armed Forces political apparatus has been affected and unexpectedly has found itself in the epicenter of perestroyka. A significant number of political officers are disoriented in its present diversity and contradictoriness and in the global shifts of spiritual life. In fighting for themselves, the most unprepared fight against everything that seems to them personally dangerous and they thereby provoke attacks on political entities. Political officers have to be more self-controlled and not panic in response to every statement by informals. It is necessary to understand that optimization of the "collective-aircraft-environment" system depends largely on the role and place in it specifically of the political officer.

The significance of the aviation physician as an anthropologist who has to recall the name of his specialization—psychophysiologist—is growing. It is a question of researching, considering and influencing such complex phenomena as public opinion, collective self-awareness, group interest, value orientations, behavioral motivation, and social aim. A tie-in of instincts and habits of collective behavior with social awareness occurs in the latter. It seems obvious to me that specialized subunits should be created which could deal with working out conceptual solutions to problems. Pioneer work to optimize the system is best done directly during flight tests of aircraft and during studies of their employment tactics. But direct work in the air regiment, including in the "collective-aircraft-environment" system, remains the chief content of functions of the service of the human factor. It cannot be forgotten that aircraft are crew-served weapons.

But there also is a system where man is the leading link in production of combat-effective aircraft. It is a more general system, absorbing all others. To ignore it or try to be outside the system means to criminally ignore the service of the human factor. A powerful and ramified hierarchy of group interests that preserves the sector's crisis has formed at the boundary between the interests of industry and of the USSR Ministry of Defense. The name "military-industrial complex" has stuck to it of late. The essence lies not in the name, however, but in a phenomenon which for now cannot be revealed by anything. Proceeding from the man and the collective, the service of the human factor could do this more effectively than any other tool.

Flight Safety Management Procedures Recommended

91UM0064F Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 16-18

[Conclusion of article by Major General of Aviation (Reserve) A. Bystrov under rubric "Flight Safety: Experience, Analysis, Problems": "Concept of Preventing Air Mishaps: Theory and Practice"; beginning of article in No 7, 90]

[Text] The concept of preventing air mishaps developed by the Flight Safety Service is based on fundamental principles formulated by the best world scientists working in the sphere of safety management. There are several of these principles.

The first is an accident resulting from the effects of a number of factors, the sum total of which leads to it. In investigating an accident efforts must be directed not at searching for a culprit and not at what was done incorrectly by the people who got into trouble, but at what is incorrect in the management system, in organization, in the technological process and in production activity.

The second consists of dangerous actions, conditions and circumstances, i.e., the direct causes of the accident. If we investigate only at the level of the symptoms, then we will direct efforts at eliminating particular factors and will allow the causes themselves to remain unchanged, which again will lead to an accident or some other error in work.

The third consists of fundamental causes of accidents. At the same time they also are the result of many unresolved management and labor problems. Accident prevention methods are similar to methods of controlling the quality, cost and quantity of products.

The fourth is the capability of forecasting accidents and taking timely steps to prevent them. Safety has to be managed like any other activity. It exists objectively and must be recognized officially as management's chief function. This relates not only to higher levels of leadership, but also to all management echelons.

The fifth is management of actions which are fixed by accountability.

The leader who does not maintain accountability, who does not assume responsibility for work safety and who acts according to the rule of the plan above all, the plan at any cost, is doomed to failure in aviation. Safety criteria ranked for each level of structural subunits must be developed for this.

Foreign experience indicates that these principles applied in practice permitted a sharp decrease in accidents on all means of transportation. Several dozen air catastrophes and accidents were prevented and the lives of thousands of passengers were saved in U.S. civil aviation over the last 15 years by means of specially developed flight safety programs. I say this in order to generate faith also in our Concept in everyone directly connected with flight activities and their support.

But having even a very good Flight Safety Concept is still far from enough to reliably prevent the air mishaps themselves. The Concept above all is a set of views on solving the problem, and in our case on preventing accidents. If scientifically grounded programs and subprograms of practical actions needed for the job are not drawn up and introduced on its basis and the necessary material and financial support is not found, then the Concept of preventing air mishaps will remain only a set of rather good slogans, appeals and good intentions, and no more.

This is why I would like to share thoughts on how to materialize our set of views, put its provisions in motion and force them to function with growing effect.

Unusual approaches to solving the problem and new methods of work to prevent air mishaps probably are needed above all. In my opinion, there can be the following directions of activity.

Continuous scientific support of practical work in the flight safety area. Science is the platform which will take safety to the necessary height. This requires sufficient material and financial support of programs and subprograms for preventing air mishaps; economy here is a source of colossal losses due to the air mishaps themselves. Then active economic and moral incentives for personnel to prevent them. Productive work should be encouraged appropriately. A revolutionary perestroyka of educational work also is needed. It should be done on the scientific basis of sociology and social psychology and be directed at a specific person and a specific military collective. But the most difficult question is how to accomplish and implement all this practically.

Initially it would appear advisable to analyze in detail the deficiencies presently hindering the work. We have the capabilities for this. Air Force scientific and intellectual potential has no equal among other branches of the USSR Armed Forces. Many military educational institutions have special chairs of flight safety and operation of combat air systems where many scientists work. Nevertheless, to this day scientific support of flight safety cannot hold up under any criticism, above all because it is not adapted to the needs of line units; those in turn see no great need for science, i.e., feedback has not been adjusted. The absence of a social need for ideas and for introducing the most valuable of them into practice led to where science does not have a decisive influence on the state of flight safety and scientists bear no responsibility at all for failures in this matter. Not only the process of searching for something new, but also of introducing what already existed was retarded. Here are a few examples.

The "catastrophe theory" developed by René Thom (France) has been actively applied throughout the world for over ten years, but scientists of our universities and research establishments still do not show proper interest in it. History attests that not one branch of the USSR Armed Forces originated in such difficult torment or functions under such rigid conditions of an acute shortage of people and of material and financial assets as our own military aviation. That situation is preserved to date. As a result, two persistent opinions formed among specialists. Some, who are far from aviation problems, believe that military aviation expends a very great deal of assets and it is possible still to reduce the already meager funds and even the number of personnel. Others (including major air commanders) have become convinced that it is useless to request additional assets: even so, they will not be given either people or money, and so they have to extricate themselves from the difficulties in whatever way they can.

There are grounds to assume that because of subjectively formed conditions, structural subunits of the Air Force (as a management system) do not have sufficient stability against the effect of risk factors in the process of functioning and so they often react to them spasmodically. As a rule, such a reaction develops into confused working in fits and starts. It would appear that it would be a great achievement of aviation science to research structural subunits and the Air Force as a whole as a system on the basis of "catastrophe theory" for stability and controllability under conditions of the effect of accident factors on them. To begin with it is advisable to count everything for this purpose if only for one line and one training regiment. I am sure that the results would force many officials to seriously ponder the problems which do not allow elevating flight safety to the necessary level or taking steps to remedy deficiencies.

Here is one other example. The theory of complex systems and their management is widely applied for organizing production processes. Combat aviation also is a very complex production and, moreover, it has specific features, but to this day there is no theory of military aviation "man-machine" (polyergic) systems or theory of managing them. Proposals to create them are rejected on insufficient grounds by a number of scientists and practical workers. As a result, military aviation essentially does not have a scientific organization and management of its activity.

The low level of knowledge or, rather, lack of desire of a certain category of officers in charge to master the theory and practice of scientific organization and management of military aviation production in their sector led to where the search for new subunit table of organization structures often was conducted by the trial-and-error method as well as the method of dubious experiments which do not provide substantial results. Science does not develop different models of the complex mechanisms for managing structural subunits and the Air Force as a whole in advance, for many years ahead, with consideration of prospects for development and combat employment of air arms; this does not permit organizing continuous scientific accompaniment of combat training and flight safety. The command-pressure method of leadership continues to shake loose the foundations of air unit flight safety and combat training.

The unjustifiably delayed implementation of the principle of operating air systems based on technical condition also can serve as proof that aviation science and practice are not in phase, as they say. Some 30 years ago people abroad boldly undertook a scientific experiment and then also adoption of this principle, first in civil aviation and then in military aviation. As a result there was a sharp increase in air fleet serviceability, a reduced number of catastrophes and mishaps, increased labor productivity of air specialists, and a multimillion-dollar saving in material and monetary assets.

Just what keeps us from doing this? Apparently inertia of thinking, adherence to stereotypes and, most important, the fear of "what if something happens?" Yes, it is high time to study world experience of operating and repairing air systems based on technical condition and take steps for its introduction. The important thing is an engineering analysis and forecast of the condition of systems, assemblies and equipment of each aircraft and helicopter for timely prevention of failures and air mishaps. Such an approach to matters will permit filling the work practice of line units, research establishments and universities with qualitatively new content.

Structural subunits will be manned with the necessary number of engineering cadres, the professional level of technical personnel will rise, and automated management systems and personal computers will find wide use. One can assume that scientists also will substantiate the transition of regiments' technical maintenance units to preventive maintenance of air systems based on technical condition. In this case an anachronism such as performing periodic technical servicing based on accrued time or flying hours and calendar dates will fade into the past once and for all.

Air Force universities will receive a powerful impetus for further upgrading the organization and improving the quality of cadre training. Engineering schools will cease to put out broad-profile specialists and "half-finished" cadres and will shift to preparing true engineers based on orders of air arms. They will not have to be used in technical positions. The problem of over-production of air engineers thereby will be removed from the agenda. The interworking of line units with Ministry of the Aviation Industry design bureaus and enterprises will be qualitatively renewed and firm support of air system serviceability will become the practice. As a result everything enumerated above will permit achieving a world level of flight safety and improving the quality of aviation engineering support to Air Force unit combat training.

The unscientific nature of work to prevent air mishaps also lies in the fact that at all echelons of "air authority" preference is given to plans and not to scientifically substantiated forecasts of flight safety levels by combat training periods for specific air units. There also are no forecasts of the effect of risk factors on an air unit during different combat training phases and their influence on the accident rate, and antifactor recommendations are not being developed.

I fully agree with Lieutenant Colonel A. Zhilin's opinion ("On Accidents in the Clear," AVIATSIYA I KOSMONAVTIKA, No 6, 1990) to the effect that apparently it is impossible to regard as proper the use of the "flying hours per air mishap" criterion for evaluating the effectiveness of work by air units, formations and large strategic formations in questions of flight safety. It appears to me that this approach is tantamount to evaluating the quality of hospital treatment according to patients' average temperature. Obviously, new reliability indicators ranked according to levels of structural subunits—subunit, unit, formation, large strategic formation—as well as by types of aircraft should be developed for military aviation.

In our time science is becoming a very important productive force of society. It would appear advisable to accomplish scientific support of flight safety along two lines: performance of basic research and assurance of the regular adoption of applied developments made on the basis of basic research. Today it is a thorough study of the entire set of flight safety problems relying on the latest achievements of the science of production management and organization that has very great importance. We need a profound scientific analysis of the reality that has formed under the influence of objective and subjective factors. Studies must not be made to fit the order of "leaders" and should not be dependent on impressions which they will produce on high-ranking leaders. Instead of many years of conjuncture that mercilessly destroys aviation, we need the truth no matter how bitter it may be. Only then is it possible to correctly build the strategy and tactics for preventing air mishaps. Their continuous daily scientific support and introduction of applied developments to practice is proposed to be done as follows.

Interworking of research establishments and universities with line units is organized on a mutually advantageous basis. The line units themselves select the scientists and contract with them for scientific support of flight training safety. Within no later than six months higher staffs issue a state order in the form of basic tasks for the next year to air regiments and to service and support units, which study the tasks and calculate the personnel and equipment for accomplishing them. Scientists forecast the most likely accident factors and work out recommendations to weaken their influence or totally preclude them. As a result a flight safety forecast is issued for each regiment. This work ends two months before the beginning of the new training year.

In the time remaining the air units and the service and support units correct the state order, refine material-technical and financial expenditures, and prepare group and individual programs for preventing air mishaps.

During flight activities scientists must regularly analyze the degree of influence of accident factors on components of the "man-aircraft-environment" scheme and on the "man-aircraft" system; study how the flight safety forecast is being borne out; determine corrective measures; and update the forecast periodically. Feedback and flight safety level management thereby will form.

Experiment in Computer Use for Engine Diagnostics

91UM0064G Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 30-31

[Article by Captain V. Mayorov, under rubric "Attention, Aviation Engineering Service Specialists: Experience!": "The Computer Assists in Diagnostics"]

[Text] **Judging from foreign press materials, over half of air mishaps now are connected with power plant failures. Something of the sort probably also is occurring in our military aviation if we take into account that at times specialists have no opportunity to obtain objective information about engine operation and consequently they cannot always prevent the development of any kind of unpleasant trends. But a system of automated diagnostics and express analysis of the technical condition of power plants developed under troop conditions by Captain I. Ilyashenko and his colleagues permits performing preventive measures on a qualitatively new level.**

Into the 21st Century With a Pencil Behind the Ear?..

To begin with let's imagine a picture typical of an air regiment. After periodical technical servicing on an aircraft, engines are being tested at all power settings right up to afterburner. There is such a roar that the ground around is shaking. And how is it for aircraft maintenance unit specialists working next to the bomber?! Powered testing lasts about one and a half hours, no less, and this is if power plant parameters do not go beyond permissible limits. But if there is trouble, then confusion begins: an explanation of reasons, performance of adjustments, and again powered testing. What if the defect is not obvious? I believe even a nonspecialist understands how much energy, nerves, time and material resources will go into necessary procedures. And you will note that all this is to the detriment of quality.

Why does this process drag on so? Well because the working capacity of engines is monitored almost manually. Two specialists sit in the cockpit: one races the engines and the other monitors instrument readings, takes the pencil from behind his ear, as they say, and writes them down on a clipboard. Take into account here that some 20 parameters must be recorded at each power setting. In addition, there are several technicians near the aircraft, each of whom checks systems in his own specialty.

One could be reconciled with this antiquated method if the information obtained permitted performing an in-depth analysis of the condition of aircraft engines. But no! Not all necessary parameters are brought out to the pilots' instrument panels. Moreover, inaccuracies are possible in noting them visually, and there need be no mention of an evaluation of dynamic processes taking place in the power plants.

Add to this our traditional lack of coordination, where a fire engine, fuel tanker or airfield jet-engine starter do not arrive at the aircraft maintenance unit ramp for a long time. In short, specialists begin to prepare for powered testing in the morning and end it late in the evening. People naturally get tired of this muddle, become nervous, and their vigilance and composure drop. Moreover, the very process of accelerating engines is unsafe. In general, there is a heap of difficulties and problems.

From "Method" to System

Software was sent to the regiment from the manufacturing plant. It was for analyzing the operation of a turbocompressor at several power settings with manual collection and input of information to the computer. By the way, this is impossible to do in flight, and on the ground it is fraught with a large share of subjectivism in evaluating parameters. But the program had merits if only because it facilitated data processing. Nevertheless, this clearly was insufficient for diagnostics. It was necessary to automate the recording and processing of a maximum amount of data and it was desirable to combine in time the processes of testing engines and analyzing data being put out by the computer.

How could this be achieved? The unit's existing computer equipment did not allow accomplishing that task due to its fixed nature and limited main memory volume. In addition, the engine people were not computer specialists and performance monitoring group officers were not very familiar with features of power plant operation. That meant patchwork and errors were not precluded. Just what was the solution?

Captain I. Ilyashenko, chief of the engine periodic technical servicing and diagnostics group, saw it in development of new software. The factory program became a unique "method." Ivan Grigoryevich was assisted by Senior Lieutenant S. Balakin, a programmer by specialty. The first try was successful. The engineers were able to "look" more deeply into the engine.

Things got rolling. Why not, they thought, use the Partner personal home computer with an enormously greater main memory volume and a speed up to 500,000 operations per second for this purpose? Especially as there was one at the Air Force installation's youth leisure center. Lieutenant A. Burtsev altered "Balakin's" program and things got going. In its final form the system contained a device for automatic collection and recording of data on engine operation and a personal computer set for express analysis.

What is valuable is that parameters, both those brought to the pilots' instrument panels as well as those read from the engine's monitoring points, can be input to the system. Added to this was the following detail of no small importance: the system is easily accommodated both on a mobile maintenance monitor and at a standard fueling area.

The system's operating principle is rather simple. After interfacing it with the object, the technician starts the engine and after warm-up slowly transfers it from idle to maximum afterburner setting and back. The personal computer analyzes the collected data and outputs results to the display according to the appropriate algorithm. A simplified mathematical model of the engine is the basis of the software. Ambient air temperature, pressure in the test zone, and position of the engine controls are used as input parameters. A display of analysis results in graphic and tabular form considerably improve their perception.

To Moscow for a Computer

The ancient sages said that any idea is good when it is implemented. Ilyashenko's idea was not simple to realize for several reasons. First and foremost was the Air Force's poverty and an absence of computers. One solution remained—to request money from headquarters to purchase them, but in order to obtain cash, headquarters first had to be convinced of the need for financing and then the prospects of the matter had to be presented in an appropriate manner. Captain Ilyashenko and Lieutenant Burtsev wrote a paper, showed it to Colonel V. Fursa, an engineer from higher headquarters, and also gave a briefing at a scientific-technical conference. The assessment of Aviation Engineering Service heads was unequivocal: the work was very promising and necessary for line units.

When money was allocated to the officers, they dashed to Moscow, where they purchased a personal computer with unbelievable difficulty. They continued research on their return. What they see is an analysis of the technical condition of engines which would include full processing of a film with recorded test parameters and dynamics of their change for the entire period of operation so that it would be possible to identify in advance the prefailure states of systems and machine units and also issue recommendations for optimum adjustments.

What Is Received in the Output?

Use of this system provides the following advantages. Time for powered testing of engines is cut almost threefold because of automatic data collection, permitting a significant saving on power plant life and fuel. One result is that environmental pollution is reduced, which presently is very important. The combining in time of processes of testing and obtaining specific results, the convenience of graphic analysis, as well as the collection of data on dynamic processes in engines permit more qualitative diagnostics of them. In short, expenditures for creating and introducing the system are incomparably small compared with that positive effect which it can provide.

But I would be sinning against the truth if I asserted that no problems remained for Ilyashenko and that the system is constantly functioning. For now, one can speak to a greater extent about an experiment and search, which is extremely complicated under troop conditions and with the strenuous rhythm of combat training. The results obtained are only the first step along the path to the goal, for difficulties do not lie just in purchasing computers. Someone has to work on them, but in this respect cadet training in engineering schools is insufficient and the positions of mathematical engineer and programming engineer are not provided in the engine periodic technical servicing and diagnostics group. Officers Balakin and Burtsev, graduates of the Moscow Power Engineering Institute, helped Ilyashenko generally on a friendly basis, but at the present time they already have been discharged to the reserve and Ivan Grigoryevich is trying to involve recently arrived graduates of civilian universities in the work. Evidently it would be advisable to prepare future engineers for this activity right from the cadet bench by granting them an opportunity to study its particular directions in diploma projects. This is a demand of the times.

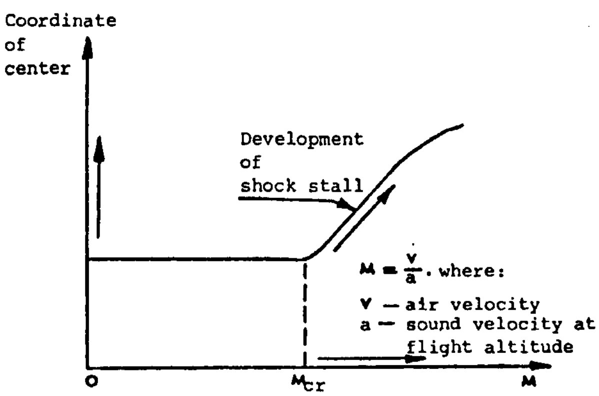
Importance of Knowing Critical Mach Number Stressed

91UM0064H Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) p 33

[Unattributed article under rubric "Practical Aviation Work": "The Critical Mach Number: What Does It Mean?"]

[Text] Those who have a keen interest in the history of aviation cannot help but know that the reason test pilot G. Bakhchivandzhi died in the BI-2 aircraft in 1942 was that he exceeded the critical Mach number (M_{cr}) in flight. Every pilot is obligated to know the chart in the diagram and the precise meaning of this curve for an aircraft being flown.

M_{cr} is understood to mean the Mach number of an undisturbed flow in which local velocity at the wing's



Position of longitudinal aerodynamic center as a function of the Mach number of flight

surface becomes equal to local sound velocity. Further acceleration of the air leads to so-called shock stall—the appearance of supersonic flow-around zones, an increase in drag, and a backward shift in the aerodynamic center, which sharply disturbs the aircraft's moment characteristics.

The significance of this number depends on the air suction peak value and is characterized by the Khristianovich curve. For example, the thicker the wing section, the greater the pressure differential and the less the speed at which M_{cr} is reached.

This also relates fully to the angle of incidence. With an increase in this angle the air suction peak on the upper part of the wing increases and the supersonic zone arises at an ever lesser flight speed. The difference between M_{cr} at small and large angles of incidence can reach 0.15-0.25.

The speed of the beginning of shock stall drops with increased altitude of level flight, since an increased angle of incidence is required to maintain constancy of lift as air density decreases. This is also facilitated by a decrease in sound velocity with altitude, leading to an increase in the Mach number when flying at constant speed. And while M_{cr} corresponds to 0.8 for an aircraft in level flight near the ground, at high altitudes it can be under 0.6.

Thus the beginning of the appearance of shock stall on the wing is characterized by inconstancy. Then just what is the M_{cr} of an aircraft's flight and what practical meaning is contained in its digital value which the pilot has to know?

Hypothesis of the Existence, Disappearance of Atlantis Presented

91UM0064I Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 42-43

[Conclusion of article by A. Voytsekhovskiy, candidate of technical sciences, under rubric "Hypotheses and Forecasts": "Space and Atlantis"; beginning of article in No 7, 1990]

[Text] In analyzing the nature of changes occurring during Earth's closing with Halley's comet, one can discover that this functional relationship is depicted graphically in the form of a unique oscillatory process, the amplitude of which varies by "beats" (see Fig. 1). In other words, the oscillatory process is characterized by the presence of so-called "crests" and "troughs" (see Fig. 2), which most likely is the result of the chaotic (random) change in orbital parameters of Halley's comet noted by Soviet scientist B. Chirikov.

Fig. 1. "Beat" type oscillatory process

At points in time of realization of the "crests," whose repetition period is around 1,770 years, Halley's comet passes closest (almost next) to the Earth. The last such mutual disposition happened in the year 837, when the distance between the two heavenly bodies was only six million kilometers. Laying off from 837 (left along the

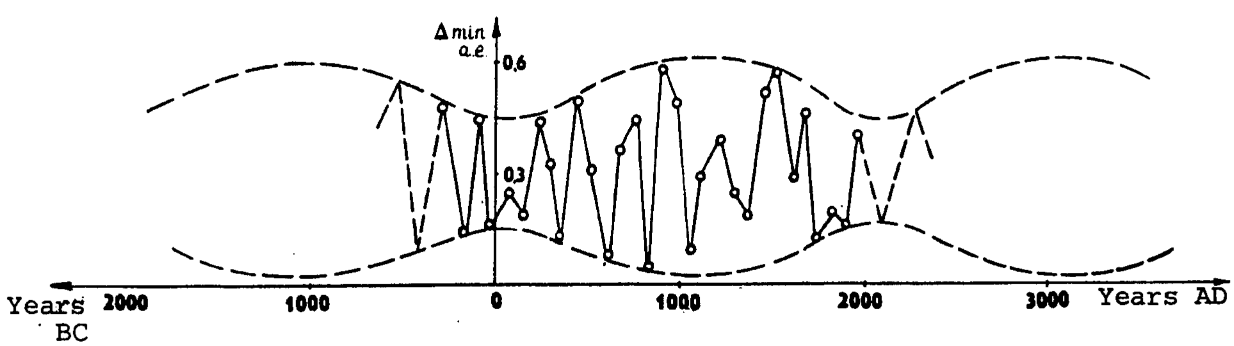


Fig. 2. Functional relationship over time of distances ($_{min}$) between Halley's comet and Earth

time scale) seven periods of 1,770 years each, i.e., the time interval between two adjacent "crests," we will obtain the year 11553 BC (see Fig. 3). Is this not a close coincidence with the "fatal" year of 11542 BC already known to us, i.e., the time of one of the passes of Halley's comet near the Earth?

And so let us assume that 13,500 years ago the comet's "shock wave" brought down a catastrophic blow on the Earth which was the reason for a global cataclysm and remained in the memory of our distant ancestors. The circumstance that the chemical composition of the Tunguska meteorite and Halley's comet is similar, as established by the Soviet Vega-1 and Vega-2 space stations, also fits rather well into the coffers of the version that has been advanced!

Here it is also apropos to cite the following fact. Greek seismologist A. Galanopus recently presented his own hypothesis in the Athenian Academy about the reason for the loss of Aegean culture at the end of the 11th millennium BC. He links this with increased seismic activity in the Mediterranean area caused by passage near the Earth... of Halley's comet. Developing this supposition, Greek Academician I. Hantakis does not preclude the possibility of a change in climatic conditions and an increased level of radiation due to a breakdown (disruption) of the Earth's ozone layer. This, the scientist believes, can explain the fact of depopulation of such areas in Greece as Messenia, Lakonia and Achaea, which were densely settled in ancient times.

Let us turn attention to the fact that a "crest" in the aforementioned "beats" again corresponds to this point in time. Consequently, one of the minimum distances between Earth and Halley's comet occurred in this case as well.

The reason for ancient inhabitants' unaccountable fear of cosmic newcomers becomes understandable to some extent. Apparently it was not without purpose that they were regarded as ominous omens of the sky that preceded various natural disasters which considerably surpassed the Tunguska catastrophe of 1908 in power and consequences.

We will cite another example of the "unsafe" appearance of Halley's comet for earthlings. Scientists have established that in the 9th century AD the flourishing lands of people of the Mayan tribe were suddenly befallen by some kind of serious catastrophe. In particular, many cities were simultaneously demolished as if by a gigantic blow. We will note the following circumstance: the last minimum convergence of Earth and Halley's comet took place in 837. They "missed each other" at a distance of only six million kilometers. Was that not why all Mayan life subsequently was marked by the expectation of a repetition of the misfortune that had befallen them?

An analysis of contemporary data about real catastrophes of the past gives grounds to believe that the dimensions of cosmic bodies and areas of destruction which can be caused by them on the Earth's surface are directly related.

The hypothesis of our planet's collision with space bodies in the past can explain a great deal. Modern scientific methods have established that the last glacial period in Europe ended around 12,000 years ago. Penetration of warm Gulf Stream waters into the Northern Arctic Basin also dates back to that same time. According to suppositions of some scientists, the catastrophe we are considering occurred near the Bahama Islands. Our planet shuddered with a powerful earthquake and was displaced from orbit. The geographic poles displaced 30° in the direction of the effect of an external force. The Earth's equator also changed its position accordingly. Masses of component parts of the celestial body that broke up were so considerable that they penetrated the relatively thin oceanic crust like cosmic bombs. There was a series of grandiose explosions. Red-hot protuberances of magma that mixed with waters of the Atlantic soared upward in fiery fountains. Millions of tons of terrestrial rock were thrown into the air. The dust and steam that formed shrouded the planet for many years. A wave of water several kilometers high rose from the impacts, rolled over islands and came down on the shores of continents surrounding the Atlantic Ocean. Dense forests, cultivated fields and flourishing cities of coastal civilizations disappeared from the face of the Earth, washed away by the watery elements.

Paleomagnetic studies of our days show that the geomagnetic field changes polarity from time to time. Such "reversals of polarity" have occurred more than 170 times over the last 76 million years, the last one 730,000 years ago. As has been established, each process of magnetic field reversal lasts around 20,000 years. It is noteworthy that abrupt discontinuities in evolution of the biosphere occur at this time, judging from the fossil remains of animals and plants: some species of animals disappear, giving way to others. It is fully likely that these discontinuities are caused by a weakening by severalfold and even the total disappearance of the

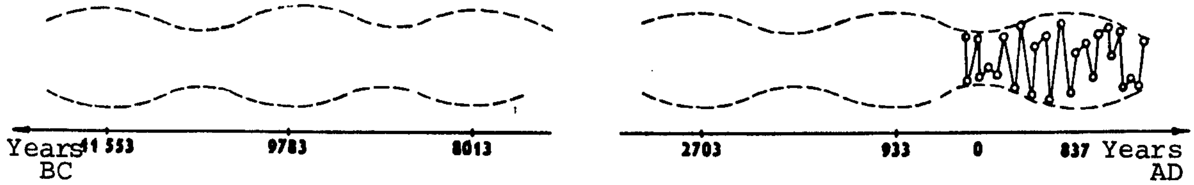


Fig. 3. Approximate dates of minimum approaches of Halley's comet and the Earth

protective shield of our planet's magnetic field. Cosmic corpuscular radiation reaches the Earth's surface unhindered and obviously has a disastrous effect on living organisms. This period also is characterized by increased tectonic activity exceeding conventional activity by tens and hundreds of times.

Specialists' attention also has been drawn lately to a phenomenon in the time structure of the terrestrial magnetic field such as "excursions" (or "episodes"). Initially they were considered nothing more than errors in paleomagnetic data, but with the accumulation of data it turned out that this is a real phenomenon repeated many times in the Earth's history. There occurs an abrupt, essentially "instantaneous" change of a field right down to a change in its polarity in a geologically brief time of around 10,000 years, but after a certain period the magnetic field returned to the initial state, i.e., the "reversal of polarity" did not persist.

"Interesting," the reader will say, "but still, what does Atlantis have to do with this?" As attested by the "span" of the paleomagnetic scale during the current million years, the whole point is that the very last "excursion" in Earth history occurred quite recently, around 10,000-12,000 years ago. This "episode" fully conforms to the aforementioned time of the presumed loss of Atlantis.

Well, whether or not Atlantis existed is a debatable question, but contemporary data indicate that it might have, because it could have disappeared...

The secret of the black oval stones discovered in the environs of the Peruvian city of Ica has excited researchers for over 20 years. The finely etched figures on them are bewildering. Judge for yourselves. Physicians making a heart transplant operation. Teachers using a telescope to explain some kind of cosmic phenomena to pupils. A prehistoric map of the world on whose "stone pages" Africa, Europe, Australia and Lemuria are visible. Atlantis and the even more legendary country of Mu are depicted on one of them next to both Americas!

Peruvian scientist Javier Cabrera gathered and studied 16,000 such tables, which gave him grounds to announce the find of a unique prehistoric library in whose "stone books" all mankind's history was engraved. The age of the pictures is determined by specialists at more than 10,000 years. There has been an attempt to explain their great concentration in one place as a deliberate step by representatives of an ancient Peruvian culture who decided to leave a memory of themselves, but who were destroyed as a result of a gigantic catastrophe. And they had a presentiment of its approach. In this case it is a question of a highly developed civilization unknown to us for now. "This is that same Atlantis," asserts Cabrera, "the dim recollections of which have remained with the ancient Egyptian priests and were told to the world by Plato." In the opinion of many scientists, the Cabrera stones are no more than an "archaeological forgery," although some researchers believe that there are genuine antiquities in this vast collection, but their secret has not yet been revealed.

And one more circumstance of no small importance. Bulgarian mathematician I. Ivanov recently presented a theory that examines periodic changes in the Earth's external shape. In Ivanov's opinion, they have a direct effect on the structure of the crust and continental drift, are the reason for strong earthquakes and so on. The essence of the scientist's conclusions is that as a result of precession, i.e., a change in inclination of the Earth's axis of rotation, molten masses inside it (particularly the core) shift toward the Southern, then the Northern Hemisphere. The periodicity of this process is 26,000 years. The axis of rotation now is inclined so that when it is winter in the Northern Hemisphere the core is moved away from the Sun and the entire planet as a whole is closer to the daytime luminary at this time.

In connection with this, the Sun's attraction displaces matter within the planet toward its Southern Hemisphere in winter and toward the Northern Hemisphere in summer. But in summer the Earth is farther from the luminary and its attraction at this time is somewhat weaker. As a result, more molten mass remains in the Southern Hemisphere, and so our planet has a somewhat pear-shaped form with a broader lower half.

The most interesting thing for us is the surprising fact indicating that the inclination of the axis was opposite the present inclination 13,000 years ago. In other words, considerable masses of interior matter were in the Northern Hemisphere. Consequently, the "deformations" connected with this circumstance and consequences of a geophysical and geological nature determined by them again occurred in the period of the presumed loss of Atlantis. Such a thing could occur during the fly-by of Halley's comet (11,500 BC) and our planet's collision with one of the gigantic meteors accompanying the comet.

What is this? Chance or a strange coincidence? But as we have seen, are there not a great many of them that fall in the ill-fated period of the middle of the 12th millennium BC?

No! Everything said can attest only to one thing: the loss of Atlantis occurred from an adverse combination of several improbable and therefore unforeseen circumstances. Well, new data and materials obtained by various researchers in recent years with consideration of a standard approach permit taking quite a different look at the phenomenon of Atlantis today than we did yesterday.

Maj Gen Avn Leonov on Soviet Lunar Program Details

91UM0064J Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 44-45

[Interview of Major General of Aviation Aleksey Arkhipovich Leonov, USSR Pilot-Cosmonaut, Twice-Honored HSU, by Major I. Kuznetsov under rubric "Our Interview Guest": "The Flight That Did Not Occur"; uncaptioned photograph of Major General of Aviation Leonov included]

[Text] ***Major General of Aviation A. Leonov, USSR Pilot-Cosmonaut, Twice-Honored HSU, tells about the Soviet lunar program and contemporary problems of cosmonautics.***

[Kuznetsov] Aleksey Arkhipovich, the journal's readers are interested in "gaps" in the history of Soviet cosmonautics. One of them is our manned lunar program, in which you had occasion to participate. Share your recollections.

[Leonov] The Soviet manned lunar program envisaged two stages: the first was a flyby of the Moon and the second was a manned landing on the Moon, and its technical director was Hero of Socialist Labor Vasiliy Pavlovich Mishin.

The first stage in the mid-1960's—that was when Center specialists joined in fulfilling it—was viewed realistically: the Proton booster rocket already was flying and the Soyuz craft, named L-1 in the lunar version, was being materialized in metal. The second was problematical, but we believed that it would be carried out. Back before the decision was made on realizing the lunar program, Sergey Pavlovich Korolev told us about the powerful N-1 booster and L-3 craft which his collective was working to create. At that time we thought that the lunar program was designed for many years. We argued about projects for creating lunar settlements and flights to planets of the solar system. All this was so, but life showed that our dreams outstripped real events.

The booster intended for accomplishing the lunar flyby program had been made and had given a good account of itself, but the first launch of the Zond—that was the name of the L-1 craft in the automatic version—was unsuccessful. Why? A booster module (the D unit) was placed on the Proton to reach parabolic velocity, but the switching of commands was confused in it and it decelerated instead of accelerating. The craft had to be liquidated. This was the first alarm signal. The next launch went normally, but later there again was a booster malfunction. After functioning for several seconds, it fell not far from the launch site. It turned out that a rubber plug had fallen into the manifold ahead of the turbopump assembly. Having gotten stuck in the line, it cut off the fuel feed. Subsequently serious troubles leading to flight disruptions were repeated every other time.

It was learned in 1968 that we would not perform this mission before the Americans. One reason was the absence of proper financing and an incorrect distribution of assets.

[Kuznetsov] You said that main efforts were aimed at realizing the L-1 program. How did the cosmonauts prepare for it?

[Leonov] A total of some 20 persons prepared for the lunar program. The first crews consisting of Leonov and Makarov and of Bykovskiy and Rukavishnikov were made up from them. Believing in the feasibility of the set goals, the entire group began work actively, since each one thought that with a successful flyby of the Moon he automatically would go over to the next stage for the L-3. Therefore training also proceeded with promise. We mastered many simulators, including a dynamic simulator created on the basis of a helicopter, and went through test pilot school at the Flying Research Institute. Realizing that the lunar landing was the most difficult element, we learned the ability to choose a site in a short time, land the craft with limited fuel reserves, and instantaneously evaluate vertical velocity.

The landing approach on the return from the Moon was to have been from the direction of the Antarctic. We even flew in Somalia in order to have a good knowledge of constellations near the Southern Cross. The craft had a star-tracker and sextant for autonomous navigation, and the cosmonauts devoted much time to studying these instruments. In the final account everyone learned to work with full understanding of the dynamics of a lunar flyby.

To practice a landing on Earth at parabolic velocity, specialists developed a precise, detailed methodology with two entries. We had to learn to choose the angle of entry after the last correction using the star-tracker and sextant. It depended on the magnitude and direction of the deceleration pulse. It was possible to "bury" oneself in the atmosphere with a large angle and to "slip through" it with a small angle. The optimum version was an entry with a "pop-up": enter, exit the atmosphere after extinguishing great speed, and reenter, already knowing the angle of incidence at which the craft had to be held in order to get to the calculated landing point. The "manual pulse input" instrument highlighted the number of pulses after passage of the first sector. From them we figured the distance to the calculated landing point, then converted distance into angle of incidence. All these operations were rehearsed on the "Volchok" dynamic simulator. As a result we learned to make a "landing" with an accuracy to on kilometer. After taking tests on craft design and flight program, the cosmonauts were ready to fly around the Moon.

The flight would be difficult even from a purely everyday aspect, since the L-1 did not have an orbital module as did the Soyuz, and two persons had to be in the descent module for a week. We followed the last unmanned flight with hope, but when the frontal shield was fired off, the command also was sent to fire the parachute system. The craft was flattened after falling to Earth. It was curious that part of the film which it delivered was preserved. This allowed us to be first to obtain beautiful, exceptionally precise photographs of Earth from the direction of the Moon.

The Americans flew around the Moon in Apollo 8 in December 1968 and our leaders shivered: "Do we have to do this now?" General Designer Mishin nevertheless got to conduct one more test flight in an automatic version, and again a failure: a disturbance of the flight configuration led to depressurization of the body. We will add to this that all three launches of the N-1 booster rocket during flight-design tests were unsuccessful. After soberly assessing the situation, the government shut down the program connected with a manned lunar landing.

[Kuznetsov] Aleksey Arkhipovich, did our plan differ from the American plan?

[Leonov] Our lunar lander was similar to the American one, and the flight schemes, as Kondratyuk had foreseen them, did not differ at all. The craft had to enter a base circumlunar orbit, and a capsule would separate from it which would make a soft landing on the Moon. True, in contrast to the American one, the capsule was to hold one person, but actions on the Moon and the return to Earth coincided fully.

I will remind you that the Soviet Union was performing parallel research of the Moon with automatic satellites. They gave us interesting data, even more complete than the Americans had at that time, but there also was one other distinction.

The accident on Apollo 13 connected with the explosion of a fuel cell demonstrated the very flexible thinking of U.S. leaders. By telling about everything honestly, they were able to unite the entire nation in those days. Literally all America followed this flight, suffered it, and suggested and thought how to save the crew. But our out-of-the-ordinary situations always were concealed in an attempt to prove the superiority of Soviet equipment. As a matter of fact, there were enormously more of them than the Americans had, but the people were not told about this. Therefore many got the impression that mastery of space was a rather simple matter and that upkeep of cosmonauts was costing the state dearly and was economically inexpedient.

[Kuznetsov] How did you follow the progress of the Americans' fulfillment of the Apollo program?

[Leonov] The entire world observed man's first landing on the Moon except for the Soviet Union and China. But with the exception of a maximum of a hundred persons who viewed the reports in one of the organizations, no one among Soviet citizens saw the launch of the craft and its landing on the Moon or the crew's actions. History appraised the merits of our ideologues Ponomarev and Suslov and the course along which they led the country. But the Americans have no false morality. In 1965 they gratefully received all our information on extravehicular activity and coordinated their program. While at first it was planned only to stick a hand out of the craft, subsequently they repeated my spacewalk and also used a handheld motor which permitted the astronaut somehow to control his body in space. Returning to the U.S. lunar program, I will say that there are no "gaps" in it for me. Moreover, I recorded the flights of Apollo 10 through 17 on video cassette.

[Kuznetsov] Did you see extraterrestrials on your films? UFO specialists assert that the first people on the Moon saw them and that extraterrestrials allegedly observed the astronauts. Is this true?

[Leonov] People fond of any sensations wrested a phrase from the astronauts' conversation and are building their fantasies on this. Clear communications were established with the Houston Flight Control Center after the Moon landing. The picture was being transmitted "there" and "back." On emerging from the craft, Neil Armstrong stepped to the ground very cautiously, then became bolder; his steps became more confident and he began to jump. I looked at these frames. James [sic] Aldrin said to him: "Look out, they're watching us." "They" in the sense of "Earth." He further advised not to violate instructions and to be more cautious. And in fact, after this Armstrong began to take normal steps. I told the ufologists this more than once: "Why are you speculating? This is in fact not so."

[Kuznetsov] We created the Buran space shuttle, it went through the first tests, but now some such as Academician Sagdeyev are saying that it is not necessary. What is your opinion?

[Leonov] We have the Mir program. If we wish to seriously receive dividends, it is necessary to return to Earth materials of the studies that have been conducted. The Soyuz craft can return a quantity of cargo that is small in volume and a maximum of 100-120 kg in weight. We plan to return tons. This can be done only by the Buran. In this connection it is impossible to agree with Academician Sagdeyev's opinion that the Buran in general has nothing to do in orbit. We need it as a component part of the Mir program's transportation system. Sagdeyev is wrong here.

And further, previously he was silent, but now he objects. It would be more ethical for his part to give an account for his subject matter: Why did the Phoboses, which he launched and into which great assets were placed, fail without having reached the target?

[Kuznetsov] Here we probably should touch on questions of improving the profitability of space?

[Leonov] Being an embodiment of foremost scientific-technical thinking, cosmonautics is really capable of enormously greater economic return. Having spent $25 billion on the lunar program, the Americans subsequently received a profit twice that by introducing new technologies and developments. Our situation is somewhat different, but through whose fault? Cosmonautics?

Back in the 1930's Academician Kapitsa posed a question before the Economic Council of the Council of People's Commissars: "What incentives for creative innovations are built into the Soviet system?" And he answered himself: "I see none." The situation has not changed since then. What projects didn't the economists substantiate to please the politicians? "Emancipation of peasants," "destruction of unpromising villages," "transfer of northern rivers" and others of sad memory. And to this day the economic mechanism has not been developed for stimulating enterprises' introduction of new kinds of products and technologies which, for example, now lie unclaimed in excess in the space sector. Hence the conversations about low profitability of space. But this is not the fault, but the misfortune of cosmonautics.

I remember how we were asked to monitor agricultural lands from space. In a 24-hour period we gave out a pile of data, but it differed from that which the State Committee for Statistics gives out by 25-30 percent, and they turned down our services. But we learned that many fields either were smaller than according to the data of the Agro-Industrial Committee, or they were not being used, or they were not taken into account at all. Results of mismanagement also are easily seen from space: trampled-down pastures, ruined rivers and reservoirs, and the polluted atmosphere of cities. We can tell, for example, about all the outrages which the Ministry of Land Reclamation and Water Resources committed on Soviet land. Much is being said now about Aral and Balkhash, but the fact is that cosmonauts were first to sound the alarm 15 years ago. I myself went to Pelshe, chairman of the Party Control Commission of the CPSU Central Committee, and told him what was being done on the Baykal-Amur Railroad and Sea of Aral. While they made certain other decisions on the Baykal-Amur Railroad at that time, they did not for Aral.

It seems our information is little needed by anyone. I personally believe that reproaches on this matter should be addressed to the economists above all, and the press must properly arrange the emphasis here. Rigid communications, both direct and feedback, is needed and then there also will be an economic effect.

[Kuznetsov] And the last question, which journal readers often ask: Do you believe that our contemporaries will be eyewitnesses to fulfillment of a Soviet lunar program?

[Leonov] Such a program is not envisaged before the year 2000. But beyond that, we will see.

Soviet, U.S. Extravehicular Activity Table

91UM0064K Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 8, Aug 90 (signed to press 18 Jul 90) pp 46-47

[Part One of article by G. Glabay under rubric "At the Readers' Request": "Outside the Craft"]

[Text] **After the publication of materials telling about the crews of Soviet and U.S. spacecraft (AVIATSIYA I KOSMONAVTIKA, Nos 2-4, 8, 9, 1989), the editors received many letters, including from foreign readers, in which they give thanks for the information and request a continuation of the story, this time about extravehicular activities [EVA] of cosmonauts in outer space and on the lunar surface.**

We are publishing material on this topic.

No	Cosmonaut, Country	Spacecraft, Orbital Station	Date, Time Outside	Basic Results
1.	A. Leonov, USSR	Voskhod II	18 March 1965, 12 min	World's first EVA by man. Distance from craft up to 5 m, belayed by tether, life support system autonomous.
2.	E. White, USA	Gemini 4	3 June 1965, 21 min	EVA by first American astronaut. Maneuvered in space using handheld jet device. Belaying and operation of life support system accomplished using a tether.
3.	E. Cernan, USA	Gemini 9	5 June 1966, 2 hr 08 min	Test of backpack device for autonomous movement and support of astronaut's vital activities in outer space. Had to give up testing the device due to fogging of the space suit visor, deterioration of radio communications with the craft and malfunction of the backpack device.
4.	M. Collins, USA	Gemini 10	19 July 1966, 35 min	Photography of ultraviolet emission of stars on the night side of the Earth through the craft's open hatch.

No	Cosmonaut, Country	Spacecraft, Orbital Station	Date, Time Outside	Basic Results
	Same as above	Same as above	20 July 1966, 38 min	Astronaut's EVA to remove two micrometeorite traps from Agena 8 rocket stage. EVA time reduced and experiments to test a tether and rehearse the methodology of rescuing astronauts postponed due to overexpenditure of fuel in executing spacecraft maneuvers. Lack of experience of working in weightlessness led to loss of camera and trap.
5.	R. Gordon, USA	Gemini 11	13 September 1966, 44 min; 14 September 1966, 2 hr 08 min	Using nylon tape, astronaut connected Gemini with Agena 11, thereby supporting the conduct of experiments to create artificial gravity with the spinning of two objects; performed scientific and technical experiments of photographing the Earth and stars.
6.	E. Aldrin, USA	Gemini 12	12 November 1966, 2 hr 29 min	With hatch open, astronaut removed two plates intended for study of substances contaminating the windows of the spacecraft cabin, then photographed the starry sky.
	Same as above	Same as above	13 November 1966, 2 hr 09 min	Spacecraft was connected with the Agena 12 rocket using a 30-meter line. During his work the astronaut used harnesses and foot restraints for the first time.
	Same as above	Same as above	14 November 1966, 59 min	Ultraviolet photography of stars and sunrise through open hatch, work with sextant.
7.	Ye. Khrunov, USSR	Soyuz IV-Soyuz V	16 January 1969, 37 min	Spacewalk and transfer from one craft to the other.
8.	A. Yeliseyev, USSR	Same as above	16 January 1969, 37 min	Same as above.
9.	R. Schweickart, USA	Apollo 9	6 March 1969, 47 min	Spacewalk and attachment of astronaut to lunar module platform, test of backpack life support system and new 7.6 m tether, photography of spacecraft main unit.
10.	D. Scott, USA	Same as above	6 March 1969, 46 min	Photography of lunar module and astronaut through open hatch, removal of backings with samples of individual materials from spacecraft body.
11.	N. Armstrong, USA	Apollo 11	21 July 1969, 2 hr 31 min	Armstrong and E. Aldrin after him were the first earthlings to set foot on the lunar surface. Study and photography of the lunar landscape, including cliffs and valleys. U.S. flag, television camera, laser reflector, and seismometer were set up on the Moon, and a roll of aluminum foil was unfolded to catch solar wind particles. Collected 22 kg of lunar soil samples.
12.	E. Aldrin, USA	Same as above	21 July 1969, 2 hr 14 min	Same as above.
13.	C. Conrad, USA	Apollo 12	19 and 20 November 1969, 4 hr 01 min and 3 hr 54 min	Two spacewalks. In the first the astronauts set up a set of ALSEP [Apollo Lunar Surface Experiment Package] instruments on the Moon: seismometer, magnetometer, ionization gauge, ion detector, and solar plasma particles spectrometer. During the second they removed a television camera from the Surveyor 3 spacecraft, part of the framework, and a clamp-scoop. Some 34 kg of lunar soil were collected. Together they covered around 1.5 km over the Moon.
14.	A. Bean, USA	Same as above	19 and 20 November 1969, 3 hr 31 min and 3 hr 54 min	Same as above.

No	Cosmonaut, Country	Spacecraft, Orbital Station	Date, Time Outside	Basic Results
15.	A. Shepard, USA	Apollo 14	5 and 6 February 1971, 4 hr 45 min and 4 hr 29 min	Two spacewalks. Astronauts set up a set of ALSEP instruments on the Moon, powered by the SNAP-27 radioisotope power unit. Manual two-wheeled cart used for the first time to carry equipment and rock samples (around 44 kg collected).
16.	E. Mitchell, USA	Same as above	5 and 6 February 1971, 4 hr 45 min and 4 hr 29 min	Same as above.
17.	D. Scott, USA	Apollo 15	30 July-2 August 1971, 27 min, 6 hr 33 min, 7 hr 12 min and 4 hr 50 min	Scott performed panoramic photography of the Moon through lunar module's open upper hatch. Three EVA's by Scott and J. Irwin on the surface. Moved over the Moon on four-wheeled electromobile (27 km covered). Astronauts set up scientific gear, including laser reflector, which closed a triangle of such reflectors set up by previous expeditions. More than 77 kg of rock and soil samples collected.
18.	J. Irwin, USA	Same as above	30 July-2 August 1971, 6 hr 33 min, 7 hr 12 min and 4 hr 50 min	Same as above.
19.	A. Worden, USA	Same as above	5 August 1971, 18 min	Worden's spacewalk on Moon-Earth route for removing exposed films from cameras of the SIM [Scientific Instrument Module] set and other scientific materials. Spacewalk procedure monitored by J. Irwin and photographed by spacecraft commander through open hatch.
20.	J. Young, USA	Apollo 16	21-24 April 1972, 7 hr 11 min, 7 hr 23 min and 5 hr 40 min	Three walks by Young and C. Duke on the lunar surface. Astronauts set up a camera on a tripod to conduct astronomical observations in the ultraviolet band, removed lunar rock samples from deep holes using an auger, performed an experiment with a magnetometer, and arranged active and passive seismographs. Collected more than 95 kg of samples and traveled some 27 km on the lunar rover.
21.	C. Duke, USA	Same as above	21-24 April 1972, 7 hr 11 min, 7 hr 23 min and 5 hr 40 min	Same as above.
22.	T. Mattingly, USA	Same as above	25 April 1972, 1 hr 24 min	Mattingly's spacewalk on Moon-Earth route for removing exposed films and other materials. Spacewalk process recorded on film by Duke.
23.	E. Cernan, USA	Apollo 17	11-15 December 1972, 7 hr 13 min, 7 hr 37 min and 7 hr 15 min	Three EVA's on the lunar surface by Cernan and H. Schmitt. Astronauts performed a number of experiments, including to measure heat flows from lunar interior, set up two gravimeters in addition to the set of ALSEP instruments, and traveled some 36 km on the lunar rover (the third during the time of the expeditions). Collected 110 kg of lunar rock samples, in the selection of which geologist Schmitt, the only scientist among astronauts who had been on the Moon, took part.
24.	H. Schmitt, USA	Same as above	11-15 December 1972, 7 hr 13 min, 7 hr 37 min and 7 hr 15 min	Same as above.

No	Cosmonaut, Country	Spacecraft, Orbital Station	Date, Time Outside	Basic Results
25.	R. Evans, USA	Same as above	17 December 1972, 1 hr 06 min	Evans' spacewalk on Moon-Earth route to remove exposed film cassettes from cameras included in the SIM set. Spacewalk process recorded by H. Schmitt on film through open hatch of the spacecraft cabin.
26.	P. Weitz, USA	Apollo-Skylab	25 May 1973, 1 hr 15 min; 19 June 1973, 1 hr 44 min	Three spacewalks by astronauts. Weitz' attempt to open jammed solar battery panel using cutters fastened on long handle failed. J. Kerwin belayed.
27.	C. Conrad, USA	Same as above	7 June 1973, 3 hr 30 min; 19 June 1973; 1 hr 44 min	Second walk, but this time by Conrad and J. Kerwin. Astronauts succeeded in remedying trouble. Station's power supply thereby restored.
28.	J. Kerwin, USA	Same as above	25 May 1973, 1 hr 15 min; 7 June 1973, 3 hr 30 min	During third spacewalk C. Conrad and P. Weitz removed exposed film cassettes from camera and repaired one of the telescope's solar battery panels.

(To be continued)

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