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The mission of the U. S. ARMY AVIATION DIGEST is to provide information of an operational or functional nature concerning safety and aircraft accident prevention, training, maintenance, operations, research and development, aviation medicine, and other related data.

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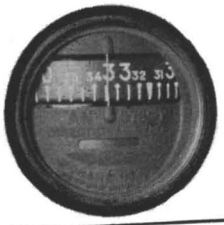


ON COURSE

Instrument Training

ANNUAL AWARD Monthly Winner CONTEST

Major Thomas R. Smith

UPDATED "on-course" instrument training for Army Aviators has been instituted at Fort Sill's Post Army Airfield. Training methods used here have been so astoundingly successful that we feel obligated to tell everyone about them!

It all began with AR 95-32, which requires instrument rated Army Aviators to fly 20 hours of actual or simulated instrument time annually. The majority of aviators perform this type of training in TD and TOE aircraft primarily because of the lack of adequately equipped synthetic trainers and trained instructor-operators. Ten hours of the annual requirement may be obtained in the synthetic trainer. Flight records indicate, however, that the average synthetic trainer time for each aviator is approximately 5 hours per year. Obviously, a problem exists. Let's take a look at it.

One probable reason for the lack of use is that the off-the-shelf 1-CA-1 instrument trainer presently in use by the Army is capable of simulating only a limited amount of instrument procedure since VOR, ADF, and ILS systems cannot be used simultaneously. Orientation problems, holding on a radio fix over a single-station radio aid, and normal one-station instrument approaches are about all the aviator can expect to accomplish.

The lack of realism in radio communications procedures and navigation aids leaves much to be desired and parallels actual flight conditions only in token fashion. A realistic radio system which looks, works, and sounds like those presently installed in Army aircraft is required if a synthetic device is to be used effectively for instrument training.

Simultaneous operation of the VOR receiver and ADF, or use

Proper use of the link reduces checkride failures

Maj Smith is an Instrument Flight Examiner and Aviation Training Officer at Fort Sill, Okla.

of the ILS localizer and glide-slope receivers, plus ADF is necessary when transitioning to the Locater Outer Marker for a full ILS approach. Changing communications frequencies from Center to approach control, to local tower control, to ground control is required of arrival aircraft. Standard Instrument Departures (SIDs), which employ many intersection combinations, are normally used on departures. Radar vectoring and 3-mile separation approaches are fast becoming standard for arrivals in terminal areas. "Dump zones" are now necessary for radar hand-offs between approach controllers and local tower control.

If all of this is required on an actual instrument mission, then the synthetic trainer, with equipment, should be able to simulate the same requirements. Ideally, the only difference in a simulated flight and an actual flight is the fact that the trainer never leaves the ground.

In recognizing these problems, the Synthetic Trainer Division, Army Aviation Section, Fort Sill, participated in a comprehensive program to improve their equipment, training methods, and operating procedures. Local Flying Regulations and Army Aviation SOP, U. S. Army Artillery and Missile Center, dated April 1962, were changed to require the following:

- Category I and II aviators will log at least 6 hours per quarter in the synthetic instrument trainer.

- Category III aviators (students at USAAMS and personnel on ground duty) will log at least 3 hours per quarter in the synthetic instrument trainer.

Since July 1962, each aviator at Fort Sill has been required to complete a refresher course before taking his instrument checkride. This course is conducted entirely in the synthetic trainer and emphasizes rules, regulations, and procedures. It is tailored to each individual's needs both in time and content. Upon completion of the refresher training, the applicant is given an instrument check in a synthetic trainer. When this checkride is successfully completed, the applicant is scheduled for his actual instrument checkride in an aircraft.

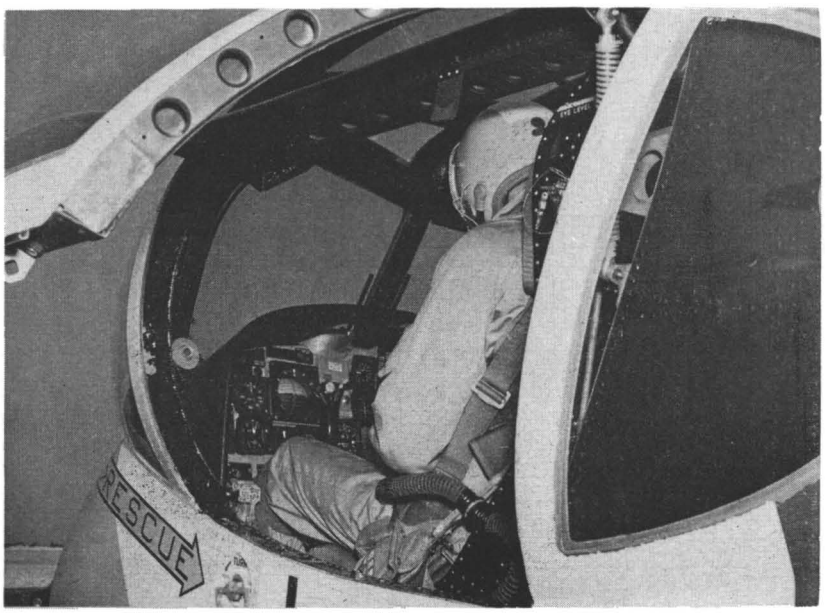
Results? You bet! Only two aviators have failed to pass the instrument check on the first go-around. We are sure this is due primarily to procedures and techniques learned in the updated 1-CA-1 trainer, since before the institution of the refresher course, one aviator in every three "busted" on the first try.

The refresher training program has increased synthetic trainer utilization as much as 340 percent over previous months' operations. The annual savings monetarily are incalculable—but high. Since buddy-riding is not necessary to log synthetic instrument time and aircraft are not required, a very real saving in time, effort, and material has been realized. Most important of all, the aircraft can be used for other missions.

New models of synthetic trainers are expensive, $25,000 and up, but the 1-CA-1 is fully operational and has been for more than 15 years. Parts are plentiful and available, and the unsurpassed technical know-how of depot area assistance personnel, highly trained for the 1-CA-1, is also readily available. Updating one 1-CA-1 to meet the modern Army training concept costs approximately $2,600 —which will be saved in the first year of operation.

The updating of our synthetic trainers at Fort Sill was accomplished by attaching standard aircraft radio navigation/com-

Link training ensures cockpit professionalism



munication equipment to the basic 1-CA-1 trainer (the Linn Automatic Training Aid Kit, built by Linn Electronics, Bethany, Okla.). The standard omni bearing selector ID-453 (three in one indicator ARC-IN-10) was installed in the instrument panel and coupled with the C81A ARC digital crystal-controlled navigation receiver tuning head. The standard C-1827 ARC-55 UHF communication tuning head with 1750 channels was installed within easy reach.

An electronically operated three-station VOR unit, three-station ADF unit, one ILS localizer selector, plus coupled glideslope receiver was placed in the overhead unit at the operator's desk. This permits simultaneous use of multistation fixes, thus reproducing in the synthetic trainer the actual flight conditions and instrumentation one would encounter on a normal instrument mission. In addition, instructors can operate two or more 1-CA-1 trainers simultaneously. It must be reemphasized that this kit is only attached and that the trainer can be returned to the original configuration in about 4 hours.

Pilot conditioning and training obtained through use of the special equipment has been valuable in assisting the Army Aviator to maintain instrument proficiency and in preparing him for his annual instrument card renewal. It quite deftly bridges the gap between standard 1-CA-1 trainers and actual instrument flight, since the pilot is using equipment with which he is already familiar and which operates the same as that in the aircraft.

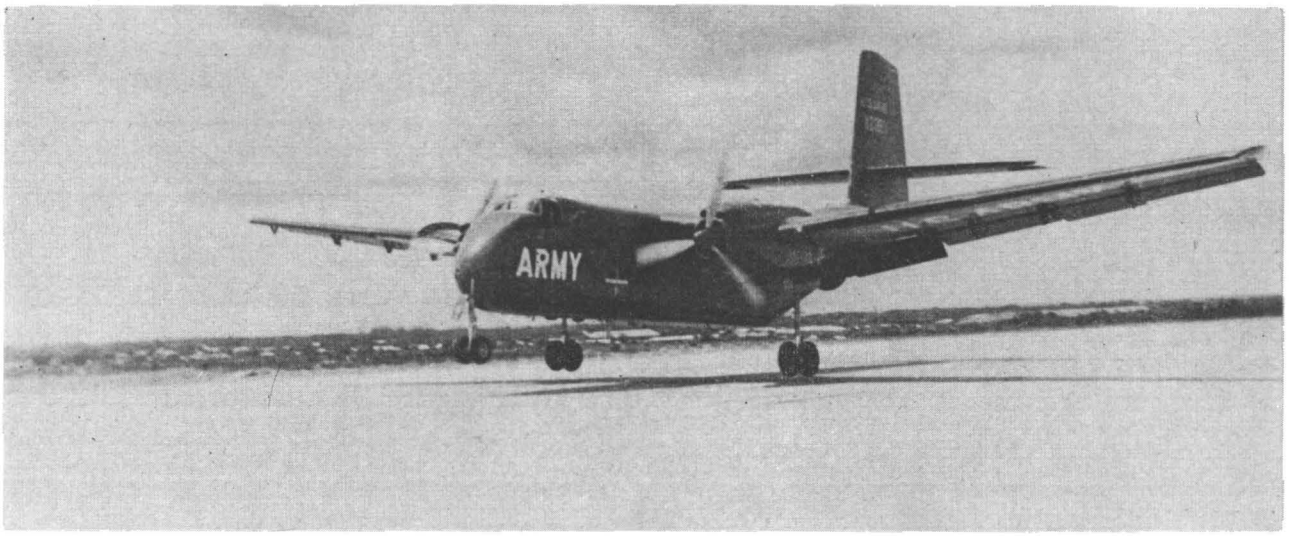
Local or sectional charts from any part of the world may be inserted under the plexiglass desk top, and appropriate navigation aids can be placed in operation within minutes. (A recorder speed reducer is used for local area charts.) An automatic glideslope receiver is paired with the localizer frequency and is unique in its operation, being linked with the trainer altimeter system electronically.

The pilot must have proper frequencies tuned or he will not receive navigation or communication facilities. Tuning and identification of radio navigational aids, appropriate en route position reporting, hand-offs from Air Traffic Control Center to approach control facilities and/or control towers, and transitioning from secondary fixes to approach fixes are now realistically simulated. Any six preselected frequencies may be used for an instrument problem in a given area. The control console serves from one to five trainers. In addition to its normal function, it is used for training junior and senior air traffic controllers.

Key personnel within the training section have attended the T-99 air traffic control course at the FAA Academy, Oklahoma City, and are current in the latest procedures for the control of air traffic. To have an effective training program, controllers must be well qualified. Close monitorship by instrument examiners enhances standardization and provides necessary quality control.

As sophisticated aircraft and equipment become a part of the Army inventory, we must accordingly think, train, and operate as professionals. The instrument rated Army Aviator must be precise, informed, current, and 100 percent up-to-date if he is to be effective in his role.

Correct instrument procedures become habit with repeated practice



SHERLOCK HOLMES AND...

THE CASE OF THE FALLEN BIRD

William H. Smith

"MY DEAR WATSON," Sherlock Holmes said, "a good cup of tea can be found almost anywhere in the world, even in an out-of-the-way place like the United States. You simply must know the customs of the natives. Now in America the men usually don't stop for tea, especially during the day, but the ladies do. So as soon as I saw the dining room of our hotel filled with ladies at tea time, I knew this was the place."

The minute we walked into the Willard Hotel dining room in Washington on this 17th day of September, 1908, my friend said that this was the proper place to have tea. So accustomed was I to his always being right in such matters that the very possibility of his being wrong had ceased to enter my mind. But I could not keep from expressing amazement at his so practical use of his reasoning powers.

Our trip to America had been sponsored by a group of avid readers who wanted to meet the great detective and hear him lecture on the art of observation and deduction. Our trip to Washington was simply to see the sights. It had taken all my persuasive powers to keep Holmes from returning to London on the next ship. He was the most perfect reasoning machine the world had ever known, and sight-seeing, to him, was not proper use of his precise and admirably balanced mind.

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As we sat drinking our tea, the expression of boredom suddenly left Holmes's face and he began staring at the entrance. As the door was to my back, it was necessary for me to turn around to see what had attracted his attention. There, standing in the open doorway, I saw a rather ill-kept and side-whiskered American Army officer. The gentleman was standing in the open door, apparently waiting for his eyes to become accustomed to the dim light of the dining room.

"That American officer," observed Holmes, "is looking for us. I wonder what he should want?"

"My dear Holmes," said I, "this is too much. How do you know he is looking for us? Why you have never seen or talked to the chap before."

"Elementary," he said. "Except for us there are only ladies present here, and that officer is in his dusty and dirty field uniform. Even in America, a member of the officer corps would not call upon a lady when so dressed, especially in a public place. It is obvious that something grievous has happened."

As if to prove my friend's point, the officer in question started across the room toward us, paying no attention to the commotion he was creating among the ladies.

Approaching our table he said, "Will you excuse this intrusion, but I was told that Mr. Holmes was in the dining room." All the time he was looking from one to the other of us as if uncertain which to address.

"I am he," my friend said. "This is Dr. Watson, my colleague, who is occasionally good enough to help in my cases. Whom have I the honor to address?"

"I am Captain Cox, U. S. Army Signal Corps, stationed at Fort Myer, Va. I have an urgent official request from the commanding officer of Fort Myer."

"Do sit down," Holmes said; "we can talk here."

"Sir, an accident occurred at Fort Myer this morning, with the result that 1st Lt Thomas Selfridge, a young officer under my command, died of head injuries and Mr. Orville Wright, the inventor of the flying machine, suffered major injuries. These two men were in a flying machine that fell. Tomorrow a board of officers meet to discuss the accident and the commanding officer would like to give them a report from a professional. Would you be so kind as to come with me to Fort Myer to observe the crashed flying machine and perhaps find just what happened?"

Without even waiting to finish his tea, Holmes rose from his chair and declared, "I would be delighted to look into the mystery of the crash."

Captain Cox had provided a hansom cab for the trip to Fort Myer. I enjoyed the ride very much, as it gave me the chance to see some of the country on the other side of the Potomac River. As we climbed the hill to Fort Myer proper we could see through the left window the beautiful old colonial home of General Robert E. Lee. To our rear was an excellent view of the city of Washington, dominated by the capitol building itself.

But Holmes was not interested in the sights. He was questioning Captain Cox about the accident, and I knew from experience that before we reached the crash scene he would have the full picture.

Apparently the Congress of the United States had appropriated a sum of money to be used in the purchase of flying machines for the Army. Three companies attempted to make a machine that would fly, but only the Wright Brothers were successful. They delivered a machine on the 20th day of August and had indeed made several flights before the unfortunate accident this morning.

"Were you present when the flying machine crashed?" Holmes asked.

"Yes, Mr. Holmes, I was."

"Then tell me just what happened."

"Mr. Wright invited Lieutenant Selfridge to ride as a passenger in the flying machine. Lieutenant Selfridge was one of the most widely informed experts on dynamics of the air and mechanical flight and was immensely interested in flying. On the fourth turn of the field a piece of one of the propellers flew off. The machine crashed to the ground like a falling bird."

"The flying machine," Holmes asked, "is it still where it fell?"

"Yes, it is. We had to move it a little to extract the two men, but other than that it is as it was."

"Guards?"

"Yes, sir! I put a guard on the wreckage with orders that nothing was to be touched."

"Kindly tell me, Captain Cox, just how the flying machine acted when it fell."

"It wavered, and then, twisting and turning, fell straight down."

"Thank you, Captain. You certainly are a model client." For the rest of the trip Holmes lapsed into silence, obviously thinking over the problem. For my part I could make nothing from the conversation. I had never seen a flying machine except for a sketch in the "Morning Post" and I did not even understand the principle of flight.

When we reached the scene of the crash, we got out and stood looking at the crushed bird. It was a flimsy looking thing, light metal and wood construction covered by heavy canvas. Amid the tangle was the motor and two propellers.

Holmes walked slowly around the flying machine. As he did so, his face became flushed and darkened. His brows drew into two hard, black lines.

My attention shifted from the flying machine to him. I watched my friend with the interest that sprang from the conviction that he had already discovered the cause of the accident and was now only looking for further proof.

Coming back to Captain Cox he asked if he had found the piece of propeller that had flown off.

"Yes, I have," the Captain answered. Picking up a small piece of wood from the wreckage, he gave it to Holmes.

Holmes took out his glass and examined the wood with obvious interest. He went over to the wreckage and peered intently first at one and then at the other propeller. He then walked around the flying machine in ever widening circles, looking carefully at every foot of ground. When he was some distance away from the machine, he slowly turned back and walked over to the guard and talked quietly to him.

I started toward them, but before I reached the pair I saw the guard hand Holmes something. Holmes looked at it with his glass for a second, nodded his head and hurried back toward us.

When my friend reached Captain Cox, he said, "This has been a case of considerable interest and thank you for asking me to investigate. You may drive us back to our hotel if you will."

"And when will you decide the cause of the accident?" Captain Cox asked.

"Oh, I have already decided," Holmes announced with great satisfaction. "I will tell you on the way back."

In a few minutes we had regained our cab and were comfortably settled. I could see that Captain Cox was anxiously awaiting the results of Holmes's investigation. So was I, as I could make nothing of the wreckage.

After a few minutes of silence, Holmes handed Captain Cox the two pieces of wood he had been holding—one Captain Cox had given him and the other the guard had given him.

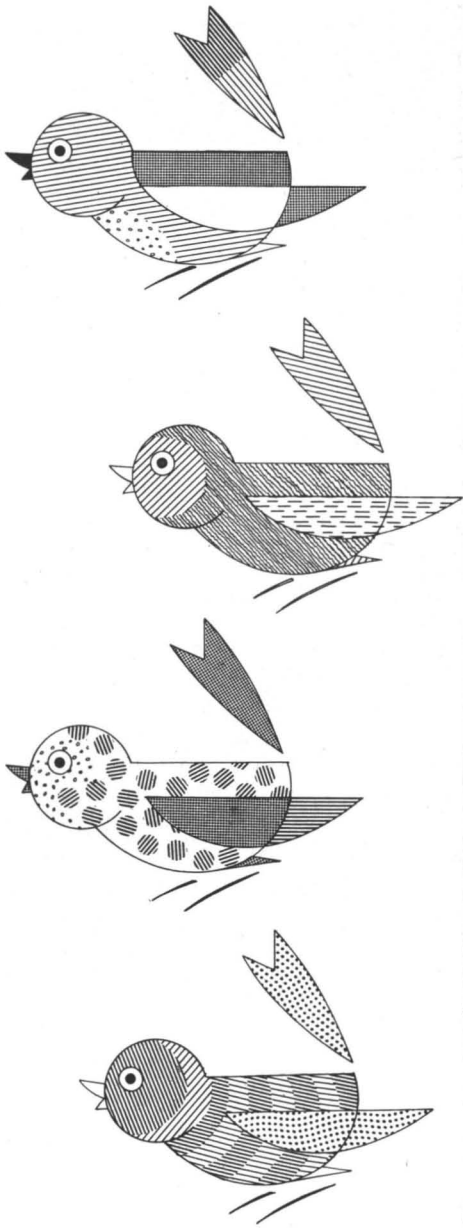
"The accident was caused by the breaking of a propeller blade and the loss of control from the failure of a brace wire running to the vertical tail.

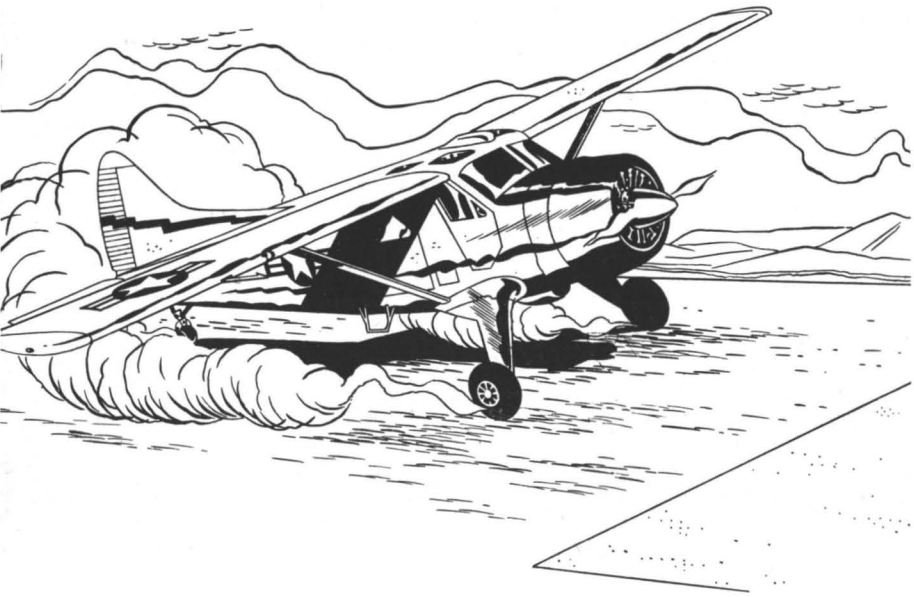
"First, the right hand propeller failed while turning and a fragment of wood flew off and hit the left propeller. This caused it to splinter and a piece of this propeller flew off and hit the brace wire, causing it to break.

"I determined this sequence of events by gouges in the broken section of the right propeller and corresponding gouges in the left propeller, which indicated, by the presence of smears of paint from the propeller blade on the brace wire, that the left hand propeller caused failure of the brace wire.

"Your guard performed his mission admirably. He kept all persons away from the wreckage. And when he picked up a small piece of wood as a souvenir for himself, he did us a further service. This splinter of wood was from the second propeller and was the key to solving the mystery."

Captain Cox was silent for a moment. Then he said, "Really, Mr. Holmes, I do not know how the Army can thank you. There is no doubt that this is exactly as it happened. Perhaps in our next machine we should strengthen the propellers and protect the control wires. I will report all you have said to the board tomorrow."





RUNWAY IMPRESSION FENCE

Major Harland Burroughs

FORTY-EIGHT accidents and three-quarters of a million dollars. That's what undershot landings at prepared airfields have cost the Army during the past five years.

Does anyone ever land short at your airfield? Check the overruns, or the areas off the ends of your runways, and chances are you'll be surprised at the number of tire marks you find.

The Air Force has come up with a novel, inexpensive, and workable solution for this problem—the runway impression fence. Now in use at many Air Force installations, the fence has cut short landings to almost zero.

The runway impression fence consists of two rows of individual stakes placed at 10-foot intervals. The rows are 6 feet apart and offset 5 feet to give the impression that the entire fence has depth and body.

Each stake consists of two sections—a frangible *styrofoam* portion which is visible above the ground and metal base plate and spikes for ground support. Each stake can be easily removed from its position at any time.

FENCE LOCATION

Optimum location of the fence for your particular runways can best be determined by the trial and error method. To do this, set the fence up and fly a few approaches over it. If the degree of slope doesn't fit your conditions, move the fence nearer or further away from the threshold and try it again. Have a ground observer record the height of your aircraft as it passes over the fence and the point of touchdown. It is recommended that a ground observer record at least 30 approaches. This will aid in making small adjustments—to find the final optimum location for the fence.

Average over-the-fence clearances will be approximately 8 feet. Most pilots will probably report that they thought the aircraft wheels would strike the fence during a good approach. Pilots who complain most are probably the ones you have saved from short landings.

Advantages of the runway impression fence over other landing aid systems are its simplicity, low cost, and ease of installation. All materials required for the fence can be acquired through your post engineer, with safety as the authority. Its greatest operational advantage lies in the fact that no concentration is required by the pilot which detracts from normal ap-

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Maj Burroughs is assigned to the Investigation and Prevention Division, USABAAR.

proach and landing procedures. It becomes effective only if he drops dangerously low on final approach. When the fence appears, corrective action is obvious, and pilot reaction is instinctive—CLEAR THE FENCE!

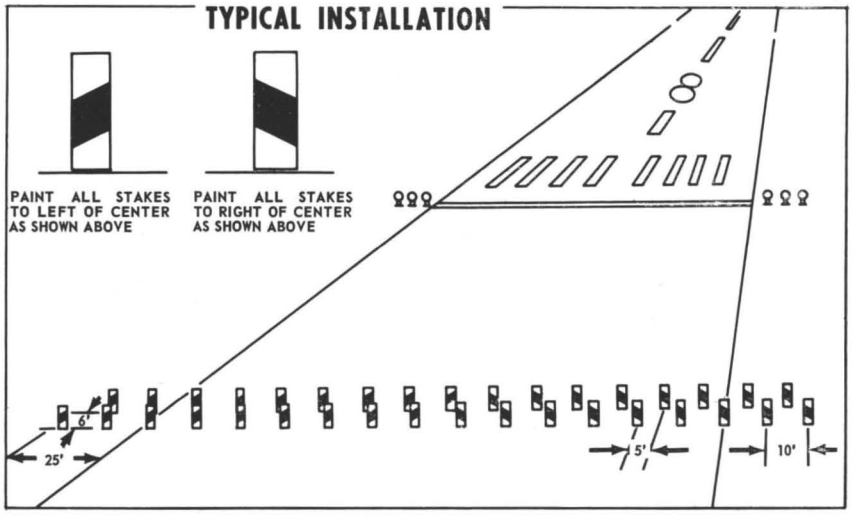
Material Specifications and Assembly Notes

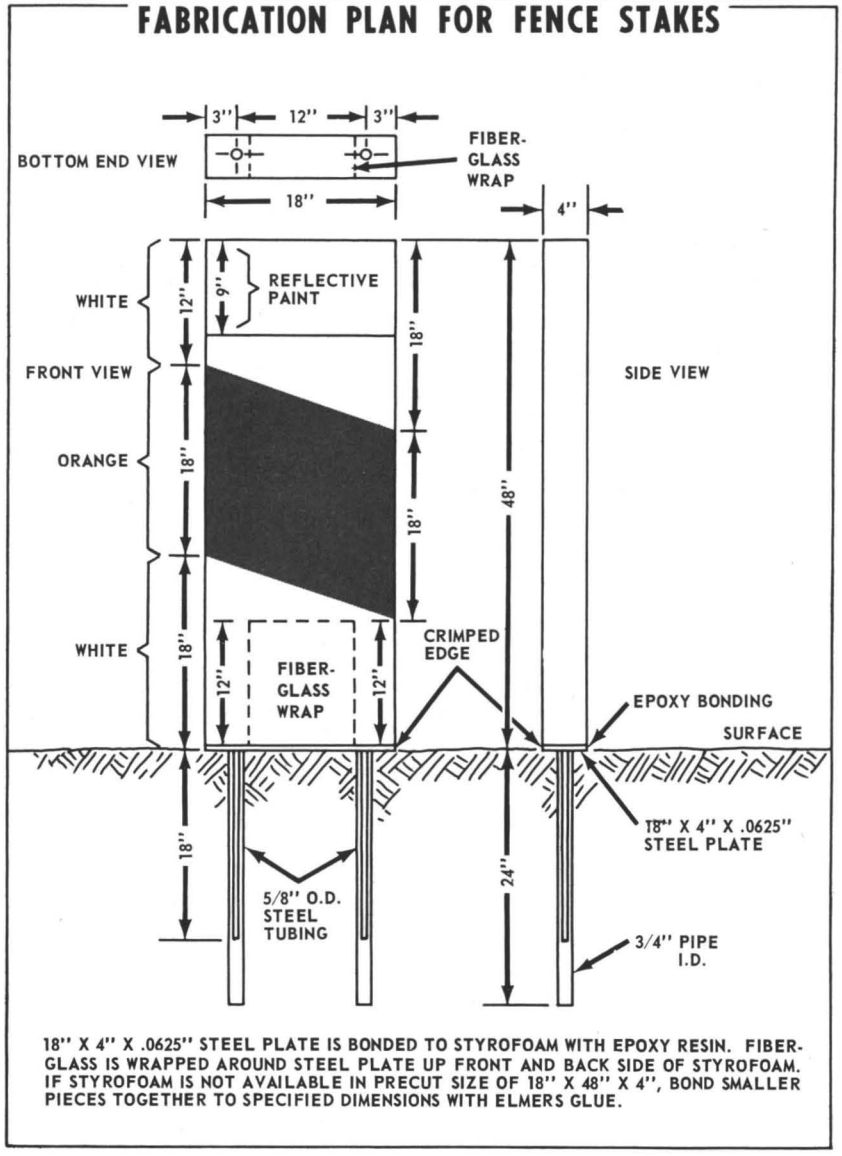
Materials:

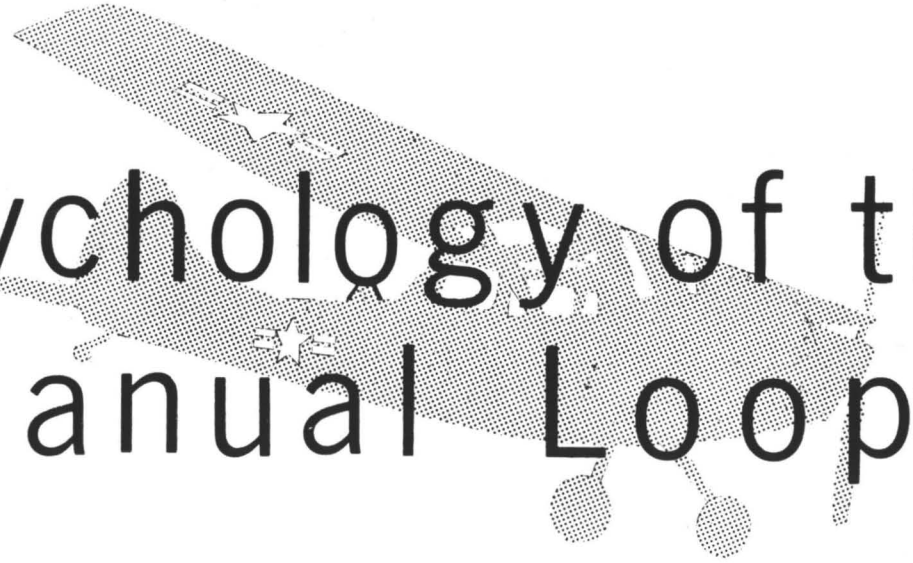
1. Epoxy resin, low temp. Mil A 8623A, Type 1, general purpose
2. Styrofoam sheet—18″ x 48″ x 4″, White. (No Mil Spec. Local purchase)
3. Elmer's glue—(No Mil Spec. Local purchase)
4. Chrome nickel steel sheet—18″ x 4″ x .0625″, FS #9615-288-6161
5. 5/8″ O.D. Chrome nickel steel tubing—18″ long, FS #4710-289-0398
6. ¾″ I.D. Chrome moly steel tubing—24″ long, FS #4710-203-7634
7. Fiberglass cloth—12 ounce, Mil G 1140, commercial
8. Liquid (Codit), white—FS #8010-576-2061, pressurized can
9. Corrosion resistant paint—Zinc chromate, FS #8010-298-2280
10. Red-orange paint—Krylon glowing fluorescent, 633 No. 3101, Mil P-21600, pressurized can

Assembly Notes:

A. Apply reflective paint to styrofoam with pressurized can. Do not use brush.
B. Crimp long edges of 18″x 4″ x .0625″ steel plate ¼″ @ 20°.
C. Apply corrosion resistant paint to steel tubing and plate areas not covered with fiberglass wrapping.
D. Apply red-orange striping and reflective paint to front and back side of each styrofoam stake.







Psychology of the Manual Loop

Major Thomas N. Hurst

A pilot needs to be competent in the use of all his navigational equipment. This includes the old navaids as well as the new.

A MANUAL LOOP approach? Good grief! I'd rather come in on the free air temperature gauge."

The reaction of many aviators might be similar if suddenly the only means remaining to get their aircraft safely "headed for the barn" was the manual loop.

And this possibility is not too unlikely.

Last winter the pilot of an O-1E, flying early morning radio relay beneath a heavy overcast, found himself cut off from any possible landing area by driving snow. He contacted a nearby approach control. No radar available, he obtained an IFR clearance, the approach headings from the outer marker, and made a successful approach using his manual loop.

The loop is antiquated and irksome. Many consider it a primitive means of navigation closely akin to releasing pigeons from the cockpit and following them home. But it can save your hide in a pinch.

In Korea, flying a U-6A on instruments, an aviator lost the automatic sensing capability of his ADF. He continued en route using the loop portion of the LF receiver, held for 30 minutes over the beacon, and completed his flight with a GCA to home field.

Let's consider an aviator flying an O-1 on a nap-of-the-earth, cross-country mission and the only piece of radio navigational equipment installed in the aircraft is the LF receiver—with manual loop! *If* he is flying VFR in marginal conditions, what then? How much of an orien-

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Maj Hurst was Chief, Doctrine Branch, Director of Instruction, USAAVNS, before his recent overseas assignment.

tation he has received, or whether he has had any recent instruction or not, is usually dependent upon the training program of his unit.

Transition training must include instruction in the use of *all* navigational equipment installed in the aircraft. If the loop is installed, the instructor pilot must check the applicant's proficiency in its use before signing the transition record. Regulations also require that the annual instrument flight examination include demonstration of proficiency in the use of *all* radio equipment installed in the aircraft in which the flight is conducted (AR 95-67 par 6e). If the loop is installed, the applicant must satisfactorily complete an examination on its use before he is qualified for renewal. [This should not be taken to mean that the examinee must perform a loop approach. AR 95-67 par 6f (12), (g) and (h) specify which entire facility procedures will be performed.]

But aviators are not usually proficient in using the manual loop. Performance usually ranges from minimum satisfactory to total incompetence, and is proportional to the effort expended by the pilot to increase his proficiency.

Lack of knowledge of the subject engenders lack of confidence and is usually accompanied by a strong dislike—and that which a pilot dislikes, he will not practice. Because a considerable amount of hard work is involved in becoming proficient, most of us react normally by attempting to avoid the subject altogether. However, every aviator has the ability to master the techniques involved. He has only to be willing to put forth the necessary effort.

The only way to become proficient is to practice. The best way to practice is to go out on a training flight with a qualified instructor pilot, preferably an examiner, and devote the entire period to this one subject. It is better to fly without the hood initially and to include the outside of the aircraft in the cross-check. In this way comparisons can be made with the indications received inside the cockpit and visual indications of the actual position of the airplane in relation to the station. Later, these visual indications are withdrawn and the pilot substitutes for them the signals which he receives, much the same as he substitutes the artificial horizon for the real horizon in first learning attitude instrument flying. This is called visual bracketing and is a standard technique used in other phases of instrument flying.

Practice of manual loop procedures in all aircraft . . .

LOOP PROCEDURE

The first thing to do is to tune and accurately identify the station. The plane of the loop should be in the maximum signal position for this tuning, i.e., if the station is on the nose of the aircraft the azimuth indicator should be in the 90°-270° position. In solving the 180° ambiguity, let it suffice here to say that if the relative bearing is increasing, the station is on the right; conversely, if the relative bearing is decreasing, the station is on the left. This has to be true unless the airplane is flying backwards.

Let us assume that the station has been properly tuned and identified and is now on the nose. We now have the problem of volume control. Just how wide should the null be? The null can be affected by distance from the station, condition of the receiving equipment, type of emission of the signals, and atmospheric conditions.

The null should be as narrow as possible. It is possible to get a good, well definable 2° null at 50 NM from the station. If we get a 1° null, it would give us a precisely accurate bearing and would make our tracking procedure simple. Wind bracketing is done exactly as when using other navigational aids once

the bearing to the station has been accurately determined.

It is not sufficient just to locate and receive a null. The width of the null must be determined by checking the extremes both right and left; the mean of these two readings is used as the bearing. This is done by rotating the azimuth indicator back and forth, from the right edge of the null to the left edge *without going past.* During this procedure the aircraft *must not turn,* or the bearings will be unreliable. (If the pilot allows the aircraft to wander while attempting to take loop bearings, the instructor should immediately discontinue the loop problem and go back to basic instruction on pitch attitude and heading control, resuming loop instruction at a later date.)

An alternate method is to set the azimuth indicator to 0° and check the width of the null by turning the aircraft. The mean of the readings on the directional gyro is taken as the bearing to the station. The important thing to remember is that either the azimuth indicator or the aircraft may be turned, but not both at the same time.

In doing a time-distance problem using the formula based on the 60:1 relationship, the aircraft should be turned 70° to the left of the station. Turning right will work, but by turning left we eliminate many computations which must be made by the pilot, and we want to keep this as simple as possible. Ideally, too, we would approach the desired track on a heading of 0° in a no-wind condition, and relative bearing would be the same as magnetic bearing. The pilot would simply read magnetic bearing directly on his azimuth indicator. The time is started when the relative bearing is 80° and is stopped at 90°.

Turning 70° initially is not a standardized USAAVNS procedure, but is recommended because at the completion of the problem only a 90° turn is required to go to the station. Having to turn 100° plus the radius of the turn can cause the aircraft to get off track and the pilot to make a track interception. How far off track the aircraft goes depends on distance from the station, airspeed, and wind. Also, the aircraft is turned *perpendicular to the desired inbound track* in the beginning, and it is not necessary to turn toward the station to start the problem.

Although any method may be used as long as it contains a wingtip bearing, this method seems simpler for most pilots because it is easier to visualize geographical position in relation to the station. Heading control is very important since the time to the station depends on the time elapsed between bearing changes. Pitch attitude is also important because a constant airspeed must be maintained. By eliminating all variables except the wind, and compensating for it, an experienced pilot can consistently hit his ETA within 1 minute or less. By using a 10° bearing change, each 10 seconds elapsed during the timing equals 1 minute of flying time to the station. Any bearing change up to 30° will work, but once again this method is simpler and no computations are necessary.

To avoid overshooting, a 90° turn toward the station must be started immediately upon intercepting the desired track. Students at the U. S. Army Aviation School are taught to turn 20° into the wind at the first off-course indication. Since 30° will compensate for a direct crosswind of one-half the true airspeed, 20° is sufficient for most wind conditions. Actually, any procedure is acceptable as long as it is satisfactorily executed, but solving for wind correction angle can begin only when the aircraft is on course and on heading. This should be started as soon as possible after turning inbound because there will be no time for it when close to the station. The pilot should

. . . can save your hide in a pinch

continue to split his wind bracket until he has a known heading which will hold him on track. This heading should then be held and not allowed to vary. (If the pilot is en route from other fixes, he should have computed an accurate estimate for the station, using previous legs.)

Now we come to identification of station passage, the most important single item of the entire loop procedure. On it rests the success or failure of the approach to follow. As the volume becomes louder while approaching the station, the null decreases in width until it disappears. Just before this happens, the volume should be decreased sufficiently to keep a null. Exactly how much is necessary can come only with experience. At some point very near the station the null disappears completely. This is the time when most pilots become confused and start dial twiddling with the azimuth indicator; the aircraft wanders, and we become hopelessly disoriented.

This can be avoided by rotating the azimuth indicator to the 90°-270° position and waiting for a fade in total volume. Volume must be turned *down* to a very low level immediately when rotating to the maximum signal position, or station passage will be missed. Just exactly when we rotate to the 90° position is a matter of individual pilot technique, but it can be done a little early if estimates are accurate and heading is absolutely maintained. This will ensure passing directly over the station.

Methods of turning off course and using wingtip null for station passage will not be discussed here since it is both desirable and possible to pass directly over the station. After rotating to the 90° position, a build in volume will be noted exactly as in a LF range problem; at this time volume should be decreased. Just exactly when to make the last volume reduction prior to station passage is again a matter of individual technique, but if made too late it can coincide with the null and station passage will be missed. If station passage is not received within about 1 minute, it is advisable to recheck null position near the nose and repeat the station passage procedure, since the estimate is obviously in error.

As the aircraft passes over the station with the azimuth indicator in a 90° position, a fade will be detected exactly like a cone of silence over a LF station. At this time, the pilot should do nothing but maintain heading and wait for a build. Getting a build proves station passage, and the pilot can now begin the approach. Holding is the same as when using other aids. In the case of a terminal station, only one station passage is required, since the aircraft will become VFR on final prior to reaching the station.

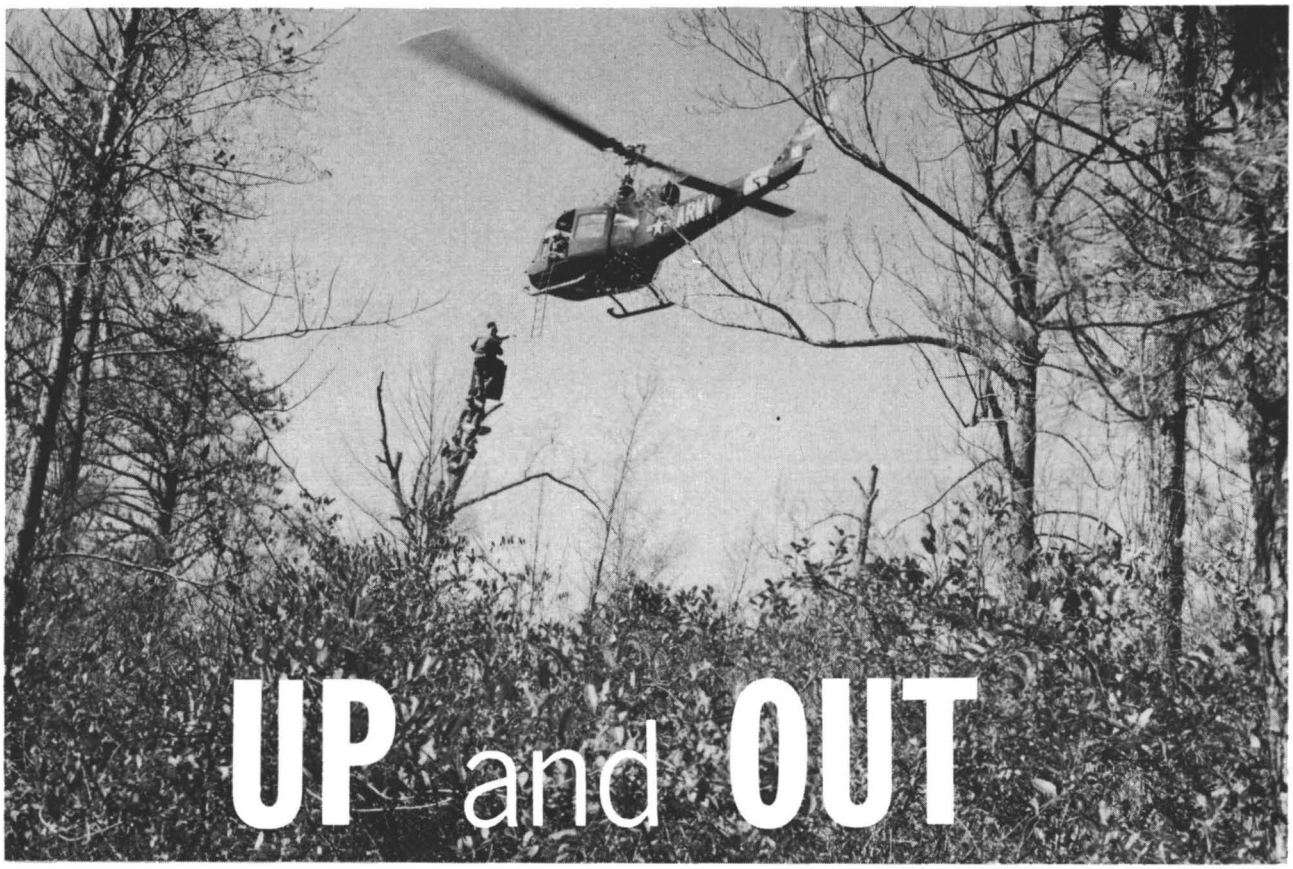
After initial station passage, the pilot has only to take bearings to make a successful approach. He should always keep the azimuth indicator pointed toward the station to avoid confusion. This is especially true when checking the 90° point in the holding pattern and in the procedure turn.

Using the ADF receiver with the function switch in the loop position requires somewhat greater skill, since there is noise when rotating the electrically driven loop and signals may be distorted during periods of poor reception. One advantage of the manual loop is its relatively simple construction. It is not subject to the normal errors of the ADF, such as chasing thunderstorms, and is therefore more accurate. Some ADF receivers go completely berserk in snowstorms, but by using the manual loop the aircraft can proceed on course and land at the intended destination.

Holding on a 30 second beacon (i.e., one that identifies itself only every 30 seconds and transmits no audible tone in between) can present new problems. On certain stations, such as type A-1 emission, turning the BFO switch ON, on switching from VOICE to CW, can produce an audible tone, but this feature is not available with the manual loop.

The location of the azimuth indicator in the aircraft is very important. Below the pilot's elbow on the left wall is not ideal. The indicator should be located in front of the pilot next to his other indicators.

How long should it take for the average pilot to become proficient in the use of the manual loop? He should be current in the aircraft and proficient in basic aircraft control using flight instruments. If so, two flight instructional periods, the first without the hood and the second under the hood, should be sufficient to learn procedures. After that it is a matter of individual ability. Certain pilots in Europe have been able to deliberately file IFR and make successful loop approaches under actual weather conditions from the date of initial award of an instrument card. This can be done consistently by pilots with average ability who are well trained. An adequate training program in all units could bring all Army Aviators up to this level of proficiency in a very short time.



UP and OUT

Operations which must be concluded by exfiltration or evacuation often cannot be considered if the terrain is inaccessible by conventional ground or air transportation. However, the XVIII Airborne Corps has found a way.

"THROW AWAY anything you can't carry!"

I chuckled cynically to myself and glanced at Sergeant Weinsik. He was looking pale already. He wouldn't be able to walk far with those arm and shoulder wounds—and then we'd be carrying him.

I pulled myself to my feet as the sergeant continued, "Come on! Come on! We've got to get moving again or they'll overrun us."

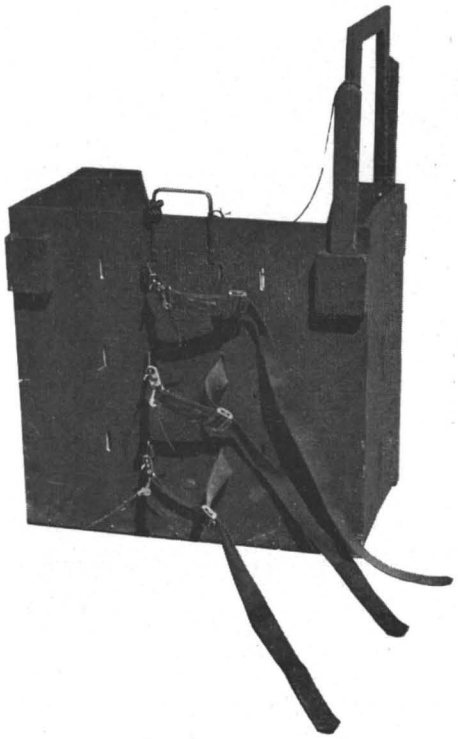
We started plodding along the rugged ridgeline. It was heavily wooded and did afford cover from the enemy. But it also was thick enough to keep the helicopters out.

So this was it! The Chinese Communist spring offensive had opened and caught our platoon in front of the MLR. They were already well to our rear on both flanks and before long would be between us and UN forces at Suchon Pass.

The company—the battalion—hell, even the regiment—knew where we were. Not 20 miles away. But they were having trouble saving their own necks. Battalion's advice to the 3d platoon? "Withdraw to Suchon Pass on your own."

A helicopter came flopping along the ridgeline. The pilot spotted us and slowly circled, but could not find a place to set down. Finally, hovering just above the trees, the pilot pointed

Copilot relays instructions on intercom



Tree box

in the general direction of Suchon Pass.

Our friend in the air hovered and watched us for what seemed an eternity. Then with a quick, deliberate move *he saluted us.*

"Cripes, we must really be in for it," I thought.

I felt miserable, but ol' Weinsik must have felt a lot worse. Here was a medical evac chopper within about 30 feet of him and he couldn't get aboard.

Weinsik's bandages were soggy. He was still bleeding, and we finally had to improvise a stretcher to carry him. This cut our progress at least 50 percent. It is the main reason the platoon didn't make Suchon Pass that day—or any other day. And it's the main reason Weinsik died.

* * *

This anecdote is based on a true incident. A lot of "Monday morning quarterbacking" is possible here, but one thing is certain: had the *hovering flight loading concept* been available, the 3d Platoon would have had a chance for a more glorious ending.

The hovering flight loading technique was developed recently by the XVIII Airborne Corps at Fort Bragg, N. C., primarily to load personnel into helicopters from treetops in areas where it is impossible to land. Basically the equipment needed is a rigid ladder and a collapsible platform. The platform is attached to a treetop and the ladder to the side of a helicopter so that it extends 4 feet below the skid.

Loading is accomplished by hovering the helicopter in a position from which personnel can reach and climb the ladder. (This technique can easily be modified to recover personnel from roof tops, reefs, small islands, boats, cliffs, etc.)

TREE SELECTION

Proper tree selection is of paramount importance. Picking the right tree greatly reduces the amount of effort required to climb and prepare it and also facilitates a safe approach of the helicopter. When selecting a tree for a loading operation, careful consideration must be given to wind direction. Since the pickup helicopter should hover nose into the wind with the ladder attached to its left side (using the UH-1), wind direction will dictate the side of the tree from which the loading will take place.

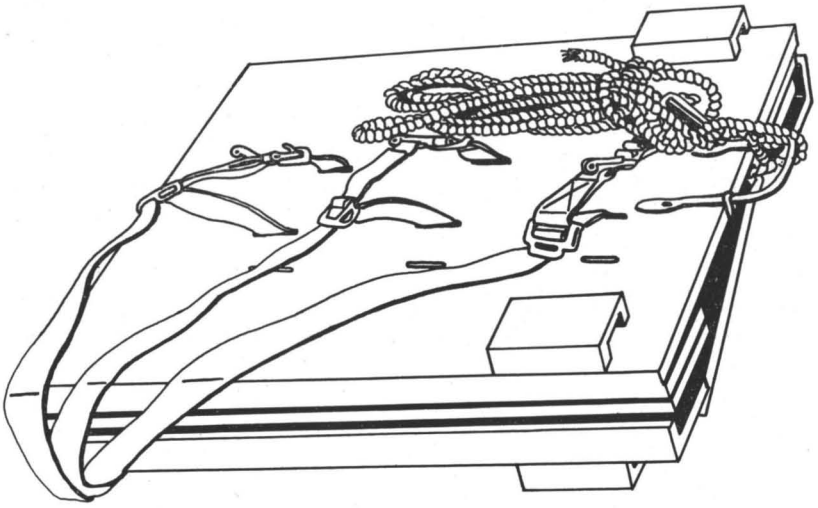
Ideally, the selected tree should stand 10 to 15 feet higher than others in the vicinity. Surrounding treetops must be cut away if they interfere with the flight path of the helicopter.

Equipment required for climbing and preparing the tree is contained in a bag. Normally this equipment is delivered to troops on the ground by free drop from either fixed or rotary wing aircraft but it also may be lowered by rope from a helicopter.

Preparation of the tree is the most time-consuming portion of the operation. The time consumed is directly related to the number of spikes required to reach the treetop. Under normal conditions it takes two men using safety belts to climb and prepare the tree. One climbs the tree by driving spikes on alternate sides of the tree at approximately 24-inch intervals. The second man follows the first as closely as possible and cuts away interfering limbs which have been bypassed. He also carries spare spikes.

The exact place to attach the tree box is determined when the top of the tree is reached. It is desirable, but not necessary, that the tree box rest on a limb for additional stability. Using machetes, both men cut away the extreme top of the tree and other interfering limbs or foliage. Care must be taken to allow approximately 2 or 3 feet of the tree to extend above the box after it is attached to the tree. This extension can be used as a handhold when standing in the box, and it facilitates climbing from the tree into the box. When standing in the top of the tree, a visual check is made of the approach and departure path to be flown by the helicopter. If surrounding treetops obstruct the flight path, they must be cut away.

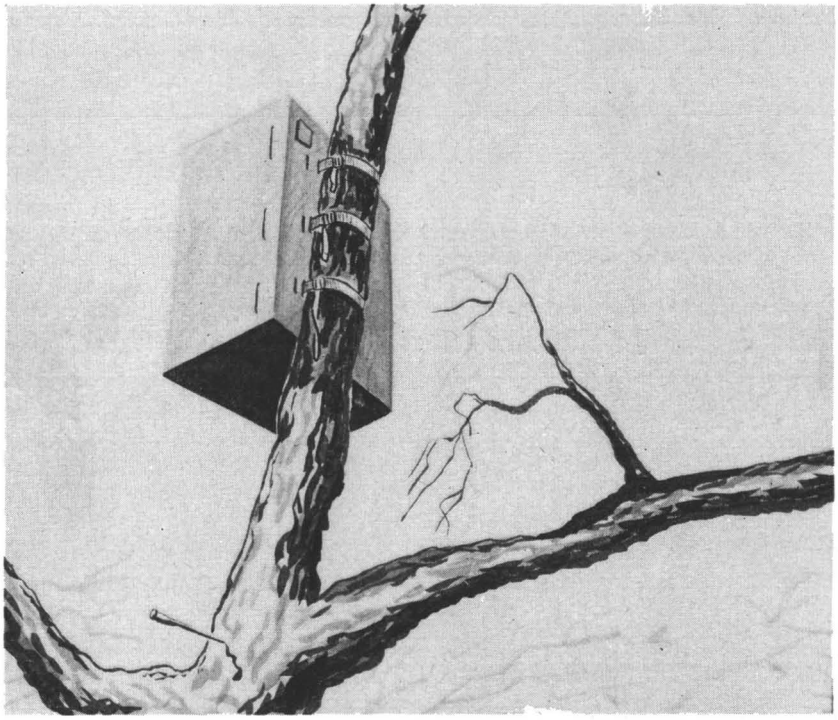
Platform is collapsible for storage and lowering from helicopter



When attached to the tree, the box provides a stable platform in which to stand and allows the individual to use both hands to grasp the loading ladder. The box can be lowered by rope from a helicopter to the ground or directly to the prepared treetop. If the box is delivered to the ground, it can be raised to the treetop by using a rope and pully contained in the equipment bag. Regardless of the delivery method, the box should arrive at the treetop in a folded condition.

At the top of the tree the box is quickly attached with three web straps and then unfolded. The web attaching straps are then pulled taut. If additional strap tension is desired, a 1″ x 4″ wooden wedge delivered with the box (or a piece of a tree branch) may be driven between

Portion of tree limb should extend above box



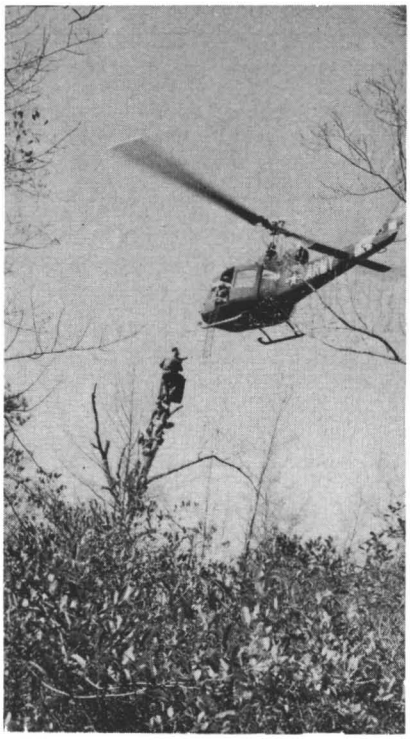
the box and the trunk of the tree. When the box is properly secured and the handrail has been put in place, the pickup helicopter can be signaled into position.

POSITIONING OF THE HELICOPTER

Before the helicopter hovers into pickup position, a rigid metal ladder extending 4 feet below the skid is attached to the left side of the aircraft. (A longer ladder cannot be transported in the UH-1B.)

During the final approach to the pickup point, the pilot of the helicopter receives all heading and altitude changes from the aircraft copilot. The copilot is positioned at the left cargo door and relays instructions through the intercom system. When the helicopter is approaching the tree and hovering in the pickup position, the ladder and box cannot be seen by the pilot. Therefore, any changes in direction or altitude must come from the copilot, who is in a position to see clearly. Extensive testing has proved this procedure to be safe and reliable. However, the pilot and copilot should develop the technique as a team and practice the procedure many times before attempting a loading operation.

Helicopter eases into position for pickup



When the helicopter is in the pickup position, the end of the loading ladder should be from 6 to 18 inches directly to the front of the tree box. A man standing in the tree box has no difficulty grasping the ladder firmly with both hands at a point about 3 feet above the bottom. It then becomes a simple matter to step from the box onto the bottom rung of the ladder. Upon entering the helicopter, personnel must move immediately to the rear of the cargo compartment and sit on the floor without moving. This procedure distributes weight and reduces aircraft control problems.

The metal loading ladder is designed to fit any UH-1B. If more than one load of personnel is to be picked up, the ladder can easily be detached from a loaded helicopter and passed to a man standing in the box. The ladder is passed from the tree to the next arriving helicopter for continuation of the loading operation.

COMMUNICATIONS

The situation dictates the best method of communication to be used between ground personnel and the pickup helicopter. The primary means of communication will be PRC 8, 9, or 10 radios on the ground and ARC 44 FM radios in the aircraft. Hand and arm signals, flares, signaling mirrors, smoke, or panels can be used as secondary means of communications and should be considered during the planning phase of a tree-loading operation.

The individual in charge should station himself at the top of the tree to signal the helicopter into pickup position. The signal for the helicopter to move in should not be given until he is fully satisfied that everything is in proper readiness. If the helicopter moves in prematurely, wind generated by the rotor system makes further preparation more difficult, tends to rush personnel in the tree, and could result in an accident.

The person in charge should closely supervise each man as he transfers from the box to the helicopter ladder. If the supervisor is not fully satisfied with any aspect of the operation, it is his responsibility to abort loading. A 15-foot safety strap can be attached to a tiedown ring in the helicopter and handed from the aircraft to the tree, where it is looped under the arms of loading personnel before they leave the tree. The safety strap is unnecessary when loading personnel experienced in the loading technique, but it should be required during initial training phases.

During equipment delivery and loading operations, the copilot should be secured with a safety belt which permits freedom of movement in the door but prevents his falling from the aircraft.

The equipment needed to accomplish hovering flight loading can easily be built by most units. Plans and detailed instructions can be obtained by writing the Editor, U. S. ARMY AVIATION DIGEST, Dept of P&NRI, USAAVNS, Ft Rucker, Ala., or the XVIII Airborne Corps, Fort Bragg, N. C.

CANDIDATE FOR SUICIDE

Lieutenant James A. McCracken

IF YOU ARE determined to commit suicide, let me suggest a means other than an aircraft as your weapon of self-destruction. The reason is obvious. First of all, it's so messy. Second, think of the innocent you might take with you; the loss of the aircraft; the countless manhours expended investigating and attempting to prevent similar occurrences.

But what is this talk of suicide? Of all the accidents in aviation history very few have been intentional. However, when some essential element is omitted in planning, preflight, or any operation under your control, you become a candidate for suicide.

Whether it is omitted intentionally or not makes little difference; the odds against the successful completion of your mission have become less. You can put a gun to your head and pull the trigger; if the gun is not loaded, all you get is a snap. Forget to check the gas; if the tank is full, you have an uneventful flight. Now take the case of the gun being loaded when you assumed it wasn't, or the case of the gas tank being almost empty when you assumed it was full. Either case can prove catastrophic.

You can't leave things to chance and expect to survive forever. You might be able to grossly neglect something for a long time and get away with it. But sooner or later, it will catch up with you. Don't have so much faith in human nature that just because you told somebody to do something that it is going to be done.

A foolproof maintenance system has never been devised. Regardless of how closely supervised, in adjustment, replacement, modification, etc., errors can and are being made. The best maintenance system is the one which minimizes these errors.

As statistics point out, maintenance is not the greatest contributor to accidents. The pilot causes or allows to be caused the largest percentage. What's the answer? How do you put a stop to all this "suicide"?

These questions have plagued flying safety personnel for many years. Many methods have been devised in an attempt to eliminate or drastically reduce the errors made by the pilot, but there is a limit to the amount of automation. Systems which prove beneficial for one individual may prove detrimental for another. There is no one simple solution.

Standardization is a partial solution, but even this can be carried just so far. The limit of human endurance or just how much knowledge an individual can absorb and be expected to recall at any particular instant is significant.

The Army Aviator is a good biological specimen for closer analysis. Just look at the multitude of abilities he must possess: maintain VFR and IFR proficiency in fixed and rotary wing aircraft, as well as keep abreast of his basic branch. For some individuals, this isn't asking too much; but for a few, proficiency in all these skills apparently is an impossible task. As a result, some area must suffer. Unfortunately lack of proficiency inevitably leads the unsuspecting aviator into a situation where he is incapable of applying corrective measures until it is too late.

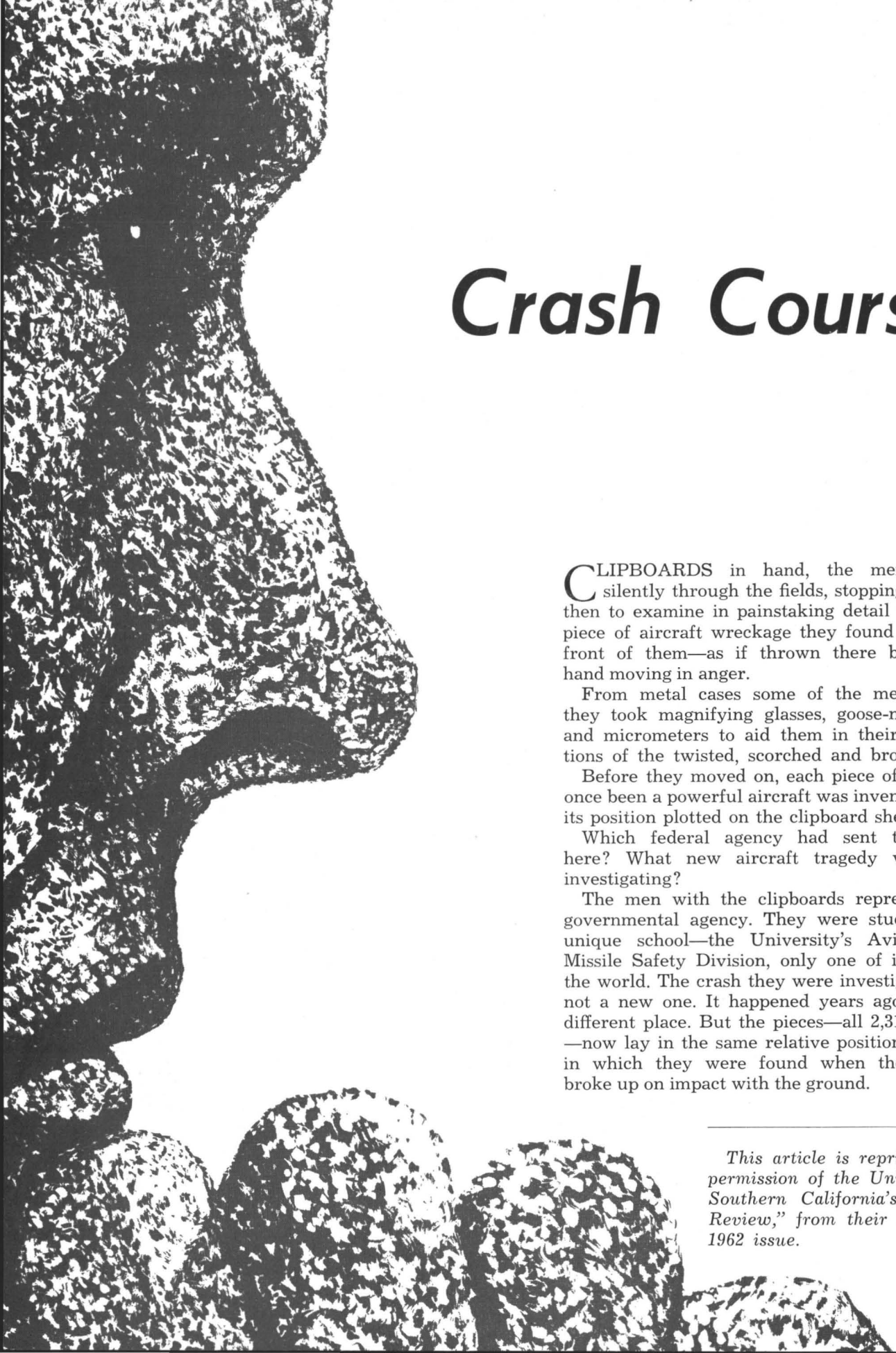
Another area worth mentioning is the complacent attitude some aviators have toward flying. It is surprising the number of pilots who adopt the attitude: "How could anybody be so stupid? I would never do anything like that," or, "That couldn't happen to me." This type individual tends to neglect essential elements of flight planning because he thinks nothing can possibly go wrong.

You can just as easily go to extremes in the other direction. There is no happy medium. You must take certain things for granted and you are required to check certain things. Your local SOP should have a preflight checklist for each type aircraft in your organization.

No one should ever be criticized for being too careful in preparing for a flight. The best means for assuring that nothing is omitted in preparation is a set of definite procedures. Procedures can't be stressed too much. If you really want to keep on living, the best insurance possible is to maintain proficiency, keep yourself psychologically and physiologically sound, and adopt a professional attitude toward flying.

Only through the combined efforts of every individual connected with aviation can we expect to make any progress toward the ultimate objective: Accomplishment of our mission with a zero accident rate.

Lt McCracken wrote this article while a student at the University of Southern California Army Safety Course.



Crash Course

CLIPBOARDS in hand, the men walked silently through the fields, stopping now and then to examine in painstaking detail some new piece of aircraft wreckage they found strewn in front of them—as if thrown there by a giant hand moving in anger.

From metal cases some of the men carried, they took magnifying glasses, goose-neck lights and micrometers to aid them in their examinations of the twisted, scorched and broken parts.

Before they moved on, each piece of what had once been a powerful aircraft was inventoried and its position plotted on the clipboard sheets.

Which federal agency had sent these men here? What new aircraft tragedy were they investigating?

The men with the clipboards represented no governmental agency. They were students in a unique school—the University's Aviation and Missile Safety Division, only one of its kind in the world. The crash they were investigating was not a new one. It happened years ago and in a different place. But the pieces—all 2,314 of them—now lay in the same relative positions as those in which they were found when the airplane broke up on impact with the ground.

This article is reprinted with permission of the University of Southern California's "Alumni Review," from their November 1962 issue.

Today the parts, reassembled in the original crash pattern along a 1,000-foot "crash course," provide a field investigation problem for the men who attend this unusual school. Everything is there—skid and impact ground marks, oil stains included.

Considering the hundreds who have followed this "crash course" in a succession of classes, the accident is doubtlessly the best investigated crash in U. S. aviation history.

But each new student, with the investigative skills learned in his class and laboratory sessions, must find anew the answer to: What caused this plane to crash and why?

Although only a detail of the instruction, the question ranks in importance with a semifinal exam. In all, more than 3,500 men have attended the Aviation and Missile Safety classes in the last nine years.

Members of this very select group—the only formally trained aircraft accident investigators in the world—are found today in key positions related to aircraft and missile safety and accident investigation.

They are flight safety officers in the air forces of half the nations of the world. Two of them are astronauts: Lt. Cmdr. Walter M. Schirra, Jr., who recently made a six-orbit space flight, and Lt. Cmdr. James A. Lovell, Jr., one of America's nine new astronauts. Spaceman Schirra studied here in 1957, and Lovell in 1961.

Many of the graduates can be found behind the executive desks of aeronautics manufacturing companies and related firms. Many have positions with the U. S. aviation agencies, and many are airline captains. And some have been brought into the insurance business as the underwriters of aviation's risks.

Youngest of this new breed are those who are trained in the safe handling of ballistic missiles. Classes in this area began a little more than a year ago, and now hundreds of missile safety officers are performing their duties at various missile installations throughout the United States.

The men who have come from across the country or from around the world, as scores have done, to attend these classes at the University have emerged with an amazing, often Sherlock Holmes-type capacity for solving the fatal riddles of aircraft crashes. It is not unusual that a hardened "expert" has been impressed by the accuracy with which a broken aircraft part becomes a tell-tale clue to disaster—once the lessons have been applied.

Just how penetratingly accurate can an Aviation and Missile Safety Division student be on the scene of an aviation tragedy?

David Holladay, head of the aircraft accident prevention and investigation section of the division, lists just a few of the things which these students can accurately determine by careful investigation of a crashed aircraft.

Even the fractured remains of a tiny vacuum tube will tell the trained investigator whether or not there was any electrical energy in the tube at the time the plane hit the ground.

Was there a fire aboard the aircraft while it was airborne? Or did the fire break out after ground impact? Instructor Holladay says in many cases this is a relatively easy question.

He picks up a part from the crash course on which his men have been working and points to a fracture in the metal: "The differences in metal fractures will tell you whether a part failed from fatigue or whether the break came on impact."

If fatigue in the metal was the cause of the break, the investigator who has learned his lessons will be able to tell you whether the break was the result of up-and-down stress or twisting—and sometimes the sequence of the stress in the lifetime of the aircraft.

Whether the landing gear was up or down, the exact setting of

Careful investigation by trained personnel usually uncovers the cause of accidents and separates fact from fiction

"Accident investigation is for the sake of accident prevention..."

the wing flaps in degrees and whether or not the craft had a fuel supply at the time disaster struck—all these are basic training lessons for the students.

Ditto: Ground scars made by the wreckage, the presence of paint flecks on parts which had no paint, and minute scars on metal surfaces, to determine sequence of failure.

Important as these investigative skills are rated, the underlying purpose of this training is even more significant. Expressed in the words of Division Director George Potter is this overriding goal:

"Accident investigation is for the sake of accident prevention. This program, our texts, our curriculum, the human centrifuge, the 'crash course,' our 'museum' of aeronautical mistakes—they all contribute to the skills we know already have saved thousands of lives and millions of dollars worth of property."

The courses offered by the Aviation and Missile Safety Division not only include accident investigation but courses in aeronautical engineering, aviation physiology, aviation psychology, and communication principles and techniques.

One of the unique aspects of the program is the use made of the human centrifuge, only such apparatus on a university campus in the United States. It is used for indoctrination and research, giving the students an opportunity to experience and witness various effects of exposure to G forces under conditions where they are not charged with responsibility for control of an aircraft. The centrifuge duplicates the forces encountered when banking steeply or pulling out of a dive.

(Beyond mere men, astrochimps Ham and Enos rode the centrifuge while being trained for orbital flights under the direction of the physiology department of the School of Medicine.)

How and why did this school come about?

According to Dean Carl Hancey of University College, it was the huge loss of personnel and equipment which the U. S. Air Force suffered in the peacetime years following the end of World War II that brought the one-and-only school into being. In 1951 the Air force Inspector General's Directorate of Flight Safety Research urged establishment of a flying safety officer course—a course where pilots would be taught the characteristics and capabilities of an aircraft; where they would learn to investigate aircraft accidents scientifically and emerge with recommendations and procedures which could be used to prevent similar accidents.

The problem landed in USC's lap less than a year later when the University was given a research contract to study skills and information needed by such personnel.

Under the direction of Dean Hancey the program curriculum and methodology of the then Aviation Safety Division was thoroughly researched, refined, drafted and made operational.

Dean Hancey says: "The Air Force came to us with a serious problem. It's the business of a private university such as USC to solve such problems. And creation of this program was a natural, direct result of that need."

After the Air Force came the Navy and then the Army for the training of Flight Safety Officers. Today the University maintains 8- to 12-week courses for all these, plus courses for the officers of Allied Nations through the Military Assistance Program. Just begun, in addition to these, is a special set of classes for the Federal Aviation Agency.

Growth of the Division has been phenomenal and the University now has 14 full-time and 17 part-time personnel engaged in the instruction of these classes and their administration.

With a decade of experience, the Aviation and Missile Safety Division today sets its sights far beyond the basics of aviation accident investigation and prevention. The Division hopes ultimately for clearer channels by which all aircraft accident investigators may funnel their knowledge to the aeronautics industry.

Says Division Director Potter: "There are many instances today of aircraft which simply do not conform to the design of the human pilot assigned to their operation. It is our hope that more careful design of aircraft and space craft of the future will result in the elimination of those 'human errors' which today are all too often dismissed as regrettable and unavoidable.

"This can be achieved only when the whole knowledge of those who investigate aircraft crashes is brought completely and speedily to the attention of those who design and those who build these aircraft or space craft."

It seems that medical evacuation missions are always on a hurry-up basis or at night. Any unit with a hospital on the installation might take a closer look at its operating procedures.

How Do You Install a Litter?

Lieutenant Howard F. Brook, Jr.

ASKING THIS question of several fellow officers, I found that only a few actually know how to properly install litters in the U-6A Beaver.

Last summer a friend was assigned to fly two medical attendants to Yazoo, Miss., in a U-6A to pick up a litter patient who had been stricken with infectious hepatitis. After filling out a flight plan and meeting the two medical personnel, the pilot and copilot picked up four parachutes. They paused for a moment to consider this question: What Army regulation requires a patient to have a parachute? They thought that AR 95-1 states that all occupants of Army aircraft [except those in observation-type helicopters] will have a parachute. The pilot finally decided to carry an extra chute, since he wasn't sure of the regulation.

Upon reaching the aircraft the pilot noted that the litter equipment had not been installed. He turned to the copilot and asked if he knew how to install the litter kit. The reply was an embarrassed negative. Since the two medics had probably been on missions of this type before, the pilot thought they surely would know how to install it. But as things would happen, they didn't know either.

What started out to be a simple flight was rapidly developing into a complicated one of rules, regulations, and knowledge. But to continue with our story, the pilot decided to lay the litter on the right side of the cabin floor and not install the kit. He then put the two center seats on the left side and stowed the sling seats in the baggage compartment.

After obtaining an extension on his weather briefing time, the pilot was ready for takeoff. During the takeoff roll he noticed it was taking a long time to build up flying speed. Most of us have experienced this peculiar feeling in our tactical training when we were making shortfield takeoffs. Of course this wasn't much of a problem with 6,000 feet of runway. But what about the length of the landing runway? Was the aircraft over maximum gross weight with full fuel load, including tiptanks, pilot, copilot, two medical attendants, and a litter patient with baggage?

The answers to the questions asked in the preceding paragraphs are only three important aspects of many involved in a simple litter patient mission.

First, we have already found from AR 95-1 that all occupants of Army aircraft will have a parachute. However, this requirement may be waived in the case of a patient and others by a major commander.

Second, remember a DD Form 365F is required for your particular load on the U-6A Beaver.

While this mission was accomplished in a U-6, it is essential that Army Aviators know how to install litters in the aircraft in which they are qualified. In addition to actual emergencies and requests, medical evacuation of Army Aviation is a requirement in all annual training tests. It is the aircraft commander's responsibility to ensure that patients and special equipment are installed properly because the people on the ground may not know how. If the request indicates that a need for oxygen or intravenous injections will be necessary en route, will the aircraft commander know how and where the additional equipment will be installed?

Can you correctly answer the above questions?

Lt Brook was an instructor with the Fixed Wing Intermediate Maintenance Division, Dept of Maintenance, USAAVNS, before his recent overseas assignment.

WHAT HAPPENED TO TAPER?

James E. Mize

THE ARMY PLAN for Equipment Record revision (TAPER) was announced on 15 February 1961. Selected units at Fort Knox and Fort Campbell, Ky., Fort Lewis, Wash., and the 4th Armored Division in Europe began testing the system on tank-automotive equipment the first of July the same year. Results of the test were so encouraging that the plan was put into effect and became Army doctrine a year later. What has happened to TAPER during this past year?

Several direct advantages and by-products were foreseen by the Maintenance Board at Fort Knox, Ky., and were brought about by the use of the new equipment record system. Two of these were: (1) more productivity at 1st and 2d echelon through the standardization of procedures and forms to ascertain the complete battle readiness or status of equipment, and (2) the consolidation of all instructions for maintaining records into a single technical manual. Some of the by-products were the reduction of forms and records, the clean-up of Modification Work Orders, and a standardization of inspection time requirements for aircraft. The overall purpose of The Army Equipment Record revision (TAER) is to collect data for the logistics system. This is being accomplished.

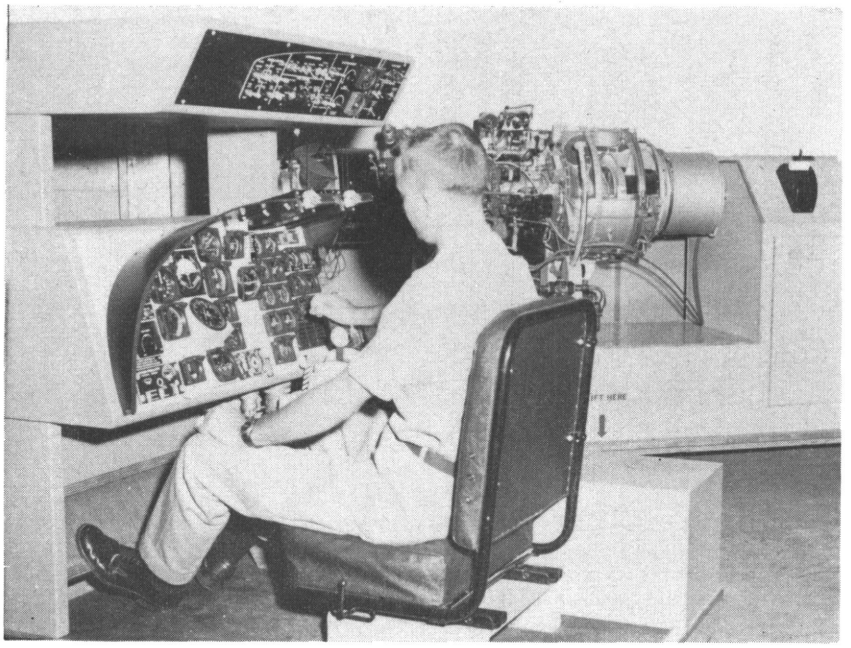
Shortly we will be getting the first revision to TM 38-750, which reflects the following changes. The Maintenance Request, DA Form 2407, is slated for complete revision and redesign. The purpose seems to remain the same: to report the application of MWOs, to request work from support activities, and to submit EIRs. The DA Form 2408-7 has been used for select items only; now it will apply to all aircraft. This eliminates the use of a portion of the -15 to reflect the transfer data. With this new use of the -7, only historical data will be shown on the -15. Status symbols will apply to all equipment and may be reflected in black, except for aircraft which will be *red*. Little change is seen in the DA Form 2408-13 except in the procedure for recording recurring inspections. The initial inspection requirement will be recorded and cleared on the -13, and the recurring inspections will be recorded on the -17. The DA Form 2408-17 has been redesigned for recording scheduled equipment inspections and has been redesignated the "Equipment Inspection List." The Aircraft Inventory Record will no longer exist as such. The equipment will be accounted for by referring to the property books and hand receipts.

The requirements for records keeping may seem to be excessive when considering only one level of maintenance; however, the Maintenance Board continues to chisel away, carving and altering the Equipment Record System to fit all maintenance levels and all types of equipment used by our modern Army.

Mr. Mize is an Education Specialist, Forms and Records Branch, Dept of Maintenance, USAAVNS.

Today's Trainer Technology

Captain Farris G. McMicken



A STUDENT climbs into the seat of a Mohawk, adjusts the straps and waits for orders to start the engine. He makes a careful last minute check of his cockpit, dials, console switches. With a firm hand he engages the crank switch, but hesitates before hitting the ignite button. He hears the engine roar, sees the dial hands jump, flutter, then settle down in their right places. But something is wrong! It's a hot start! But no harm has been done. The student is being trained in the Trainer Corporation of America's OV-1 Operational Simulator, known as the Traco jet engine trainer. The trainer will primarily be used in mechanic training for cockpit procedure and for engine analysis. It is the first of its kind to be used here and so far has impressed people with its versatility. The trainer consists of four main parts—cockpit station, engine display cross section, instructor's station, and a computer.

The Mohawk cockpit station consists of instrument panels, left eyebrow panel, and control pedestal. All engine instruments and some flight instruments are operational and give a good simulation of the reaction of Mohawk instruments. This station also incorporates well simulated engine sounds. Airspeed (0-400 knots), altitude (0-34,000 feet), and free air temperature ($-50°$ to $+40°$ C) are active instruments controlled from the instructor's station. Instrument Bezel lights are active for night instruction.

A cross-sectional view of the T-53-L-3 turboprop engine simulated by the trainer is presented in color. The view is backlighted and animated. An arrangement of keyed illumination, color of the animated panel, flow presentation, rate of flow pattern, and sounds of both turbine engines vary automatically as power and propeller levers on the control pedestal are moved. Two rows of instruments simulate the actual aircraft instruments. Also present are instruments that assist in engine analysis.

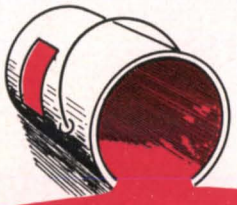
The instructor is stationed at a portable unit containing all the controls to simulate a wide variety of normal and abnormal engine conditions. The unit's portability allows the instructor to have clear observation of all students and stations and allows convenient classroom arrangements. A microphone which will cut out all engine noise and serve as a loud speaker system is a most convenient feature. The instructor is able to simulate failures and near failures which could not be duplicated on an actual engine without damage or loss of expensive equipment.

Many situations may be created by the instructor. If a student is making a maximum power check or acceleration check, the instructor can push a toggle switch marked "bleed band stuck closed." As the student advances the power levers he will see and hear the reaction from this trouble.

Troubles are induced either by the incorrect procedures of the student or by the instructor from his station. The trainer works on the students' senses of sight, hearing, and touch.

We think it will be an invaluable asset to student training.

Capt McMicken is Section Chief, OV-1 Mohawk, Fixed Wing Branch, Advanced Maintenance Division, Department of Maintenance, USAAVNS.



FLUORESCENT PAINTS & MID-AIR COLLISIONS

MORE THAN 85 PERCENT OF ALL MID-AIR COLLISIONS OCCUR DURING CONDITIONS OF GOOD VISIBILITY.

Why then do collisions occur? It is obvious that conditions other than good weather affect the visibility of an aircraft in flight. Yet, if an aircraft on a collision course can be detected in time, evasive action can be taken by the apposing aircraft. Much thought and effort have gone into making Army aircraft as conspicuous as possible, especially those habitually flown

in the continental United States where camouflage is not necessary.

When first introduced, fluorescent paints were hailed as the answer to the visibility problem. In 1957 the U. S. Air Force painted 1,600 aircraft with this paint and noted an immediate improvement in collision statistics. In 1958, the Civil Aeronautics Board (CAB) was told that fluorescent color increases visibility of an object three or four times.

Recently, though, many have begun to question the use of fluorescent paints. They doubt that the present comparative visibility of fluorescent paints to other coatings justifies their high cost and complicated application. Even among the advocates, differences of opinion have arisen about the patterns and colors that ought to be used.

The Air Force unit that first claimed fluorescent paints improved their collision statistics took another look and admitted that modified traffic procedures, special training sessions, and intensified safety measures contributed significantly to the improvement. Those who had praised fluorescent paints to the CAB were challenged by others who said that, after hundreds of observations, not a single case was observed of conspicuity enhancement by fluorescent paint.

Finally in 1959, the Federal Aviation Agency (FAA) decided to settle the question. It designated Applied Psychology Corporation of Arlington, Va., as prime contractor in a research program to investigate the most effective visual methods for preventing collisions during VFR operations.

One principle part of this research was to investigate the relation between surface treatment of aircraft and their conspicuity in the daytime, which included use of fluorescent paints.

The contractor learned that certain technical matters relating to paint had to be understood. For instance, aircraft exterior paints serve a number of purposes not primarily related to visibility. White and light colored paints reduce absorption of sun radiation. When used on the upper surfaces of the fuselage, the result is lowered interior temperatures. Flat black paint is used to reduce glare on such surfaces as the inboard portions of engine nacelles and on the fuselage immediately in front of the windshield. Sometimes special colors are used for identification purposes. (The Army uses olive drab no. 504 for identification as well as camouflage purposes.)

The characteristics of fluorescent paints must also be understood. Painted surfaces reflect some of the light received and absorb the rest. Reflected light gives the surface its appearance of color, brightness, and texture; and the absorbed light is dissipated as heat. Fluorescent

MID-AIR COLLISIONS
U. S. Army Aircraft
1 Jul 57 - 30 Apr 63

	Fixed Wing	*Rotary Wing*	*Total*
No. of Aircraft	10	14	24
No. of Occurrences	5	7	12
Fatalities	4	2	6
Costs	$59,610	$224,340	$283,950
VFR	All	All	All

paints convert some of the absorbed light energy to that of a different color. This transformed light is emitted along with the reflected light to give colors a higher brightness and color purity than is possible with non-fluorescent paints.

The high apparent reflectance of fluorescent paint puts it in the class of white or other very light colored paints. Thus, if a pattern using two colors is desired, one light and the other dark, one such pair might be white and non-fluorescent red-orange. If, however, one of the colors is to be fluorescent red-orange, then the second color should not be white but a dark color, say dark gray or olive drab.

Other factors in using fluorescent paint are that it costs more and applying it to an aircraft is somewhat more exacting and time consuming. Consequently, whatever conspicuity advantage it offers must be appraised, in part, in terms of economic impact. Conversion costs may range from $50.00 for a small aircraft to $5,000 for larger aircraft with complex patterns.

The life of fluorescent paint is short compared to conventional paint. Average life of fluorescent paint varies between 4 and 12 months, according to the type of airplane. Generally non-fluorescent type lacquers and enamels have a life expectancy of 4 or 5 years.

In accomplishing his mission, the contractor used laboratory, field, and flight tests, and reviewed the work of other investigators. In addition, the usefulness of paints was discussed with pilots, operators, and maintenance men to obtain the benefit of their practical experience.

In the laboratory, the contractor made five experiments, using simulated viewing conditions and 21 paint patterns applied to scale-model aircraft. Based on the results of these experiments, six paint patterns were devised to test the effects of three general principles:

different brightnesses of the top and the bottom of the aircraft;

different amounts of red-orange fluorescent paint;

splitting up given total areas of paint coverage into several separate smaller areas.

Flight tests of visual factors in collision avoidance were extremely troublesome to design and carry out. Nevertheless, numerous ground-to-air and air-to-air tests were made, and with the analysis of numerous observations by pilots, the contractor was able to conclude the project.

FINAL REPORT

In his final report, the contractor said that for conspicuity purposes even some paint on the exterior surfaces of an aircraft is measurably better than no paint. The primary visual function of paint is to provide information useful in making collision avoidance maneuvers at close and intermediate ranges. An optimum standardized paint pattern should be developed to include elements for positive and negative brightness contrast, and color contrast. This is best accomplished with high-reflectance paints on upper surfaces of the fuselage, low-reflectance paints on under surfaces, and color on fixed surfaces of empennage.

Fluorescent paints in the orange and red portions of the spectrum are preferred where visual recognition of color is important. These, within close ranges, are identifiable at greater distances than all colors of enamels. They also have the advantage of color contrast with a majority of the natural backgrounds encountered during flight.

Present methods of applying and maintaining these paints are relatively expensive and complicated, and the test agency believes that an effort should be made to simplify this procedure.

In spite of certain disadvantages, the contractor concluded that fluorescent paint is a definite help in avoiding mid-air collisions in the close or intermediate range aircraft and that its use should be encouraged.

References
"The Role of Paint in Mid-Air Collision Prevention," Dec 61.
"Comparative Conspicuity of Several Aircraft Exterior Paint Patterns," Jun 61.
"Aircraft Flight Attitude Information As Indicated By Exterior Paint Patterns," Jun 61.
The above reports were prepared by Applied Psychology Corporation, 4113 Lee Highway, Arlington 7, Va.

HAS IT OCCURRED to you that you'll never stop learning to fly until you stop flying?

New equipment comes out. A few things are different. You've really got to learn how to use it, start it, fly it, and get the feel of it. Gauges likely will be relocated, so you'll have to train yourself to look for them in a new spot.

New airways are established and old landmarks disappear. You have to keep yourself familiar with new routes, landmarks, and layouts of runways and exits.

New regulations appear and usually apply to you. You've got to keep up on those regs, or you'll learn about them the hard way.

A good flier is a constant student of flying. He is always learning from his own experiences, from various kinds of instruction, and from the experiences of others.

His cargo can change as the years pass by—and the requirements for handling it change, too. For example, only a few years ago Army Aviators hauled very few passengers. Now, they haul up to 32 troops—and new sets of hazards and safeguards must be handled.

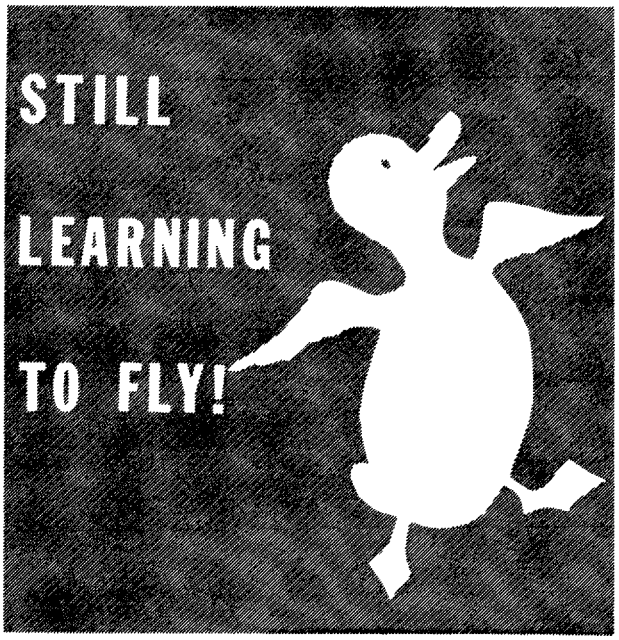
So, good flying is a continuous process of learning. When an aviator stops learning to fly, he is apt to stop living!

Trouble is, some of us don't realize when we're going to school in this flying business. Our classroom isn't like the schoolrooms of our childhood. It is usually our aircraft, or it could be the ready room, or a meeting room. It may be something you read in the paper, the DIGEST, or on the bulletin board. It may be the printed instructions on the side of a Mohawk. *It might be right now!*

A good many of us took dancing lessons when we were kids. But dance music and dance steps change. It's pretty hard to waltz to rock-and-roll. If you haven't kept up your dancing, you're in trouble.

Same thing's true of flying. The music has changed. So has the dance floor! We go faster, farther, and we have less time to "pick up the beat" if we get out of step while flying.

We each learned to fly one way or another. But fliers of today simply can't get along with yesterday's method. They have to know quite a bit about their aircraft, FAA regulations, and the laws of nature. They have to understand records and manifests, keep logs, and sometimes handle and account for moneys. They review accidents and try to figure how they would cope with the same problems.



Donald S. Buck

Don't get the mistaken idea that you are your own teacher in this business of flying.

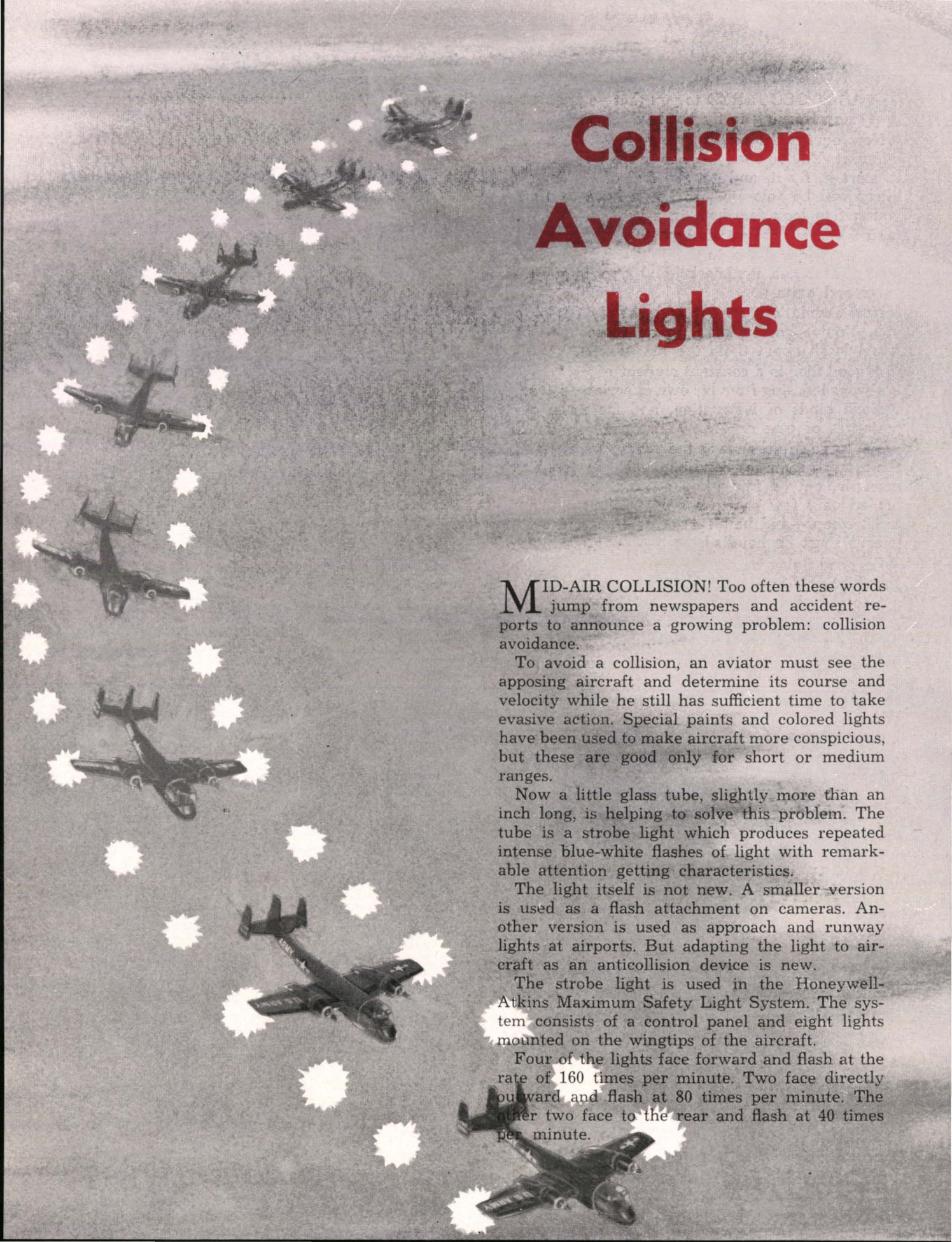
Every time you had to explain a mistake, you likely learned something. Every time you had a real near-miss, you should have learned something.

In a sense, flying is like soldiering. You never stop learning and training for the big showdown. Equipment and tactics may change, but training goes on, adapted to the times.

Training is up to you. A great deal of literature is available to add to your store of flying savvy. Most read the literature carefully, seeking all possible knowledge to improve themselves. A few may stick the material in the nearest waste basket, certain that you can't teach an old dog new tricks.

No one can make you learn; you can only be offered the opportunity to learn. Some of you will grab every chance to learn, knowing that someday it might help save a life. Others will turn aside and learn little along the way. The type of pilot you are is directly related to your propensity to learn. We can offer pilots an opportunity to learn, but we can't make them learn. That is up to them. But one thing is sure—when you are too old to learn, you are too old to fly.

Adapted from a safety lecture by Donald S. Buck, Director of Safety, Headquarters, U. S. Continental Army Command, Fort Monroe, Va.



Collision Avoidance Lights

MID-AIR COLLISION! Too often these words jump from newspapers and accident reports to announce a growing problem: collision avoidance.

To avoid a collision, an aviator must see the apposing aircraft and determine its course and velocity while he still has sufficient time to take evasive action. Special paints and colored lights have been used to make aircraft more conspicious, but these are good only for short or medium ranges.

Now a little glass tube, slightly more than an inch long, is helping to solve this problem. The tube is a strobe light which produces repeated intense blue-white flashes of light with remarkable attention getting characteristics.

The light itself is not new. A smaller version is used as a flash attachment on cameras. Another version is used as approach and runway lights at airports. But adapting the light to aircraft as an anticollision device is new.

The strobe light is used in the Honeywell-Atkins Maximum Safety Light System. The system consists of a control panel and eight lights mounted on the wingtips of the aircraft.

Four of the lights face forward and flash at the rate of 160 times per minute. Two face directly outward and flash at 80 times per minute. The other two face to the rear and flash at 40 times per minute.

This arrangement surrounds the aircraft in four sectors of flashing lights (fig. 1) on a horizontal plane and shows the observer the direction of the opposing aircraft. Rapid forward flashing indicates that the aircraft is approaching and calls for immediate action. The medium speed side flashes alert the crew that another aircraft is on a crossing or parallel flight path. The slow speed rear flashes indicate that the aircraft is moving away from the observer.

Present navigation lights provide only three sectors of flashing lights. With this system, an observer seeing a yellow or white light knows that he is overtaking an aircraft. A red light tells him that an aircraft is on his right. A green light indicates an aircraft is on his left.

The brilliant arc lamps are visible in all light conditions (see conspicuity chart). In bright sunlight, or at high altitudes, the intense white light is visible and eye-catching for distances much greater than ordinary lights. During dawn and dusk, when the aircraft's surface and its conventional lighting system tend to blend with the sky colors, the xenon arc flash of the strobe light is easily seen. At night the blue-white light looks much different from stars and land based lights. The flash of the lights is also easily spotted in marginal weather when aircraft outlines and conventional lights are obscured by haze.

Each of the lights that faces forward produces 80 flashes per minute and is synchronized to produce 160 flashes needed in the forward sector. The outboard-directed lights are synchronized with one of the forward-flashing lights, and the rear-directed lights are synchronized with the outboard directed lights. This synchronization is necessary to ensure a smooth passage from one sector to another without a confused double flashing.

An example of the way the Honeywell-Atkins Safety Light System works can be seen in a comparison with the present lighting system.

With the present system, two aircraft approach on a collision course. The aviator in one aircraft sees a red light on the other. He should make a right turn. If, however, the angle of convergence is less than 90°, the rate of convergence is difficult to ascertain. The difficulty with the present system is that the observer has no immediate way of knowing if the angle of convergence is less than 90°.

With the addition of Honeywell-Atkins Safety Lights, it is possible for the observer to know his degree of convergence (fig. 2). If he sees the 160 flashing rate, the correct turn is to the right.

CONSPICUITY

DAY

Conditions	*Average Range*
Bright sun	2 to 4 miles
Clear	4 to 11 miles
Haze and smoke	3 to 8 miles
Overcast	7 to 15 miles
Twilight	11 to 21 miles

NIGHT

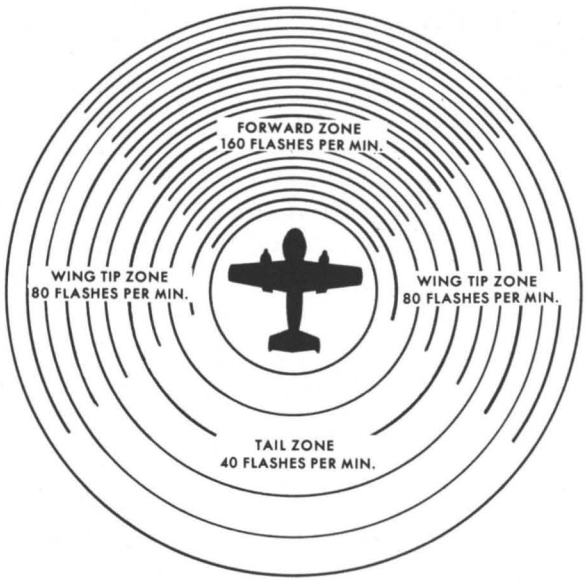
Average Range	*Effectiveness*	*Intensity*
0 - 15 miles	Excellent	70° to 104°
15 - 25 miles	Distinct	40° to 70°
25 - 35 miles	Good	5° to 40°
35 - 55 miles	Fair	3° to 5°
55 - 100 miles	Occasional	1° to 3°

But if he sees only 80 flashes, then the correct turn is to the left.

The flash duration is approximately 0.001 second. This is long enough to be seen by the human eye, yet not so long as to produce a latent image on the retina. Thus, when an aviator sees the flashing light at night, his adaptation to the darkness is not damaged. This short flash has more of an alerting effect than a steady light.

The system weighs about 35 pounds and exclusive of the xenon lamps, has a calculated mean time between failures of approximately 2,000 hours. Life expectancy of the xenon lamps is more than 1,000 hours.

Figure 1



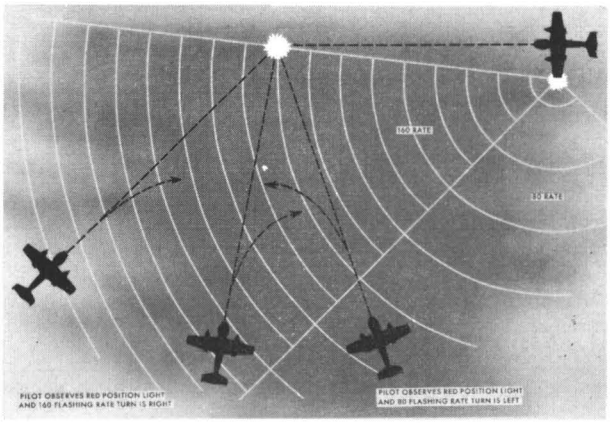


Figure 2

The Federal Aviation Agency has issued approval for the installation and operation of the system on aircraft flying on U. S. airlines for both day and night use. It is in active service on the DC-3, Lodestar, Ventura, Beechcraft, Convair 340, DC-6, C-54, C-121, T-33 and similar aircraft. Army Aviators can expect to see these lights in ever increasing numbers and should know what they mean.

This new system will help to reduce mid-air collisions, but it's still up to the aviator to look for and avoid other aircraft.

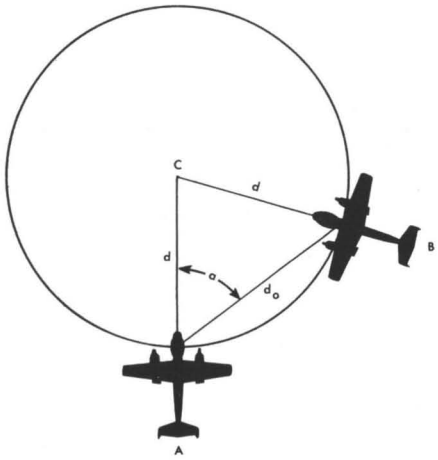
COLLISION GEOMETRY

Regardless of the relative speeds and headings of two aircraft on a collision course, the bearing of one aircraft relative to the other remains constant to the impact point. The aircraft which remains angularly stationary relative to the other aircraft may appear quite harmless but is, in reality, the dangerous aircraft when the two are on a converging course. Caution must be exercised when another aircraft appears stationary, and its direction of motion must be determined as quickly as possible. Once the aviator is aware of the other aircraft and can determine its location relative to his own, he can carry out whatever evasive action is required.

Of interest then is the determination of the sighting distance necessary to provide the required time for evasive action. The distance will be a function of relative velocity and angle of approach, assuming a given warning time.

Figure 3 illustrates an example of two aircraft converging on a collision course. The sighting range is computed as a function of warning time in seconds (t), velocity of the two aircraft in miles per hour (v), and the sighting angle (a). Depending upon maneuverability of the aircraft, the desired minimum warning time generally accepted is 10 to 20 seconds. Figure 4 shows the relation between sighting range in miles and sighting angle required for 10 second and 20 second collision warning.

Figure 3



AIRCRAFT A AND B TRAVELING TOWARD COLLISION POINT C AT VELOCITY (v) IN MILES PER HOUR.

t=TIME IN SECONDS AIRCRAFT A IS WARNED BEFORE REACHING COLLISION POINT C.

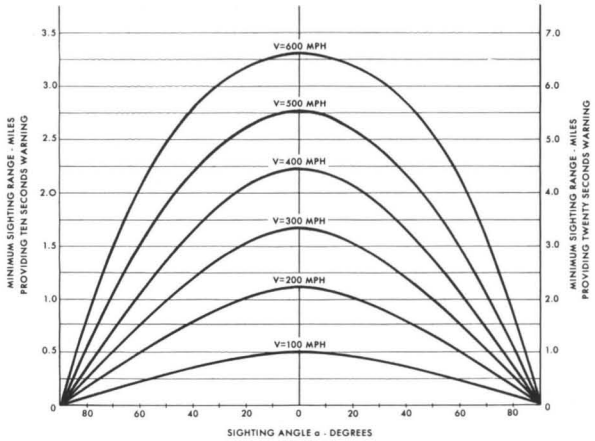
do=SIGHTING RANGE IN MILES REQUIRED FOR (t) SECONDS WARNING.

d=DISTANCE IN MILES BETWEEN AIRCRAFT AND COLLISION POINT.

$d = \frac{tv}{3600}$, $do = \quad do = 2d \cos a$

COMBINING, $do = \frac{tv}{1800} \cos a$

Figure 4



PLANNING The Field Exercise

Captain Ronald K. Andreson

THE OFFICER walked out of the CO's office with a completely bewildered look on his face. The old man had just assigned him the job of preparing and planning a 3-day field exercise for his aviation company. As far as this aviator was concerned, the preparation of a field exercise involved a mountain of paperwork, and a great deal of time and coordination. It was, therefore,

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Capt Andreson is an instructor, Command and Staff Division, Dept of Tactics, USAAVNS, Ft Rucker.

Detailed ground reconnaissance is a must

in his opinion, a task that should only be attempted by an experienced staff section—not by himself.

The problem facing this officer seemed insurmountable. Certainly, he had little background to assist him. Where to start? How to write the plan? What procedures to follow? He couldn't think of an answer to any of these questions.

Sure—at the major unit level (battalion and higher) the preparation of the tactical exercise is a staff function. The planning phase of exercises conducted at this level is detailed. Because of the extensive coordination required, the preparation is usually delegated to a group of officers. At the company level, where no staff sections exist, exercise preparation is normally assigned to one individual. Quite likely, the aviator assigned to this task will have had no previous experience in the preparation of a field exercise. However, this need not mean a reduction in its quality. On the contrary, the beginner can prepare and plan an effective exercise by following certain logical steps and injecting a maximum of his own initiative.

It is quite possible that someday you may be confronted with the problem of planning a field exercise. To answer the questions of where to start, how to plan, and what procedures to follow, let's take a look at the essential steps of exercise planning at the company level.

The preparation begins with the commander's directive. In the company unit this is generally an oral directive and includes, as a minimum, the purpose, the type of training to be stressed, and the time and place the exercise will be held.

For clarity, assume a situation. The CO of a divisional aviation general support company has directed you to plan a 3-day field exercise for the unit. The purpose is to determine the company's ability to provide aviation support to a division force in the conduct of a mobile defensive operation. In particular, the commander wants to stress the performance of continuous operations while conducting aerial escort, reconnaissance, and surveillance missions over the division sector. After defining the terrain area available for the problem, he states that the remainder of the preparation is your responsibility and that he expects to see your plan within 10 days.

The commander has issued the basic instructions of the exercise directive. Now you are ready to begin the detailed planning that will contribute to the success or failure of the problem.

Your first step should be the research of all pertinent material. Information gained from the research phase allows you to place the problem in an authentic and realistic environment. A realistic exercise will command the interest and enthusiasm of the participants. Take another look at the purpose: to measure the company's ability to provide aviation support to a division force in the conduct of a mobile defensive operation.

This will be the central theme of the exercise. You need to determine how the division size force conducts a mobile defensive operation and what support requirements are expected of aviation. Reference sources are numerous and include field manuals, subject schedules, service school publications, ATTs, and copies of previously conducted problems. Where possible, consult persons who have experience in the planning of similar exercises.

Your research must also include the choosing and development of the aggressor force. The aggressor should not be arbitrarily designated. Field Manuals 30-102 and 30-103 contain detailed information of the history, capabilities, and structure of aggressor units. Use of these two references in the selection of aggressor forces will add to the authenticity of the exercise.

Your second step of exercise preparation is a reconnaissance of the terrain available. To make effective use of the area allocated to the problem, you must conduct a thorough reconnaissance both of tactical maps of the area and the terrain itself. Of prime importance is the selection of the airfields and heliports to be occupied by your unit. Additionally, locations must be selected for the drone section. Other considerations include locations for specific aggressor activities, simulated locations of friendly units, and the routes to be used by ground elements of your unit.

Your reconnaissance complete, you are ready to assemble the facts and begin writing the exercise. The written portion of the problem is termed the scenario, and its composition is the heart of the planning phase. The scenario is the story of the exercise. Quite naturally its effectiveness is largely dependent upon the effort spent on the research and reconnaissance. The scenario consists of a series of tactical situations arranged in sequence to provide continuous problem play. Each situation must be adaptable to the training objectives outlined in the commander's directive. A scenario has four elements: a general situation, an initial situation and requirement, subsequent situations and requirements, and a time schedule.

The unit commander should receive the general situation at least 24 hours before the beginning of the exercise. It includes a description of the opposing forces, the general mission and activities of the friendly forces, and the capabilities of each. The situation and intended operations of the friendly forces two echelons higher than the aviation general support company are given. Therefore, you must explain the division situation to your unit. Reference should be made to the intended mission that aviation elements will be assigned. This element of the scenario will require no action from your unit. Its purpose is to provide a base of information that will ensure smooth transition into the tactical play of the problem.

The initial situation requires the company to commence tactical play of the problem. It is written so that a logical solution on the part of the commander should start the exercise along the desired lines. The commander must be informed and understand exactly what is expected from his unit. The operations order or the warning order are commonly used formats for the initial situation.

The initial situation seldom provides training in all aspects of the exercise objective. It is generally necessary to prepare and inject into the play of the problem subsequent situations at predetermined intervals. As a rule, the subsequent situation will require major additional action by the participating unit. For example, a change in the division situation that would require the company to displace to another airfield is justification for the insertion of a subsequent situation. Care must be taken to maintain the continuity of the exercise when inserting subsequent situations.

A time schedule is a breakdown of the problem into the planned time devoted to each situation. The sequence of events is normally used in conjunction with the time schedule. Its purpose should be to impose specific requirements on specific elements of the company. When planning the sequence of events include the date/time, action requirement, and the element of the company that will perform the event. Here again, emphasis is placed on exercise objectives indicated in the commander's directive. In our example, specific requirements will be inserted that call for the unit to perform aerial escort missions, reconnaissance missions, and surveillance missions. The sequence of events will also encompass other requirements that will round out the exercise and provide for continuous play. Intelligence, CBR, and aggressor attack situations are written into this portion of the scenario. Activities should be planned for each element of the company. Overcome the tendency to place all requirements on the performance of operational aviation missions. Insert problems that require maintenance, supply, and administrative personnel to perform their normal functions in a tactical environment.

These are the basic steps of field exercise preparation for the company size unit. The field exercise, when realistically executed, is the best means of increasing your unit's ability to perform its primary mission: effective support of the ground force. Likewise, the foundation upon which the success or failure will hinge rests in the planning phase. Adherence to the format mentioned here does not in itself produce successful planning. Your unit will benefit from the training only to the extent of the effort and initiative that you put into the plan.

Seek the experience factor gained by others

THIS IS A CRASH FACTS MESSAGE

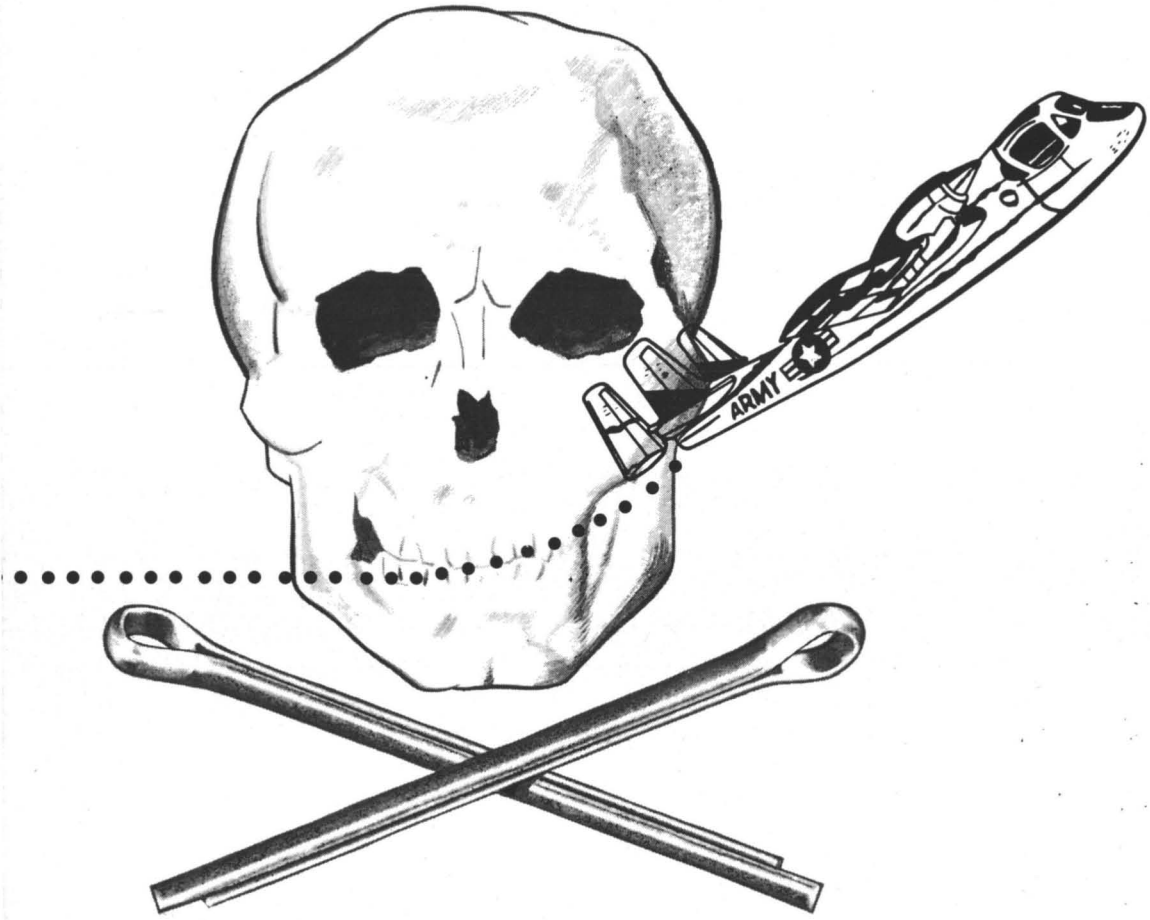
1. DATE - 18 JULY 1963
2. AIRCRAFT TYPE - OV-1C
3. FORCED LANDING–NO DAMAGE
4. OPERATOR DUTY - PILOT
   MISSION OF FLIGHT - SERVICE
   NAME - BENJAMIN, WILLIAM J.
   SERVICE NUMBER - 02266133
   GRADE - CAPTAIN
   USE OF SHOULDER HARNESS - YES
   DEGREE OF INJURY - NONE
5. N/A
6. N/A
7. AIRCRAFT WAS IN STRAIGHT AND LEVEL FLIGHT AT CRUISE POWER AND PROP SETTINGS AT APPROXIMATELY 1,500 FEET. THE AIRCRAFT WAS TRIMMED FOR THIS CONDITION AND GAVE NO UNUSUAL INDICATIONS. SUDDENLY, THE AIRCRAFT SHOOK VIOLENTLY AND THE NOSE PITCHED UP RAPIDLY. FULL FORWARD PRESSURE WAS APPLIED TO CONTROL STICK AND THE PILOT USED BOTH HANDS TO STOP THE NOSE FROM GOING HIGHER. PITCH ATTITUDE REACHED APPROXIMATELY 50° NOSE HIGH BEFORE STABILIZING. AS THE AIRSPEED DECREASED, THE NOSE BEGAN TO LOWER AND THE AIRCRAFT STARTED ROLLING TO THE LEFT. DIRECTIONAL CONTROL WAS MAINTAINED WITH AILERON AND RUDDER. STICK PRESSURE WAS REDUCED AND THE PILOT WAS ABLE TO HOLD ATTITUDE WITH ONE HAND AS HE REDUCED POWER TO APPROXIMATELY 20 PSI AND ROLLED IN FULL NOSE-DOWN TRIM. WITH THE AIRCRAFT UNDER CONTROL, POWER WAS INCREASED TO 30 PSI AND THE AIRSPEED STABILIZED AT APPROXIMATELY 150 KNOTS. FORWARD PRESSURE WAS STILL NECESSARY BUT COULD BE HELD WITH ONE HAND. THE AIRFIELD TOWER WAS NOTIFIED AND ONLY SLIGHT FORWARD STICK PRESSURE WAS NECESSARY TO ACCOMPLISH A NORMAL LANDING AT REDUCED POWER SETTINGS WITH NO DAMAGE TO THE AIRCRAFT.
8. WEATHER WAS NOT A FACTOR.
9. SUSPECT MANUFACTURE OR INSPECTION DEFICIENCY. COTTER PIN MISSING FROM MOUNTING BOLTS OF ELEVATOR TRIM PUSH ROD ASSEMBLY. CONDITION OF ZINC CHROMATE COATING INDICATED PIN HAD NEVER

BEEN INSTALLED.

10. PARTS NUMBERS – ELEVATOR TRIM PUSH ROD ASSEMBLY, 134CZ0029-3; BOLT, NAS 1104-21D; BOLT, NAS 1104-14D.

Thanks to his strong arms and skillful flying, this missing cotter pin cost Captain Benjamin only a few moments of terror. The results might have been far different had he been IFR or just breaking ground during takeoff.

Other missing pins have cost lives and aircraft (see CRASH SENSE, July 1962 and September 1962).



Component Life

Major Joseph A. Gappa, Jr.

AN AIRCRAFT from another service was in normal cruise flight at 500 feet. Suddenly one main rotor blade snapped off and fell away. The aircraft crashed out of control and exploded, killing all five aboard.

The cause of this accident was materiel failure of the rotor blade due to fatigue caused by cyclic stresses. A check of the records disclosed that the blade should have been condemned 100 flying hours before. But because of an error in time computation on the component card, the blade was left on the aircraft. This check also revealed that the blade probably had other operating hours which were not recorded in addition to the 100-hour error.

Another helicopter crashed during landing due to failure of the lateral aft screwjack assembly at the lower mount. The screwjack should have been replaced at 1,000 hours. At the time of the accident, it had operated 220 hours over the time limit. The form for logging daily running time totals on components did not contain a column for screwjacks.

Maj Gappa is with the Human Factors and Engineering Division, USABAAR. He is an aeronautical engineer.

Though the principles in the following description apply to any helicopter, the factual information does not. This information pertains only to the UH-1B. Portions of it, in tabular form, can be found in TM 55-1520-211-10. The remainder has been prepared by the Bell Helicopter Company.

Probably the least understood but most important airspeed limitations of any helicopter are those imposed by component life.

Why is airspeed limited due to component life? How is component life established? The answers to these questions are of immediate importance to all aviation personnel who operate or maintain helicopters.

The first barrier to pushing on to greater airspeeds is not power limitations or blade stalls. Rather, it is component life limitations.

What components? The answer to this is any component subject to failure through normal operation—a pitch change link, swash plate drive scissors, rotor blade, etc. The term "normal operation" is the key to establishing component life.

Using the pitch change link, for example, we could establish a spectrum of loads to which this link is subjected and their frequency of application as the air-

Figure 1

OPERATING LIMITS

DENSITY ALTITUDE	CALIBRATED AIRSPEED - KNOTS							
	6600 LB OR LESS		7200 LB		8000 LB		8500 LB	
RPM	6400	6600	6400	6600	6400	6600	6400	6600
SEA LEVEL TO 2000 FT	120	120	109	112	95	101	86	95
3000 FT	116	116	105	108	92	97	82	92
6000 FT	102	106	92	97	77	86	68	80
9000 FT	90	94	79	86	65	76		
12000 FT	77	84	66	75				
15000 FT	64	72						
18000 FT	51	61						

FROM 0 TO 70 KNOTS USE 5800 TO 6600 RPM RANGE - S.L. TO 2000 FT.
FROM 70 TO 120 KNOTS USE 6400 TO 6600 RPM RANGE

REDUCE AIRSPEED WHEN VIBRATION IS EXCESSIVE

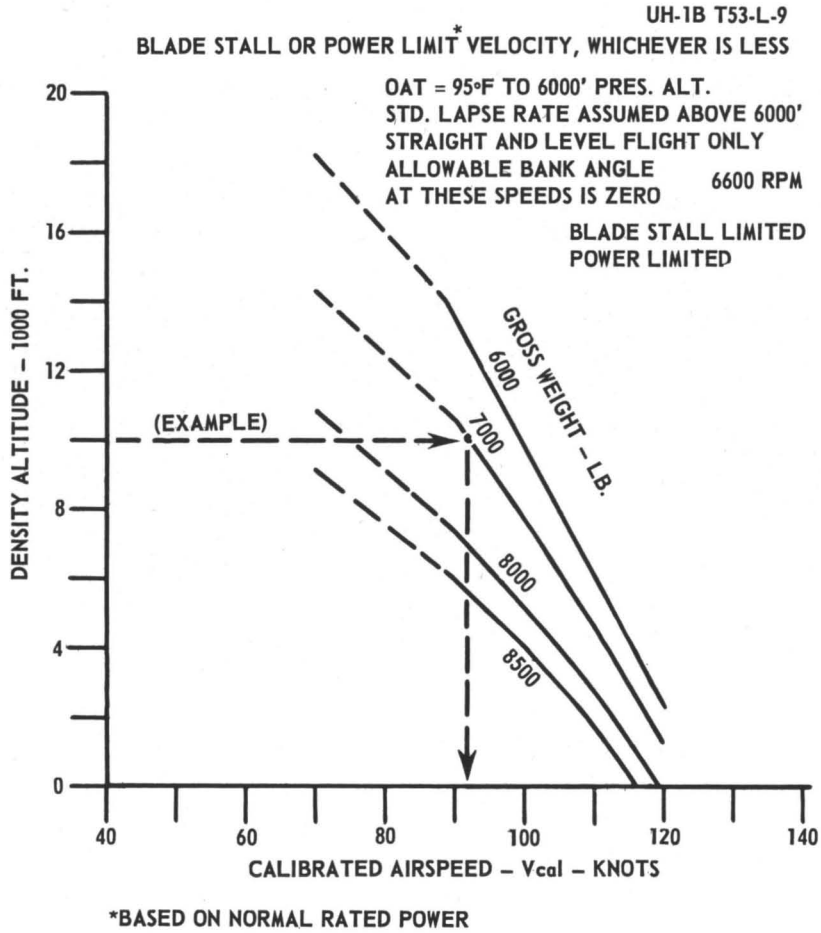


Figure 2

craft is flown in its various modes of flight. But we know that one mode of flight can and will place greater stresses on the link than another. How then is the total life of the component divided into numbers of hours in high, intermediate, and low stress ranges? Projected usage, past experience, and instrumented tests provide most of the needed information. Normal operation is assumed. Other than traditional safety factors, no provisions are made for overstress.

Although the process is not a simple one, and considerable time is needed to conduct the actual tests, an item under test is subjected over a spectrum of stresses for periods of time considered necessary or until failure occurs. This is a simple explanation of how component life is established.

Figure 2 shows how component life is the first obstacle to greater airspeed. It is a graph of blade stall or power limit (whichever is less) under various conditions of density altitude vs calibrated airspeed for standard day conditions. Comparing figure 2 to figure 3, it can be seen that blade stall or power limits are less likely to occur than component life limitations. But this is only true as a general condition. The -10 points out it is possible to encounter blade stall within the operating range under conditions of high gross weight, altitude, high airspeed, acceleration, or low rpm. Up to this point we are still speaking of ideal conditions—straight and level flight with no wind gusts.

What positive indication can a pilot expect when component life (placard) limits are exceeded? Ideally, a change in flight characteristics, vibration, or sound would be desired. But a comparison of figure 2 and

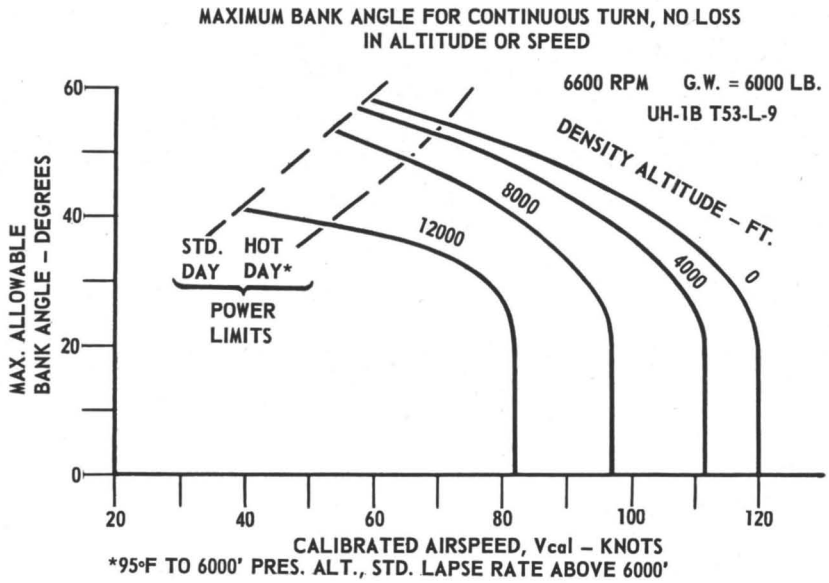


Figure 4

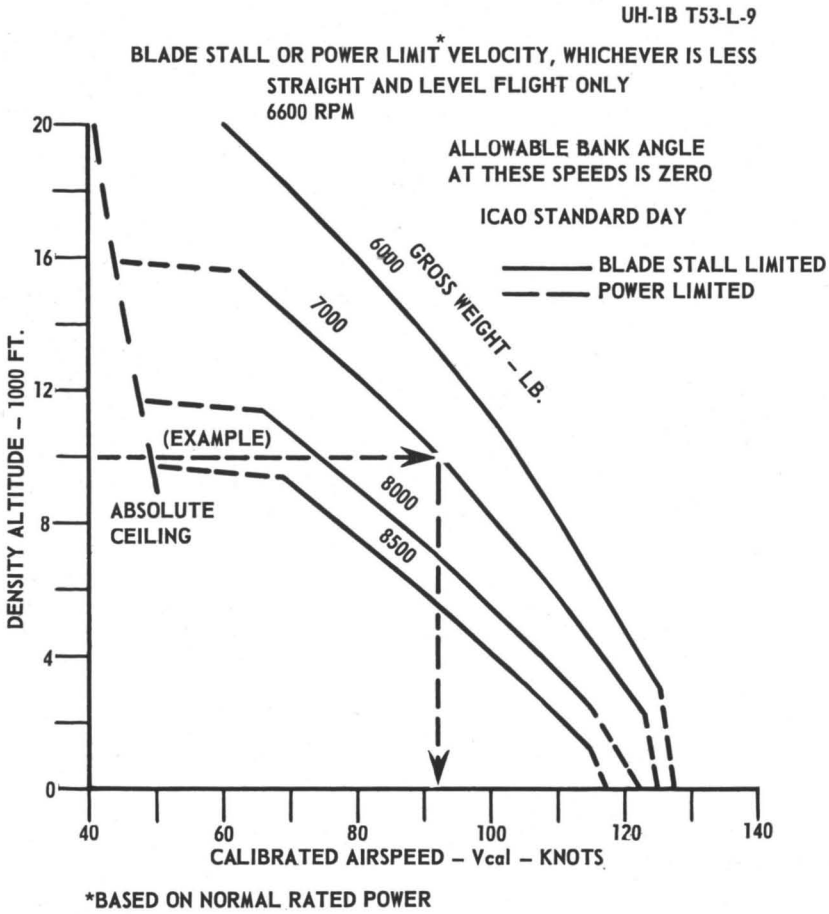


Figure 3

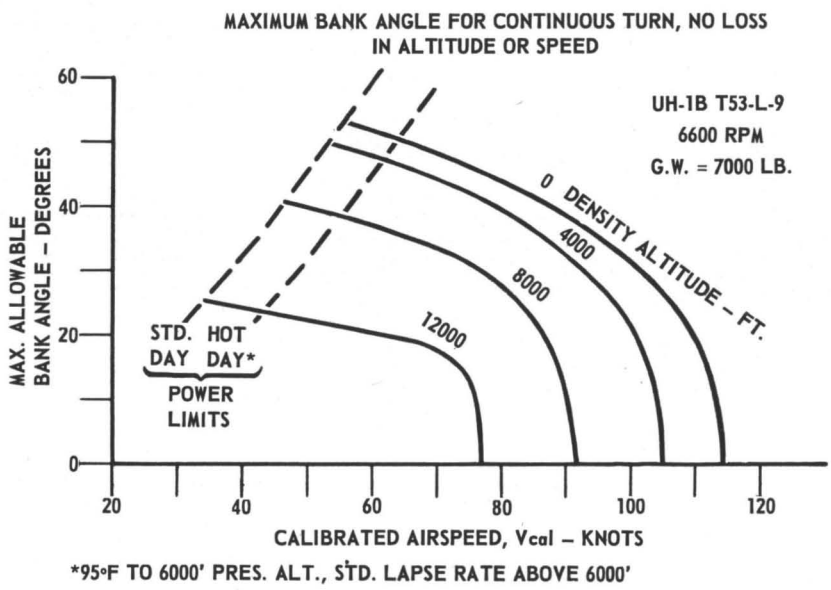


Figure 5

figure 3 shows that blade stall limits are *generally* greater. Because of this, component limits can be exceeded with no warning.

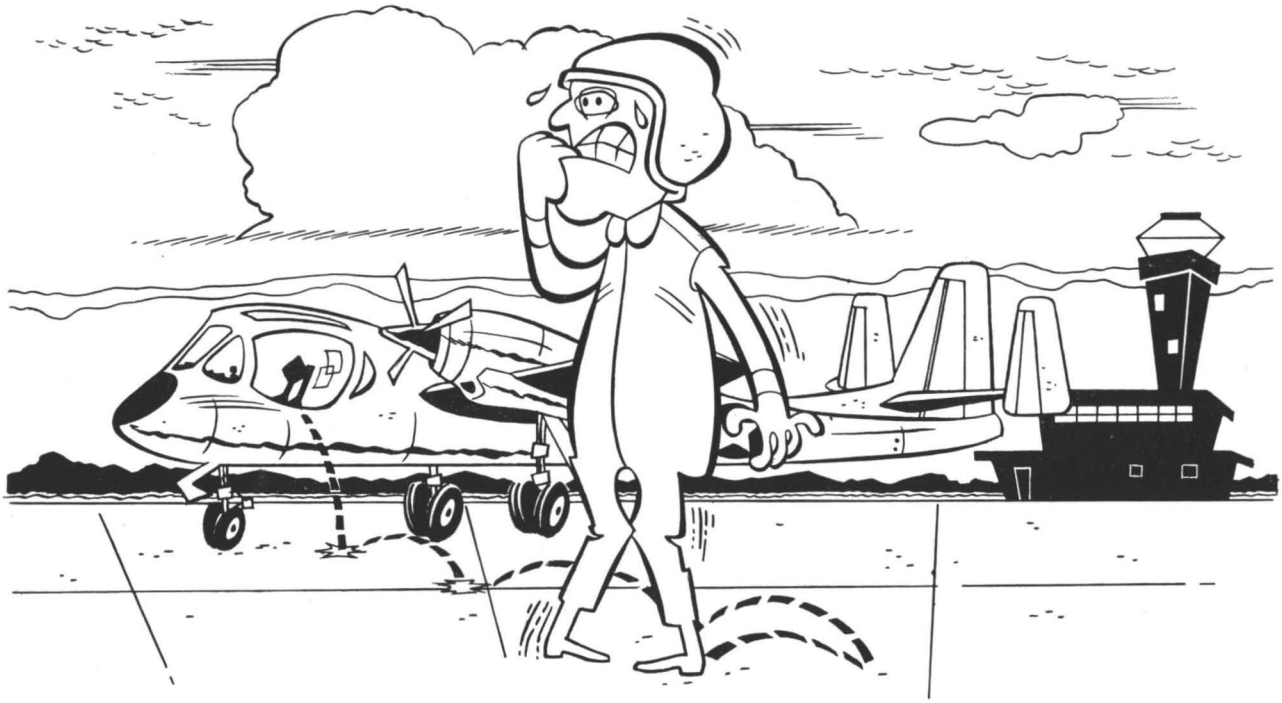
Components are designed with a life expectancy based on the normal operating range. Stresses beyond this range subject a component—such as our pitch change link—to an unplanned and shortened life. How would *you* feel about flying a helicopter a few hours before the pitch change links were scheduled for replacement if you knew the aircraft had been consistently operated beyond placard limits? And how would *you* feel about flying the same helicopter if you knew a component had not been replaced as scheduled?

An example of how permissible airspeeds must be reduced due to bank angle for various density altitudes and two specific gross weights can be seen by comparing figure 4 (6,000 lbs.) and figure 5 (7,000 lbs.). Note the constrictions of a 1,000-pound addition in gross weight from figure 4 to figure 5. Also note that the figures in these graphs are based on the lowest of the three airspeed limits—component life, blade stall, or power. Component life limits are generally the first speed limit encountered.

We have described how component life limits are established and given you examples of the consequences of failures to abide by them. We have shown how added gross weight, increased density altitude, and bank angles impose additional component life restrictions. We hope you will refer to the -10 for the limitations of the aircraft you fly. And we hope you will give the same consideration to component life limitations that you give to your personal health. Your life may depend on both.

SHARE IT

an anonymous report of a near accident or flight hazard



OBVIOUSLY, the gent above has just gone through some type of nerve-wrecking experience. If he could tell us about it, chances are we could all learn how to avoid or cope with whatever it was that has him biting his nails. Up to now, unless he had an accident, an incident, or a forced landing, he'd have no way to pass on what he learned and he would be the only one to benefit.

This is no longer true. By the time this is published, the Army-wide SHARE IT near-accident and flight-hazard reporting system will have been launched. Automatic distribution of forms and posters will be made to all Army Aviation units.

We can all learn from near-accident and flight-hazard reports. They have proved a valuable prevention tool in the other services' air safety programs. Following are some near-accident and flight-hazard reports recently received by USABAAR.

"On 23 May 1963, I was flying on a VFR clearance when I experienced a near-accident.

"After level-off at 2,000 feet I looked to my left front and below and saw a jet aircraft approaching at a high rate of speed in a climb attitude on a 90° collision course toward my aircraft. I immediately pulled the Otter into a steep climbing left turn to avoid the other aircraft. The jet continued on its flight path and came within 100-200 feet of me as it passed forward and beneath. The time lapse from first observing and passing the jet was approximately 6-8 seconds."

"On 24 June, I was flying on a VFR clearance when I experienced a flight hazard.

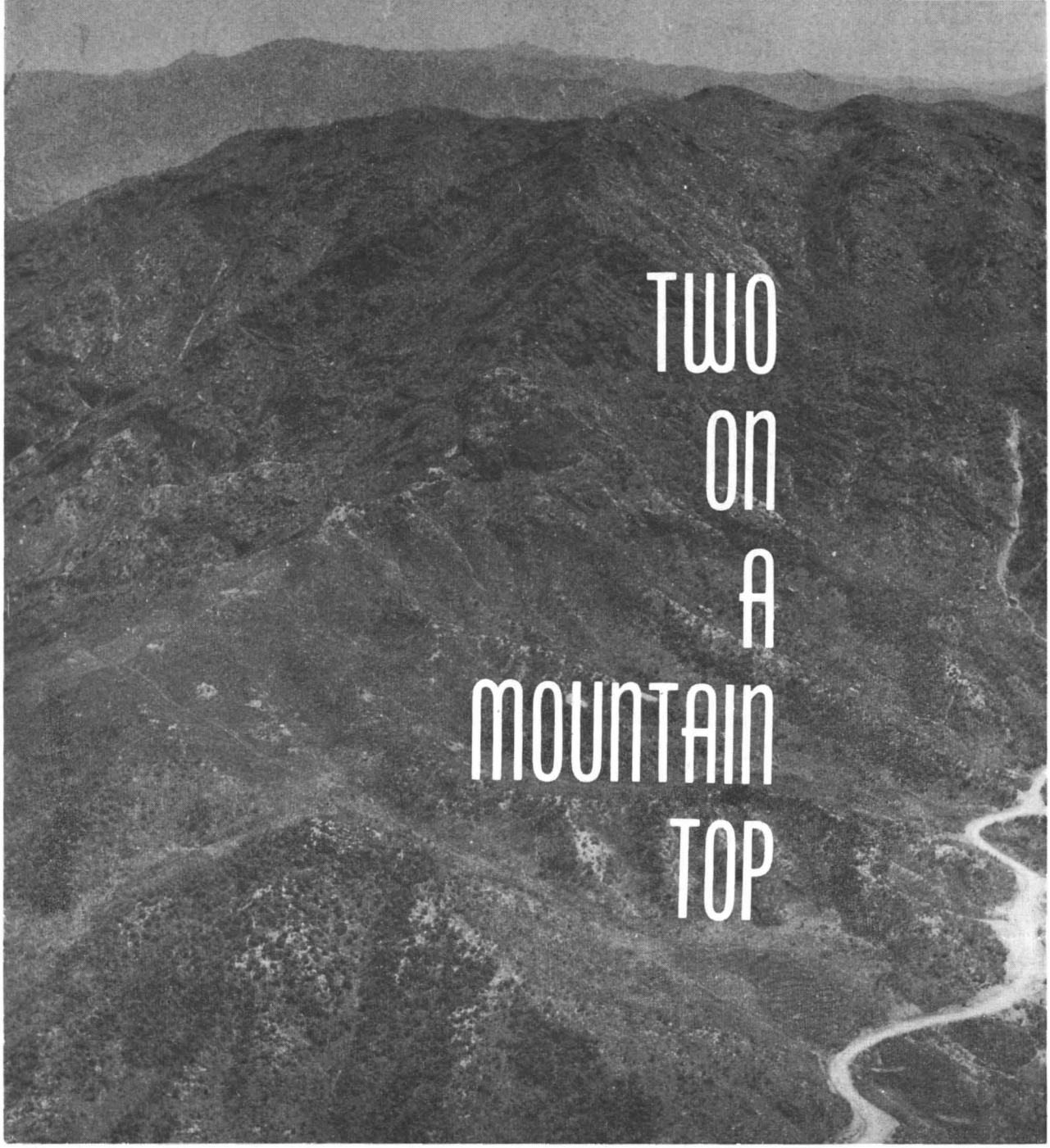
"This is what happened: I had called the tower over the homer for landing clearance. They cleared me straight in to runway 28. The ceiling was about 800 feet and visibility approximately three miles. When I was about four miles out on final, a C-54 came down out of the overcast about one mile ahead of me. He was on a three mile final with gear and flaps down. I called the tower and asked them if they were aware of the C-54, and the tower operator replied that he had no radio contact with the C-54."

"On 3 May, I was flying on a VFR clearance when I experienced a flight hazard.

"This is what happened: At approximately 1400 hours, I approached the airfield from the south and asked for landing instructions. Communications were garbled but I received instructions for a right turn to base leg for runway 8. I was cleared to land and at touchdown noticed that we were landing slightly downwind and that another U-6 was on short final for landing on the same runway in the opposite direction. The pilot of the other aircraft saw us and executed a go-around. Later discussion with the pilot of the other aircraft revealed that he had been cleared by the tower for his landing to the west. He had VHF and we were on UHF."

Won't you please see to it that these forms and posters are prominently displayed—and used—when they reach your unit?

This article was prepared by the United States Army Board for Aviation Accident Research.



crash sense

PREPARED BY THE U. S. ARMY BOARD FOR AVIATION ACCIDENT RESEARCH

COMPLETING his reconnaissance, the OH-23F pilot set up his approach to the east. The weather was clear—temperature 65° F, wind calm, density altitude 5,800 feet. His approach was normal until the last 40-50 feet when he realized the rpm was low (3000). He applied full throttle but the rpm continued to fall. He held what pitch he could in an effort to reach the pad.

The aircraft touched down along the forward slope of the pad, with the left skid approximately 1 foot below the level area. It began to roll forward due to its forward speed, and the pilot applied collective pitch, raising it up and over the pad in a nose-low attitude. Engine rpm dropped to 2800. As the helicopter continued over the pad, the pilot applied right pedal in an attempt to regain rpm.

Completing a 180° turn, the helicopter settled into the brush, facing the helipad in an upright, tail-low attitude. There were no injuries.

From the Pilot's Statement

"I have no doubt the primary cause of the accident was my permitting the engine rpm to lower to 3000. I believe this happened shortly after I lost translational lift. Prior to this, my rpm had been holding at a steady 3200.

"There was never an opportunity for a go-around once the engine rpm was down to 3000, as the aircraft was out of translational lift and did not have sufficient power remaining.

"I did not, I am certain, experience settling with power.

"The only slightly extenuating circumstance I can think of is the fact that this was my first flight in this particular aircraft and the throttle correlation apparently differed from that of the other OH-23Fs I have flown. I recall, however, hearing another pilot say the day before that the throttle correlation didn't seem right to him, so I should have been more conscious of this possibility."

Cause Factors Listed by Investigation Board

1. Pilot failed to maintain adequate rpm during the final phase of the approach.

2. Inattention of the pilot on final approach allowed the engine rpm to drop from 3200 to 3000.

3. The correlation between collective pitch and throttle was less responsive than previous OH-23Fs the pilot had flown.

4. The relatively shallow approach made by the pilot and the early loss of translational lift restricted his go-around capability during the final phase.

5. It is suspected that the pilot inadvertently applied collective pitch at the time he applied full throttle, causing a further loss of rpm.

6. Lack of training and experience of the pilot in helicopter operations at gross weight above density altitudes of 5,000 feet.

7. Improper recovery technique was employed after initial touchdown to regain lost engine rpm.

8. It is suspected that unnecessary people too close to the landing pad distracted the pilot after initial touchdown.

Recommendations of the Investigation Board

1. That a standardization program be established to train and check the proficiency of all newly assigned pilots prior to their being assigned a service mission. The time required for each pilot will vary due to previous flying assignments and past experience. Under no circumstances should this program be sacrificed by operational commitments.

2. That this transition program be closely supervised to include checkrides to ensure that pilots practice the required maneuvers. This should eliminate the practice of flying transition time without gaining proficiency.

Statement of Reviewing Official

1. Concur with the findings and recommendations with the exception of cause factor number 3. The *possibility only* exists that the correlation may have contributed to the accident. Further investigation of the controls was prohibited due to damage sustained from the UH-19D accident (see below).

2. It should be noted that this pilot had 62 hours in the OH-23F before the accident, and this was his fourth approach and landing to this point. Lack of recent experience in this aircraft is doubtful.

3. This pilot did not use the solo time during transition training to practice all of the maneuvers he is expected to perform in daily operations.

4. This and other accidents point out the need to establish a mountain helicopter training program. Current and projected commitments make it difficult to establish such a program at this level of command.

5. Recommend area standardization board be augmented to include high altitude mountain helicopter training.

ACCIDENT NUMBER 2

Two days later, a UH-19D flew to the accident site to drop off a member of the investigation

Top: Photo of UH-19 as it came up over edge of pad following first impact. Note high angle of attack of main rotor blades with no appreciable coning, indicating ample rpm. MP was 38½″ at this point. Bottom: UH-19 came to rest below wreckage of OH-23. Note front wheel crumpled by first impact.

board and two other passengers for the investigation of the OH-23F accident. The pilot made a low pass over the pad and elected to make his approach to the east southeast.

He encountered an updraft on short final of his first approach and made a go-around. On the next approach, he shallowed his approach to about 8°. Forward motion stopped just before the aircraft reached the pad, and it began to settle. The aircraft nose gears and lower clamshell struck the side of the hill about 10 feet from the edge and 2 feet below the pad level. Both nose gears were sheared at this time.

Hesitating a moment, the aircraft then nosed up over the pad in a normal attitude with forward motion and full power. It proceeded across the pad and the right main gear struck the ground just to the right of the leveled pad and on the opposite side from initial impact.

The aircraft tilted to the right and struck the wreckage of the OH-23F. It then crashed just below the OH-23F on its right side, with the tail section downhill. There were no injuries.

Discussion

Density altitude at the time of this crash was computed to be 5,900 feet. The weather was clear, visibility unlimited, and the wind was light and variable. The prevailing wind was from the left front during the approach.

The first approach was aborted due to an updraft and the second approach was more shallow in anticipation of the updraft. Both pilot and copilot reported that the aircraft's forward speed dropped to near zero just short of the pad. Settling was encountered and continued until the front gears touched the hill.

The most logical reason for the settling would be from turbulence caused by the wind moving over the trees to the left front of the helicopter and to the left of the pad. Some forward speed at initial impact was reported by two witnesses located to the right of the flight path.

After the gear collapsed, full power was applied and a considerable amount of collective pitch was added. The pilot stated that the go-around was attempted rather than an attempt to land on the pad. This decision was influenced by the presence of personnel near the pad.

The "hovering out of ground effect" chart in TM 1-1H-19B-1, March 1959, indicates that hovering under the existing weight, 7,228 pounds, and atmospheric conditions would have been possible, but in the marginal area. Variable wind conditions could have overbalanced the capabilities of the aircraft.

In summary, the approach was shallow and too slow in the final 100 feet prior to touchdown. Any deviation from a perfect set of conditions would have adversely affected the approach. As for what condition caused the settling, this would be strictly conjecture. However, wind conditions were considered the most logical explanation.

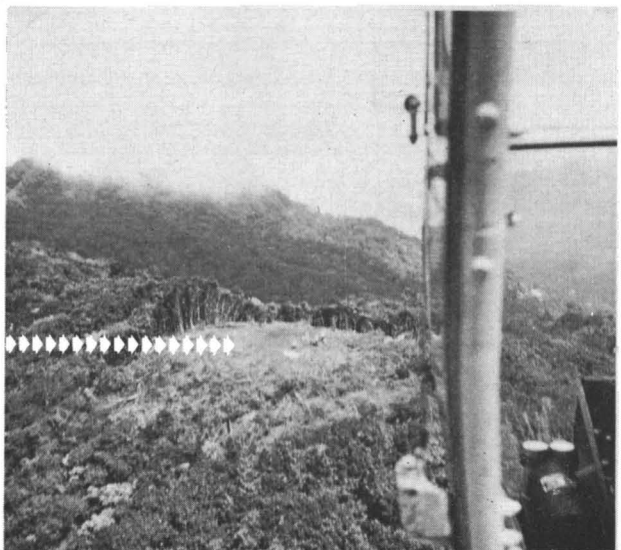
Cause Factors Listed by Investigation Board

1. Misjudgment of speed and altitude in final phase of approach.
2. Incorrect technique employed in recovering from an adverse condition caused by settling.
3. Lack of experience in high altitude flying.
4. Weight in excess of local directives.
5. Presence of personnel near pad influenced pilot's estimate of the situation.

Recommendations by the Investigation Board

1. Establishment of a training program for high altitude helicopter operations.

Arrows show shallow approach flight path



Depressions mark point of first impact

2. Provisions of local memo (density altitude vs gross weight restrictions) receive added emphasis.

3. That a minimum number of personnel be near any pad or landing area during the operation of aircraft.

Statement of Reviewing Official

1. Concur with the findings and recommendations with the exception of cause factor number 4. The local memo indicates the maximum gross weight should not have exceeded 6,775 pounds for a density altitude of 5,900 feet. However, the aviator was not flying a unit mission or in a unit aircraft. Rather, he was flying for the aircraft accident investigation board under the supervision of ..... Therefore, the provisions of the local memo do not apply. The aviator did use TM 1-1H-19B-1 and was within the maximum gross weight for the density altitude.

2. A review of UH-19D accidents indicates the density altitude charts in the current TM 1-1H-19B-1 should possibly be re-evaluated in view of the age of this type aircraft.

3. This and other accidents point out the need to establish a mountain helicopter training program. Current and projected commitments make it difficult to establish such a program at this level of command.

4. Recommend area standardization board be augmented to include high altitude mountain helicopter training.

FAA ADVISORY CIRCULAR 00-12

The FAA reports a case in which an airline pilot's navigational computer (1936-37 model) suddenly began smoking in flight and was difficult to extinguish. Enough smoke was produced in 30 seconds to seriously restrict visibility in the cockpit.

The cause of ignition of the computer was not known. However, investigation of this incident revealed that all navigational computers manufactured prior to 1939 were made of cellulose nitrate sheet (commonly known as Celluloid), which is a highly inflammable material. Since 1940, most navigational computers and plotters have been made of rigid vinyl sheets which will not burn or smoke.

The potential hazard associated with use of celluloid computers, particularly in the presence of lighted cigarettes or concentrated sun rays is serious. All flight crew members are cautioned about the hazard associated with the use of computers or other equipment made of celluloid material.

WHAT'S YOUR LINE?

Sudden loss of power control forced a helicopter pilot to autorotate into rough terrain. The aircraft was wrecked, but the occupants escaped without serious injuries.

Investigation revealed an open throttle linkage. The missing bolt could not be located.

The aircraft was on its second flight after a periodic inspection. It must be assumed that the missing bolt was not properly safetied at the time of the last inspection.

Which of the following methods should responsible management use in response to this accident?

Who-Do-We-Hang Method:

Pick the last man who should have caught the deficiency—the pilot. If he had made a thorough preflight, he would have noticed the missing safety wire or loose nut. Why do we have these fellows climb all over the aircraft if it isn't to check these items? Let's ground him and put him up for an evaluation board!

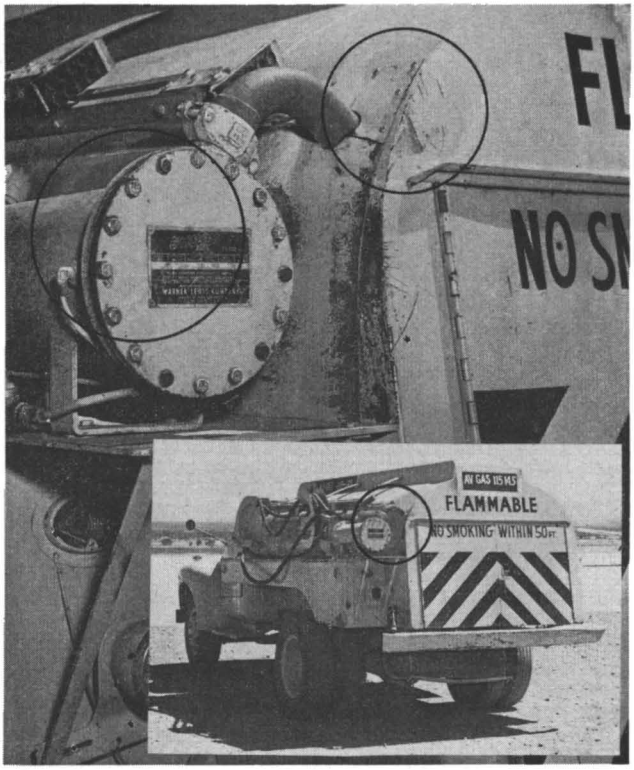
Stick-to-the-Letter-of-the-Regulation Method:

If the bolt had been safetied, the accident would not have happened. Therefore, the missing piece of wire was the cause of the accident. This also makes it easy to form recommendations which are supposed to prevent recurrence of the same type accident. Tell the pilots and mechanics to keep their eyes on this particular bolt and recommend that this accident be given Army-wide attention.

Where-Do-We-Come-In Method:

This accident involved more than a penny's worth of wire. Of course the pilot was involved, but so was the crewchief, and the mechanic who performed the P.E., and the mechanic's inspector, and the inspector's supervisor, and the supervisor's supervisor, ad infinitum, until the whole mess landed right on our own desk. If all these experts can overlook such a basic item, there must be something wrong with the standards of performance in our unit. We'll have to see to it that this is going to be our last maintenance-error accident and that our pilots will no longer treat the preflight as a formality.

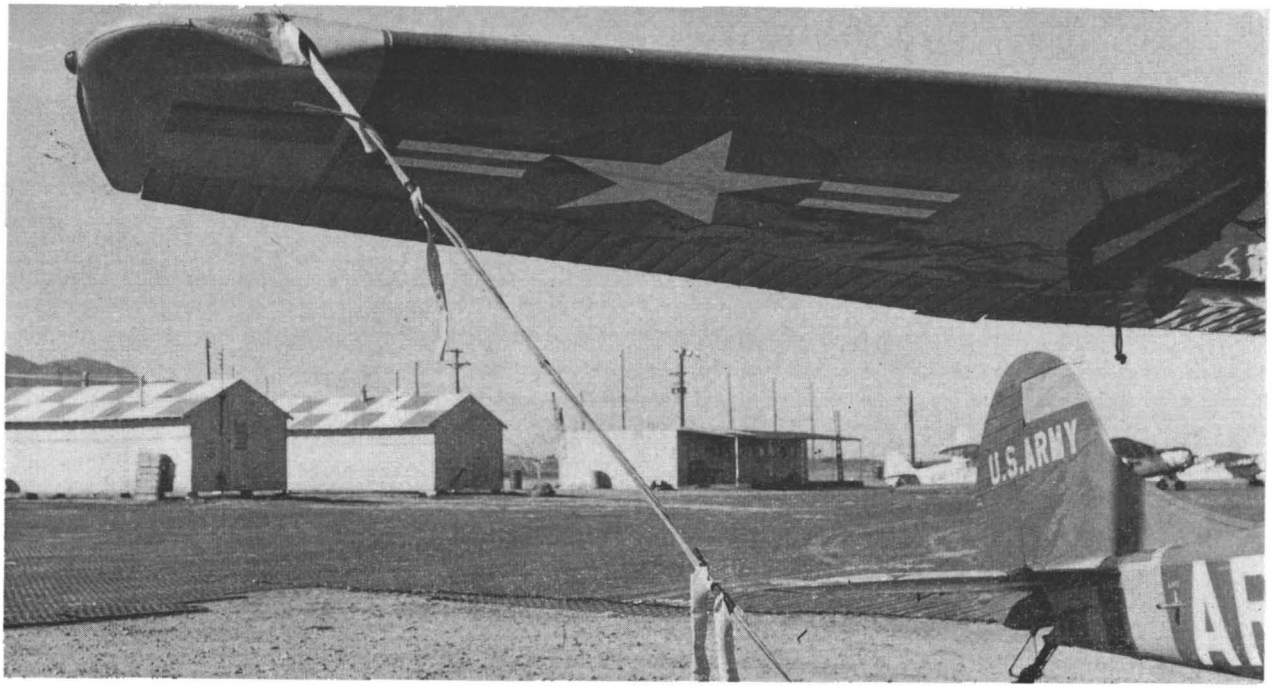
This is an elementary illustration of a commander's dilemma when confronted with the symptoms of failure. If efficiency and mission accomplishment are your prime concern, rather than the absence of accidents, you should never have a problem making the right choice between scapegoatism, camouflage, or self-evaluation.

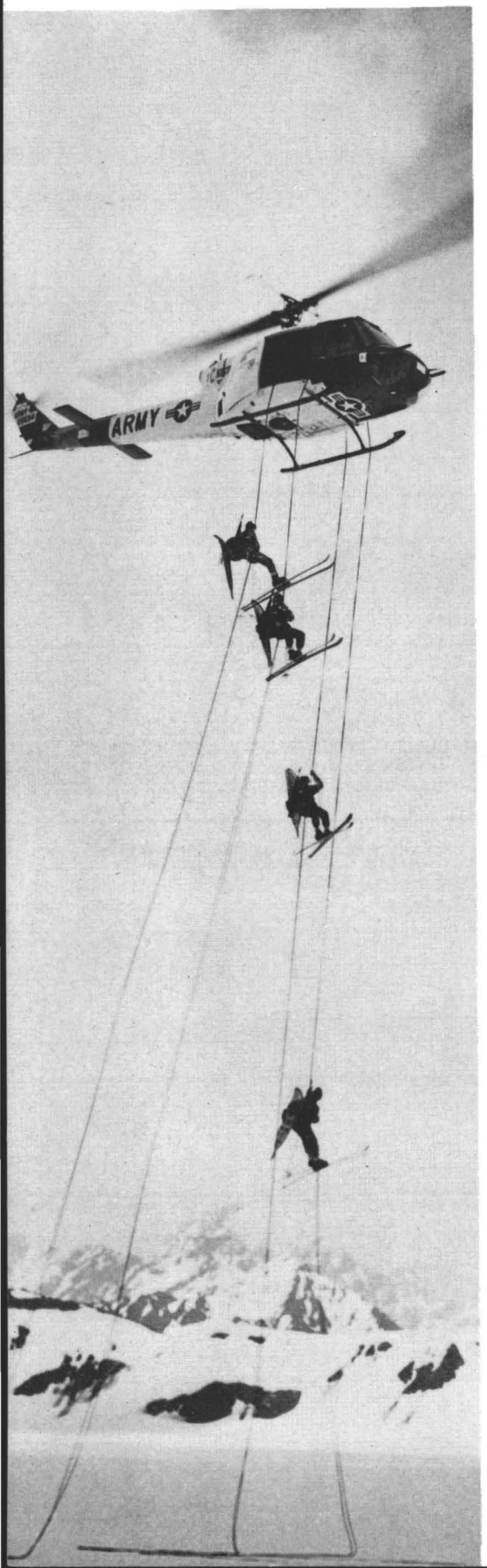


Ground Handling Accidents Take Their Toll

Above: Fuel truck backed into U-8 aileron, causing major damage to aileron and wing

Below: Towed Bird Dog trips on well marked guy wire. Impact also buckled undersurface of wing and top of center section.





GOING DOWN —OR UP?

U. S. ARMY, Alaska, has perfected a method to deliver troops by air without parachuting and without landing the aircraft.

The new method combines mountaineering techniques with heliborne operations and allows fully equipped troops to rappel from a hovering helicopter into areas where it is impossible to land the aircraft.

Besides the obvious advantages of allowing the men to be delivered into heavily timbered areas, swamps, city rooftops, or steep mountainsides, rappelling has an especial value to northern operations. Often in Alaska an area will be unforested but covered with deep powder snow. When a helicopter attempts a landing, the terrific downdraft created by the rotors causes a ground blizzard which obstructs the pilot's vision.

Early rappelling experiments were started by the 82d Airborne Division at Fort Bragg, N. C., and the 101st Airborne Division, Fort Campbell, Ky. USARAL Combat Developments Agency started tests this spring to perfect methods of helicopter rappelling. They have standardized methods and published the results of their experiments for use by other Army units.

Arctic and sub-Arctic conditions increase the problems of Alaskan rappellers because a man must carry with him everything necessary for survival.

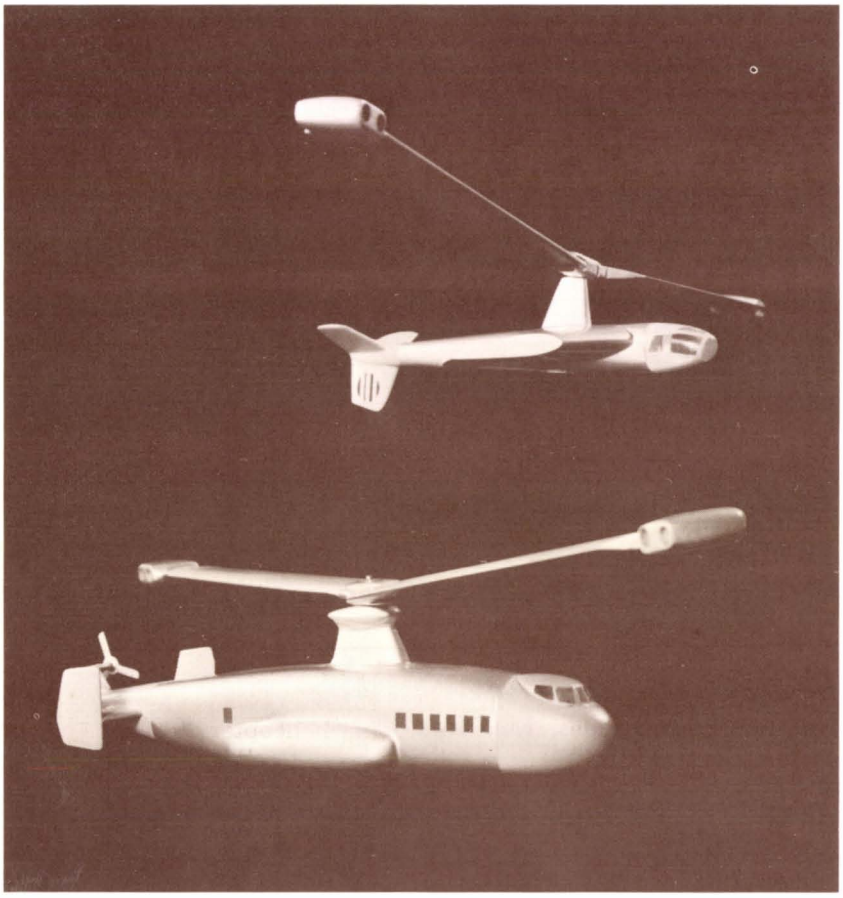
The added weight and bulk of such Arctic equipment as skis, snowshoes, and extra clothing make exiting from a small helicopter something of a project in itself. However, Alaskan troops wearing their skis are being rappelled from the UH-1A helicopter as the normal technique for entering inaccessible snow-covered areas. This has increased Alaskan troop mobility.

Rappellers use a standard mountain climber's seat sling rope. A lead rope passes from the helicopter through a link at the rappeller's waist, over his shoulder, and to the ground. He guides himself with one hand and brakes his descent with the other.

Rappellers may also reverse the procedure to a certain extent and can be picked up by the same exit rope. The seat sling is comfortable and a man can ride the rope almost indefinitely, at least far enough to reach an area where the helicopter can land and allow the man to board.

Men of the 172d Infantry Brigade (Mechanized), stationed at Fort Richardson, have been working with the Combat Development Agency to standardize and improve rappelling procedures. They will serve next as instructors to train other soldiers. Helicopter rappelling will soon be a routine part of Alaskan troop training.

TIP TURBOJET FLYING CRANE



THE U. S. ARMY Transportation Research Command has awarded Hiller Aircraft Company a contract to design a giant rotor system powered by turbojet engines mounted at rotor blade tips.

The contract will be the first of several phases leading to construction of a flying article if the study indicates feasibility. The second phase would involve construction of a full-scale lift and propulsion system, which will be tested in a special whirl-test facility.

With power source removed from the fuselage and placed at the tips of rotor blades where power is required, complex transmissions and shafting are eliminated with resulting increase in performance and lower cost of operation. Greater design freedom than conventional helicopters would yield flying crane types (top) and transport configurations (bottom) for both military and civilian use.

Army Evaluating Enstrom 3-place Trainer

The U. S. Army Aviation Test Board at Fort Rucker is scheduled to evaluate the F-28 primary trainer helicopter made by the R. J. Enstrom Corporation, Menominee, Michigan.

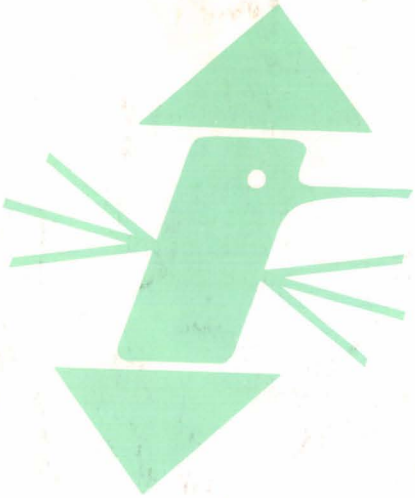
The 3-bladed F-28 combines design simplicity and ruggedness with aerodynamically clean lines. Using a Lycoming 0-360 4-cylinder, 180 hp engine, the F-28 has maximum sea level speed of 100 knots; a cruise speed of 87.5 knots; a climb rate of 1,335 ft/min; endurance of 3.3 hours; and a range of 235 statute miles.

To fly like a hummingbird—forward at jet speed, hover in mid-air, straight down, and straight up—is the goal of the Army's newest aircraft, the XV-4A Hummingbird.

In May of this year the first goal was achieved when it made its first vertical flight. At Marietta, Ga., the birthplace of this radical new aircraft, the Hummingbird has begun free hover flight tests, the second of these goals. Transition tests from the hover mode to conventional forward flight are expected later this summer.

Heart of the aircraft is a system of ejector mixing chambers buried in the fuselage, which is fed by high velocity exhaust diverted from the two jet engines mounted in pods along either side of the fuselage. The mixing chambers are, in turn, enclosed at top and bottom by bombbay type flush doors.

For vertical takeoff, the flush doors are opened and hot exhaust gases are diverted from the engines and fed to the mixing chambers. Here they are directed downward through jet nozzles for vertical lift.



Two of the planes have been built under a U. S. Army Transportation Research Command contract.

In its production version the Hummingbird will have:

Maximum Speed @ S. L.	575	knots
Maximum Ferry Range	2,000	NM
Maximum Payload, over	2,000	lbs
Maximum Operating Radius	400	NM
Rate of Climb at Military Power, over	18,000	fpm
Maximum Altitude Capability	50,000	ft