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CAMP RUCKER, ALABAMA

SEPTEMBER 1955 VOLUME 1 NUMBER 8

ARMY AVIATION SCHOOL

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ARMY AVIATION
DIGEST

VOLUME 1 SEPTEMBER, 1955 NUMBER 8

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COVER: The H-37 features two 18-cylinder piston engines in high outboard pods mounted on stub wings to give greater power and increased cargo capacity. It has a retractable landing gear, a single five-bladed rotor, and can carry very heavy loads, such as the 105-mm howitzer or several lightweight jeeps up to 200 miles at a speed of more than 150 mph.

This copy is not for sale. It is intended for more than one reader.

PLEASE READ IT AND PASS IT ALONG

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Manuscripts, photographs, and other illustrations pertaining to the above subjects of interest to personnel concerned with Army aviation are invited. Direct communication is authorized to: Editor-in-Chief, ARMY AVIATION DIGEST, Army Aviation School, Camp Rucker, Alabama.

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THE COMMANDANT'S COLUMN

Brigadier General Carl I. Hutton, *USA*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army.—The Editor

Ten Years

It is a common saying among academic professionals that twenty years are required for a newly discovered fact to be absorbed into academic lore. Last month (August) included the tenth anniversary of the first employment of atomic weapons in war. If there is a twenty year lag in military matters, similar to the academic cycle, then we are now halfway through the process of absorbing the implications of the atomic bomb.

Army Aviation, ten years after Hiroshima, is in a state of confusion which appears to reflect the overall confusion as much as anything else. The need for increased mobility is apparent but the actual hardware by which mobility may be increased is not at hand. The necessity for greater dispersion is obvious, but the means for retaining command control do not exist. Consequently, much thought is being devoted to these problems, and, as might be expected, there are many tentative solutions. The variety of solutions is evidence of creative thought and the confusion is a healthy sign of progress.

It is inevitable that a change in warfare such as that brought about by the atomic bomb will force us to revise our thinking. The task is difficult enough by itself, but it is much more difficult under the artificial restriction which we have imposed upon ourselves. This is the restriction placed upon Army Aviation by the various memoranda of understanding and the functions papers. These were attempts by former administrations to solve immediate problems.

In hindsight, the attempts have proved to be erroneous because they visualize battle situations which are very likely never to occur again. They force the Army to think in terms of World War II and Korean formations, and thereby block progress in the direction of increased mobility. It is within our prerogatives to eliminate the block.

The question is much broader and deeper than is generally understood by the term "close support." The very expression arises from a type of thinking which is self-limiting to the type of battle we have seen in the past. It pre-supposes a walking Army which under certain conditions may receive gracious cooperation from the air. It automatically assumes that the role of the Army in war is secondary. Who controls the close support aircraft is important, but it has nothing to do with the broader question of how to give the Army freedom to cope with the problem of warfare in the atomic age.

Ten years after Hiroshima we have barely touched upon that.

This is the sixth in a series of columns written by Brigadier General Carl I. Hutton, Commandant of the Army Aviation School, for the ARMY AVIATION DIGEST.—The Editor

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1954 Accidents by Type of Aircraft

The following table was compiled from accident reports received by the Army Aviation Safety Board, Army Aviation Center, Camp Rucker, Ala.

Aircraft	Accidents	Injuries	Fatalities	Cost
L-17	15	1	2	$ 35,458.15
L-19	130	7	9	311,810.93
L-20	18	0	4	180,682.35
L-23	9	0	0	20,928.56
LC-126	3	0	0	1,217.26
H-13	83	4	1	765,796.52
H-19	18	1	3	352,383.49
H-21	2	0	0	37,150.00
H-23	62	6	3	779,647.83
H-25	12	0	3	808,040.73
TOTAL	352	19	25	$3,293,115.37

This table cannot be used as comparative data because of the unequal number of hours flown by the various types of aircraft.

AOCP

Captain Joseph J. Muter, *Transportation Corps*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

You know it! I know it! Everyone knows it! An aircraft on AOCP status presents an undesirable situation. In some air sections it is only a thorn in the side to the air and maintenance officers; in other, smaller air sections it amounts to a major catastrophe.

To combat the problem, an SOP to obtain the part and return the aircraft to serviceable status has been established by the Transportation Corps. The unit maintenance officer submits immediately to the supporting supply activity an AOCP requisition for the necessary part. The supply activity then issues the part if it is available from warehouse stocks. If the part is not available in stock or cannot be procured through local purchase, a TWX covering the part is sent to the supporting Air Force depot. Although this method is usually effective, the unit maintenance officer's responsibility does not end with the submission of the AOCP requisition. He must accomplish whatever follow-up is necessary to secure the part promptly.

Lateral Supply

While the AOCP requisition is being processed, the unit maintenance officer should attempt to obtain the part through the too-infrequently-used method of lateral supply. Telephone contact of other air sections in the near vicinity often results in finding the part in stock in the supply room of a comparable air section. A requisition to the unit having the part and a short airplane trip then make the part available and facilitate return of the aircraft to serviceable status. Needless to say, this service should be used only for AOCP and must be reciprocal to remain effective.

Controlled Exchange

Another method of obtaining an AOCP part is through controlled exchange. Removing the required part from another unserviceable aircraft reduces the number of unserviceable aircraft within the unit and consolidates part shortages. However, this procedure, although authorized by AR's 750–5 and 750–94, should be used only as a final resort to remove the aircraft from unserviceable status because of the excess man-hours required to remove the desired part and to replace it at a later date. The maintenance officer must insure that this method of obtaining parts does not develop into cannibalization, an irreversible process of reducing a reparable aircraft to a carcass. Before controlled exchange is used, definite requirements must be met, and AR's 750–5 and 750–94 must be reviewed by the maintenance officer.

Usage Factors

Although AOCP's will always be with us, methods discussed here are effective in removing aircraft from this unserviceable status. The best way to keep an optimum number of aircraft flying, however, is to have the necessary part on hand when the failure occurs. Although this is not always possible, it will be a more probable occurrence if parts are stocked on the basis of experience gained from actual usage rather than the initial allowances shown in TC 7U–series supply catalogs. Stocking by previous experience is advocated by all TC supply publications and has proved to be the best means available for keeping AOCP's to a minimum. The number of AOCP's will always be a direct result of the amount of effort put forth by the unit maintenance officer and the support given him by the unit commander in the performance of his primary mission, maintenance.

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BOUNDARY LAYER CONTROL

A. N. Petroff

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

Last September at the Air Show in Dayton, Ohio, an event took place which was hardly noticed by the press, radio, television, and general public.

It was unseasonably hot in Dayton, and crowds of tired people, waiting for the climax—the brilliant acrobatics by jet aircraft flying in formation, did not pay much attention to the preliminaries.

During these preliminaries a side-by-side demonstration of take-off and landing performance by two Cessna airplanes took place. One of the aircraft was the standard L–19 Army observation airplane nicknamed "Bird Dog" and the other was a modified L–19 equipped with a Boundary Layer Control system, or BLC for short. The modification and design of the system was made by the Research Department of Cessna Aircraft Company in cooperation with the University of Wichita under the sponsorship of the Office of Naval Research and Department of the Army.

Spectators could see clearly that on take-off the airplane with BLC was already airborne, while the standard L–19 was still on the ground. Landings showed the steeper approach angle of the airplane with BLC.

Now what is this BLC, and why are scientists and engineers striving to develop it?

Since the time of the Wright Brothers, one of the problems for an aerodynamicist has been to achieve a wider spread between the stalling speed and the top speed of an airplane.

Prodded by urgency of wars, a tremendous effort has been made to increase top speed of aircraft, to the extent that present research is 10 to 20 years ahead of the practical application. After

hurdling over the imaginary "sound barrier," airmen are bracing themselves to scale the apparently real "temperature barrier." On the other hand, the effort to keep the stalling speed down has been utterly inadequate. In fact, the stalling speeds of today are rapidly approaching top speeds of not so many years ago and require miles of paved runways in order to accelerate and decelerate the aircraft on the ground. Needless to say, millions of dollars can be saved by shortening these runways throughout the world and at the same time making take-off and landing a safer procedure.

Some critics of BLC say that the long runways are already here to stay and we might as well use them. The answer to this argument is that for a given length of runway the airplane equipped with a BLC system will lift a higher payload in proportion to the increase in lift coefficient generated by the system. I would like also to mention a secondary feature of BLC, an emergency device which improves an aircraft's chances for safe landing in case of a partial or a total failure of the main power plant. The pilot, by merely pressing a starting button, will have at his disposal an additional lifting power to pick up the wing with the dead engine or go over a fence in case of a dead stick landing.

Figuratively speaking, all this can be done by coaxing the wing to continue flying, when it is ready for a stall, by re-energizing the tired out and decelerating stream of air moving over the wing. This stagnant low-energy air is either accelerated by blowing a high velocity jet of air through a slot or sucking it through a slot or porous skin of the wing. The idea was advanced in 1904 by Prandtl—and that was the birth of boundary layer control.

The law of classical aerodynamics states that there is no relative motion between an infinitesimally thin layer of air next to the surface of an airfoil in motion and the surface itself. In other words,

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particles of air are actually clinging to the surface due to the viscous properties of air. This is very unfortunate because particles of air within this layer, moving at different velocities with respect to each other, create shearing stresses which constitute drag, commonly known as a skin friction drag, an obvious misnomer. Perhaps a better description of the phenomenon can be made by stating that, in addition to the apparent mass of an airfoil, there is a virtual mass consisting of boundary layer air, which moves with the airfoil and therefore requires an additional expenditure of power.

Experience shows, as we progress toward the trailing edge of the wing, that the boundary layer becomes thicker and more turbulent. This interferes with the efficiency of controls, such as flaps and ailerons, and sometimes renders them virtually ineffective, especially at low speed. Therefore, attenuation of the boundary layer of air at high speed and prevention of turbulent separation of flow at low speed are the aims of scientists and engineers working on this problem.

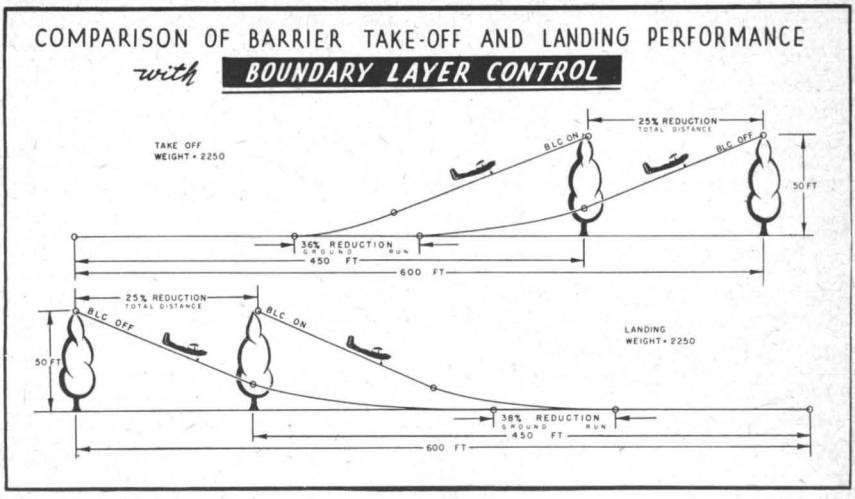
The development of the idea for practical application has been painfully slow. For nearly 30 years it could not pass the laboratory stage, and only during the last 20 years have there been a few isolated attempts (Stuper, Regenscheit) to try it on actual aircraft. In the last five years, however, there has been a marked increase in research effort here and abroad to solve this problem.

At the risk of boring those who are familiar with the subject, I would like to re-state that there are two distinct aims for the application of BLC.

1. To reduce drag at high speed through maintaining laminar flow over the wing by attenuating the boundary layer of air. This is accomplished by suction through slots or strips of porous skin of the wing.
2. To increase lift of the wing at lower speeds by preventing separation of air flow over deflected flaps. This also can be done by suction through the slot or porous skin or by blowing through the slot.

The "Arado" system, developed in Germany at the beginning of World War II, utilizes the combined action of blowing and suction through a slot.

The research work conducted at Cessna is concerned with the



As shown above, Boundary Layer Control enables the L-19 type aircraft to reduce its takeoff run 36 percent and its landing roll 38 percent thus greatly improving short field performance.

second aim, to improve the performance near the ground by increasing lift of wings with deflected flaps at low range of speeds.

The improved Arado system was installed on the existing small aircraft and flight tested. The results indicate approximately 40% reduction in take-off ground run, and maximum lift coefficient in excess of 4.5.

Efficiency of the BLC Systems

The apparent slow progress in the practical application of BLC to aircraft, mentioned before, can be explained in the following manner. The Germans blazed the trail some 20 years ago by brilliant analytical work corroborated by wind tunnel tests. However, it is still an uphill fight to design and build an efficient BLC system worthy of installation on aircraft. The suitable source of power and the machinery to pump air is the inevitable compromise between the conflicting requirements of efficiency, light weight, and compactness.

Experience shows that the chosen system should be incorporated into the preliminary design and tailored to a specific aircraft

before it is built. The problem essentially is that of pumping air through narrow slots or strips of porous material. It requires integration of motor, air pump, ducting, and suitable slots into one efficient unit. Consequently, there are thermodynamic as well as aerodynamic aspects of the problem, thermodynamic efficiency depending upon the combined performance of the motor, air pump, and ducting arrangement. The efficiency of the installation can be evaluated as the usual ratio of energy output to energy input.

Critics of BLC often say that, if the power diverted to BLC is utilized as thrust horsepower and the weight of the system is taken into consideration, the net improvement due to installation of BLC is negligible and not worth the trouble. In the past when the designer was forced, for the sake of expediency, to work with heavy and bulky equipment available on hand at the time, this was true. Even now there are very few suitable ready-made power plants and air pumps in existence, and the designer often has to improvise and adapt obsolete and inefficient "off-the-shelf" components to do the job. However, steady progress is being made by various research groups toward increasing the efficiency of components and at the same time reducing their size, weight, and cost. All of this, confirmed by flight tests, is reflected in the improved performance of the aircraft near the ground.

For instance, due to intensive development in the field of guided missiles and starters for jet engines, "power package" units, light and compact sources of power that can be utilized as power plants for BLC systems, are now appearing. The typical power package consists of a gas generator which decomposes monofuel and drives a high-speed, small-diameter turbine geared down to the required RPM. The relatively high cost and complexity of these units should be balanced against the fact that, being independent from the main power plant, they will supply power to generate the needed extra lift in case of main engine failure during take-off or landing.

The writer is convinced that ultimately the most direct method of pumping air is by an axial turbo-compressor or turbo-fan designed for the specific purpose and operated independently of the main power plant of the airplane.

Effect of Propeller Slipstream

Some 20 years ago two Englishmen, Goodman Crouch and Harold Bolas, designed and built the "Dragonfly," a twin-engine biplane. The idea was to utilize the slipstream for generating additional lift and to produce an aircraft of exceptional performance near the ground. The idea did not catch on for various reasons, mostly of mechanical nature: heavy engines, lack of available gearing to reduce RPM of propellers, and, probably, poor control at low speeds.

Now interest in this type of aircraft has revived due to recent developments in BLC, availability of light geared engines, and efficient controllable pitch propellers.

Recent tests at the University of Wichita and National Advisory Committee for Aeronautics wind tunnels indicate that kinetic energy contained in the slipstream of a propeller can be utilized for generating additional lift in combination with BLC, which, in turn, augments lift by preventing separation of airflow over deflected flap. It is possible now to deflect propeller slipstream through nearly a 90-degree angle without stalling flaps.

This opens new possibilities of generating high lift by propeller thrust at low speeds provided that problems of control will be solved.

Control at Low Speeds

One of the most difficult problems confronting aerodynamicists is control at low speeds of a fixed wing aircraft. As forward speed diminishes, there is a limit when conventional longitudinal and lateral control surfaces, even when highly deflected, lose their effectiveness. This usually happens because of the combined effect of two things—low dynamic pressure and separation of airflow over the deflected surfaces. Experience shows that all airplanes equipped with conventional high lift devices such as leading edge slots and double slotted flaps are subject to this limitation. BLC, by energizing air in the region of flaps and ailerons, lowers this limit to a point where it is possible to fly airplanes at speeds well below those of a conventional aircraft. However, in order to achieve this, we have to feed energy into the system by, for instance, applying BLC on the tail. Nevertheless, as forward speed goes down still

further, say to 10 mph, there is still a real problem which will tax ingenuity of aerodynamicists for years to come.

The most promising solution offered so far is an automatic pilot, actuating control surfaces through large angles of deflection. Such a device would preclude development of large disturbing moments by generating adequate restoring moment very shortly after the origin of the disturbance.

Future

There are two definite ways of applying BLC to actual aircraft:

1. To modify the existing aircraft by installing a suitable system. This approach is dictated largely by expediency and economy and, while showing improvements in performance, will not realize true capabilities of BLC.
2. To make provision for installing the system before the airplane is built. Then the system will work efficiently throughout the whole speed range of the airplane, reducing drag at high and cruising speeds and increasing lift during take-off and landing.

Possibilities at both ends of the speed range are unlimited. It can be safely said that BLC in some form is the only solution to avoid excessive temperatures anticipated at hypersonic speeds. On the other hand, it is also logical to assume that successive reductions in stalling speed will lead to an airplane with zero take-off and landing run. Whether we are attracted by the glamour of the future hypersonic speed aircraft and wish to penetrate the forbidden region beyond the thermal barrier or whether we are interested in slow speed flight leading to VTO fixed wing aircraft, the basic problem is the same: to study the ultimate nature of the boundary layer, its mechanism, and learn how to manipulate it to our advantage.

In the past, while studying problems associated with boundary layer control, we attempted to make airfoils aerodynamically smooth by giving them the best possible super-finish. We went to the other extreme by purposely roughening the surface. We heated or cooled airfoils. We charged them with static electricity. We blew and sucked through slots and porous skin. *(Continued on page 32)*

ARMY AVIATION AND RADIOACTIVITY

First Lieutenant Frank L. Jensen, Jr., *Signal Corps*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

During Exercise Desert Rock VI, a new task was assigned to the Army aviator: aerial monitoring, or determining from the air the intensity of radioactivity on the ground in an area that has been subjected to a nuclear explosion.

Although certain types of monitoring are regularly performed by high-performance aircraft equipped with large detectors, Army aircraft have not previously been used extensively as vehicles for tactical-type surveys of contaminated areas. In the past, such monitoring has been subjected to the limitations of ground parties using wheeled vehicles or on foot. Routinely these ground parties proceed to an area and move slowly back and forth across it, taking readings on radiation meters. A record of readings and locations is maintained and later posted on a map of the contaminated area. By posting these readings and connecting points of equal intensity with drawn-in colored lines, "iso-intensity lines" are formed. These lines, as the name implies, outline areas of radiation. From such a map, important facts can be determined such as the fall-out pattern of radioactive contamination, the "yield" or size of the nuclear device, areas safe for troop movements, time limits in which personnel can remain in the various areas without danger of being over-exposed to radiation, and other information which a commander must have in order to formulate plans in the event of use of nuclear weapons by either our own forces or by an aggressor.

Ground survey parties must operate under certain limitations including road nets leading to the contaminated area, condition

of the terrain over which they must make the actual survey, and the slow speed at which they can proceed.

Aircraft

It was felt that Army aircraft could be utilized in radiation survey and thus overcome some of the limitations of ground vehicles. Exercise Desert Rock VI provided an excellent opportunity to test their effectiveness in such operations.

To develop techniques for aerial monitoring, an officer from the Radiological Safety Office, Camp Desert Rock, was assigned project officer. L–19's and pilots were made available by the Camp Desert Rock Air Officer. Enlisted volunteers who were trained in the use of radiac detectors were employed as monitors. They rode in the back seat of the aircraft, taking readings and keeping necessary records.

Emphasis was placed on developing a technique that would be available to the commander through the use of equipment normally available in the field. This, of course, precluded the use of elaborate radiation detectors, timers, and recorders.

Before any actual monitoring had been done, it was believed that the aircraft would have to fly slowly at a low altitude to effect accurate measurement of radiation on the ground. Considerable time was spent practicing these low and slow patterns before this assumption was proved inaccurate. Actually useful data could be obtained without low-altitude flying.

Ground Zero

One of the biggest problems encountered in aerial monitoring is that of accurately fixing the exact position on the ground at the instant the reading is made. It is extremely important to indicate

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the exact spot on the ground at which each reading is made so that the information can be plotted on maps with accuracy.

In order to solve this problem, a number of experiments were conducted using various patterns, altitudes, and air speeds. Some of the factors that entered into the problem were: location of ground zero, the amount of radioactive contamination involved and the length of time the aircraft was required to stay over an area of given intensity, whether the terrain was level or hilly, wind conditions, and availability of reference points which could be identified both on the ground and on the map. Aerial photographs were found to be far superior to maps for aerial monitoring.

During each pattern, the pilot must maintain an accurate air speed, accurate heading, and accurate altitude. He must inform his monitor the exact instant at which he is over the various reference points in order to accurately time the runs.

Close Coordination

The pilot must also keep the monitor informed of the run number, direction, altitude, air speed, instances at which to start and stop the stop-watch, and of each pass over apparent *ground zero*. The monitor must read his instruments accurately, keep time precisely, and make correct and legible entries on the log sheet. He must also keep the pilot informed of the amount of radiation encountered. During Desert Rock VI flights, monitors frequently became airsick because they were unaccustomed to flying and had to watch the instruments while the plane turned and banked constantly.

At the completion of the mission, the monitor's log sheets are submitted to the Radiological Safety Section together with any pertinent comments the pilot may have. This information is then plotted on the maps.

Advantages

Advantages of using aircraft for radiation monitoring are many. With an aircraft, surveys can be made faster, thus exposing surveying personnel to less radiation than that received during ground missions. Teams can be dispatched to remote points quickly, complete the survey, and return before the ground parties could even get to the contaminated area. *(Continued on page 33)*

JUNGLE RE-SUPPLY WITH L-19

First Lieutenant James E. Claunch, *Infantry*

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

Each special-type operation has its own "bugaboo," or characteristic, to be coped with. In jungle operations it is the unbelievably dense tropical vegetation, which not only impedes movement of troops but usually screens them completely from view.

Under such circumstances, which is the best method of ration drop? Can water be dropped in the absence of streams and water vines? How can a plane best help a unit on the ground maintain its course?

The 10-day jungle march of a provisional company across the Isthmus of Panama last April provided us with a few answers to these and other aspects of troop re-supply under jungle conditions. Tabbed "Operation Gold Road" and covering some of the toughest jungle country to be found anywhere, the march took 72 men of the 33rd Inf. Reg., 23rd Inf. Div., US Army, Caribbean, from Madden Airfield in the Canal Zone to Porto Bello, Republic of Panama. One test feature of the operation was to re-supply the unit completely from the air by the use of one L–19 aircraft.

Ration Drops

The dropping of rations presented the most critical problem since rations would be re-supplied to the company daily. We had three choices: para-drops, free falls with A–5 cargo straps, and free falls with metal bandings.

Several considerations ruled out the use of parachutes. We were faced with an economy factor throughout the operation because of the inability of troops to recover nonexpendable drop equip-

ment. The average weight of packs carried by individuals was already around 70 pounds. Further, with the depth of the jungle ranging from 100 feet to 175 feet, a parachute could land in a tree, resulting in the loss not only of the parachute but of the rations also. Use of A–5 cargo straps was ruled out for almost the same reasons as use of parachutes: they were nonexpendable property and bulky, although not as likely to hang in trees.

Banding

We chose metal banding as the least expensive and most practicable solution. With the use of a banding machine, we secured four cases of C-rations together, running one band around the four cases through the bomb shackle D-rings and two bands around the other dimension just to the outside of each D-ring. One of these bundles was secured to each bomb shackle, making it possible to drop eight cases of C-rations at a time. The banding method worked actually better than was expected, with 100 per cent drop recovery and loss of rations due to breakage averaging only about 30 per cent. Breakage on individual drops ranged from 10 to 50 per cent.

If the average breakage had been as high as 50 per cent, the cost would still have been less than that involved in expending two parachutes or two A–5 kits per drop. By dropping bundles containing four cases of C-rations instead of two, breakage allowable was doubled. Generally, the two cases hitting the ground first received considerable damage; but even with a total loss of these, the two remaining cases were recoverable in every drop.

Undergrowth

As far as the manner in which drops were made, we found that dropping directly into the jungle, with bundles landing in the

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undergrowth, gave the best results. Drops into a large pool of water ran a close second. Bouncing bundles through the tops of very high trees, allowing them to drop vertically, and dropping into soft sand proved less successful.

It is not recommended that canned juice be dropped into water because of the explosive quality of a can of liquid when it hits the surface. The result of one such drop was the largest bowl of non-alcoholic punch in Panama.

Water Drop

At one point in the march, a problem was posed for which we found no solution. This was the dropping of water. Fortunately, when the company requested a water drop because of the lack of water vines and streams, we were able to locate a stream on their route of march and direct them to it. The problem, however, needs a solution. You are probably thinking, "Use a helicopter in a hovering position." However, the 50- to 60-foot undergrowth, the matter of load balance, and the difficulty of delivery present many problems in this case.

We considered, but were unable to test it at the time, using heavy duty truck inner tubes and putting approximately five gallons of water in each. They could be folded double and wrapped with a light rope which would break on impact, allowing the inner tube to bounce its way down through the trees.

Radio Relay

For communications, we used a relay system which contributed considerably to the success of the mission. The unit on the ground used the AN–PRC 6, and regimental headquarters (some 70 miles away) used the AN–GRC 7. A modified installation of the AN–PRC 10 in the L–19 enabled the pilot to serve as relay between the regimental commander and the provisional company commander during contact periods.

Radio contact was excellent and maintained at all times. By utilizing the AN–PRC 6 with the AN–PRC 10, its range was increased to 20 miles in test cases.

Headings

The L–19 was used successfully to give headings to the unit on the ground. Headings were obtained at least twice a day by flying over the unit and giving the reading of the directional gyro to the company commander. This enabled him to check his bearings and, in several cases, prevented the company from drifting off the desired course. The re-section method was also used in verifying unit position for the company commander.

Blind Drops

The majority of the re-supply missions were made without the pilot's seeing the unit. This was made possible by the use of the pyrotechnic pistol and the sound-flash. As the L–19 approached the unit area and established radio contact, the unit gave the pilot his bearing in relation to itself. By then flying a square around the unit, the pilot could determine its approximate location. A sound-flash from the unit on the ground pin-pointed its location. This method proved very successful since all drops placed in this manner were recovered.

The 7x12-inch, rubberized, phosphorous red, message drop bag was used extensively throughout the mission. It proved practicable for dropping a variety of small items including medical supplies, additional canteens, and clothing.

"Operation Gold Road" proved that a small unit operating in the jungle can be effectively supplied from the air by Army aircraft and, further, that Army aircraft are invaluable in acting as radio relay stations for such isolated units.

INCIDENTS WHICH PREVENT ACCIDENTS

William R. Gaines

The views expressed in this article are the author's and are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

During the past six months, the following *incidents* were reported as occurring at the Army Aviation School.

1. "Practicing simulated emergencies. Started to climb out of field, engine hesitated and sputtered. Field surrounded by power lines. Instructor cut engine and landed. No damage to A/C or property."

2. "Used about 5 quarts of oil in 1:40. Engine cutting out pretty bad on left mag. One hour of flying time was at cruising RPM; the 40 minutes was in take-offs and landings."

3. "A near-miss mid-air collision. Due to the distortion of the instrument flying hoods, their condition, plus the extremely poor vision (forward) in this type aircraft (LC–126), two aircraft missed a mid-air collision by approximately 30 feet while flying at 6,000 feet. Recommend new type instrument flying hoods to be made available to the instrument flight."

Ounce of Prevention

To the Army aviator these incidents may sound like "all in a day's work." But safety-wise they are something entirely different, the ounce of prevention worth a pound of cure to an aviation safety program.

The quotes are only a few of the 300-odd near-accident reports received by the Safety Division, Camp Rucker, Alabama, during the past six months. Such incidents are daily occurrences and might

well go unnoticed in an aviation program which is training 1,700 pilots and mechanics a year. But each one serves as a basis for education or corrective action which results in a saving of lives and dollars.

Accident Pyramid

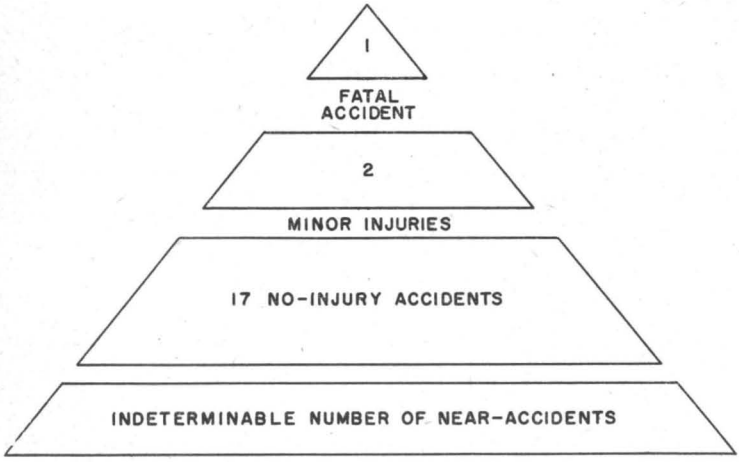
Why are near-accidents so important in aviation safety? Basically it goes back to safety authority H. W. Heinrich's premise that the foundation of major injuries is accidents, not injuries. He presents this principle of safety as a pyramid. At the base are accidents from which no injuries resulted. Above these are accidents from which minor injuries resulted. At the top of the pyramid is an accident in which major injury is received. Such an accident occurs after so many no-injury and minor injury accidents have been allowed to happen.

For industry, the established figures are 300 no-injury accidents and 29 minor injury accidents to each major accident. That is, in a unit group of 330 accidents of the same kind and involving the same person, 300 would result in no injuries, 29 in minor injuries, and 1 in a major injury.

Even one fatal accident in 330 is no enviable safety record, life- or money-wise. But when compared to aviation, industry has no problem at all. In aviation, it has been found that for every 20 reportable ($50 damage or more) accidents there is a fatality. At the bottom of the pyramid (see illustration, Page 23) are 17 no-injury accidents, above these, 2 minor-injury accidents, and on the peak, 1 fatality.

William R. Gaines *is the Safety Director at the Army Aviation Center, Camp Rucker, Ala. He received his B.S. from Pennsylvania State Teachers College in 1940, then entered Naval flight training. At the time of his separation from active duty as a lieutenant commander, he was in charge of flight instructor training at the Naval Air Station, Pensacola, Fla. He has logged over 5,000 hours flying time and is a graduate of the New York University safety engineering course.*—The Editor

FOUNDATION OF A FATAL AIRCRAFT ACCIDENT



Out of 20 reportable aircraft accidents ($50 or more damage) 1 will result in a fatality. The fatality may result from the very first accident or from any other accident in the group. Eliminate the accidents—by corrective action on the near-accidents—and the injuries will take care of themselves.

Severity

In safety circles, this is termed a difference in severity. Aviation has about fifteen times the severity rate of industry in general. A look at world-wide Army aviation accident figures for 1953 and 1954 emphasizes this extreme severity.

Of 668 aircraft accidents reported world wide for the two years, 117 resulted in injury, 61 of which were fatal. In 1953, this was 46.4 accidents per 100,000 hours of flight; in 1954, 51.7 accidents per 100,000 hours of flight. In addition, property damage reached $2,981,912 and $3,469,180 during the two years respectively, a total of almost six and one-half million dollars. This was an average property damage of $9,873 in 1953 and $9,479 in 1954.

Costs

Extremely high accident cost is another reason why sound, constantly-applied safety programs are imperative in aviation and why *incidents* play such an important role in Army Aviation Safety programs.

Until recent years, Army aircraft have been well under the $50,000 cost figure, with the H–13 and H–23 costing approximately $30,000 and L–19 costing only $11,000. With the purchase of cargo rotary wing aircraft, the H–34 and H–21, for example, the cost figure has soared to approximately $750,000 per aircraft. Even the utility helicopters, the H–19 and the H–25, cost approximately $200,000 per aircraft.

During 1954, when the average aircraft accident cost was $9,479 in property damage alone, few if any of the larger helicopter models were included in accidents reported. As more of these aircraft get in operational status, the property cost of the average aircraft accident could well increase proportionally.

Added to property damage costs in a fatal aircraft accident are approximately $23,000 in insurance and related costs per individual killed. During 1953 and 1954, these costs for the 61 fatalities ran to more than one million dollars. Also to be considered are the even higher losses in training costs. Unquestionably, aircraft accidents are so expensive that we cannot afford a single major accident.

How, then, can an aviation safety program most nearly approach the goal of eliminating major accidents?

Start at the Foundation

Obviously, not every major accident, or even every fatal accident can be eliminated. But, back to Heinrich's accident pyramid, if no-injury and minor-injury accidents can be prevented, there will be no foundation for major injuries; and chances of a fatal accident are thus correspondingly reduced. This is the premise on which the safety program of the Army Aviation Center, Camp Rucker, operates to keep major accidents to a minimum.

Like every sound safety program, the Army Aviation School program is built on the "three E's of safety": *education, engineering revision,* and *enforcement.* Through such things as regular safety meetings in which recent accidents are reviewed, safety SOP's

for each training unit, and mimeos based on corrective action and issued to each training unit, the Army Aviation School safety program utilizes education to cut down no-injury and minor-injury accidents, and thus forestall that one fatal accident. In 89 per cent of the cases, an accident is caused by an unsafe act, some omission or commission by an individual which later results in a hazardous condition and an accident. Therefore, if the individual can be made safety conscious through safety education, a major portion of accident prevention will take care of itself.

The engineering revision phase of the program includes recommendations to and follow-up with aircraft companies and maintenance units in modifying existing aircraft or redesigning undelivered aircraft to eliminate safety hazards. If the education and engineering revision phases of a safety program are adequate, it is seldom necessary to emphasize the enforcement phase.

Coupled with these basic safety principles and routine safety program operations is a feature of the Army Aviation Center's safety program which gets one step closer to the beginning of an aircraft accident. This step is a near-accident report system, through which incidents such as those quoted at the beginning of this article are reported to the Safety Division. These incidents resulted in no property damage or damage of less than $50 and are not reportable accidents. Thus they are referred to as "near-accidents," each being an incident which on its next occurrence could result in a minor or major accident.

Heinrich's safety pyramid is based on his premise that the foundation of major injuries is accidents, not injuries. In aviation safety, the pyramid is composed of 17 no-injury accidents, 2 minor-injury accidents, and 1 fatality. But below this actual-accident pyramid are an undeterminable number of near-accidents, incidents which could have resulted in accidents.

Near-accidents are important for two reasons: They (1) provide the basis for corrective action directed toward eliminating accidents and (2) provide accident prevention statistics.

Every time a safety program can eliminate 17 no-injury accidents and 2 minor-injury accidents, statistically, it forestalls a fatality. Thus, if the no-injury and minor-injury accidents can be eliminated, the fatalities will take care of themselves. The most timely and least costly avenue of attack is through correcting near-accident incidents.

If an engine coughs, a seat belt comes loose, a radio fails, or a plane almost tangles with wires, an accident-potential is present. Each of these incidents, if allowed to go unchecked, could result in an accident. Because they are reported as near-accidents and corrective action is taken, they do not result in accidents.

In addition, the accident severity in aviation is too great for safety engineers to use actual accidents as the basis for accident statistics. In the first place, the cost of aviation accidents is too high. Secondly, the true cause of the accident may not be determinable after the accident. Thus, there must be some pre-accident conditions on which to base accident expectations. Near-accident reports provide these conditions. Over a period of time, near-accident reports can be compiled and studied to reveal the most prevalent causes of accidents, weaknesses in equipment, hazardous conditions in training or operations areas, and many other points valuable in an accident prevention program.

Reporting System

A near-accident reporting system can provide an unlimited source of accident information to any air unit. Its use should not be limited to training or large section operations. Any air section commander or operations officer will find such a system an effective addition to his aviation safety program. Every near-accident on the ground or in the air should be reported. Two points are important in reaching this goal: (1) Reporting should be made as easy as possible and (2) follow-up must be accomplished.

If near-accident reporting is kept as simple as possible, maximum participation is fostered. At the Army Aviation Center, a pilot can call in a near-accident report or he can make a written report on anything from a piece of scratch paper to a local form provided for the purpose. When reports are called in, Safety Division personnel type them on the locally-designed form and file them for action of the safety director.

Follow-Up

Consistent follow-up must be made on near-accident reports if the system continues to function. Suppose a pilot notices a hole on a landing strip and makes out a near- *(Continued on page 32)*

Gray Hair

Upon approaching his H–13, a pilot noticed that the aircraft was moored. He told a mechanic to make sure that the skids were untied and proceeded with his preflight inspection. He almost made a complete inspection, but because an auxiliary power unit jeep was parked close to the left side of the helicopter, the pilot, after

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Major Hubert D. Gaddis, *above, is the very senior Army aviator featured this month in the Gray Hair Dept. Major Gaddis is the Assistant Director of the Department of Rotary Wing Training, Army Aviation School, Camp Rucker, Ala. He received his pilot training in the Air Training Dept., Fort Sill, Okla., in 1942. Additionally he is a graduate of the Bell Aircraft Corporation's Helicopter Mechanics (1946) and Helicopter Pilots (1947) courses, and of Southern Airways Flight Instructor Training course (1951). During WWII he was assigned to the 28th Infantry Division as a pilot, and in the Korean War he served as CO of both the 8191st Helicopter Ambulance Evacuation Army Unit and the First Helicopter Ambulance Company. He is instrument rated, qualified in all Army fixed and rotary wing aircraft, and has logged over 4100 hours pilot time.*—The Editor

checking the gas and oil, walked across the litter and got into the pilot's seat, neglecting to check the left litter and skid.

He started the aircraft, made the usual run-up, and started bringing the helicopter slowly to a low hover. As the helicopter cleared the ground a few inches, the pilot called the tower for take-off clearance, received "clear for take-off," and pulled more pitch. The helicopter immediately rolled to the left and crashed.

This is a normal reaction of any helicopter when take-off is attempted with one skid tied down. A piece of 24-inch rope, costing only a few cents, caused a $12,433 accident. Worse, the energy and time expended to bend down and personally check the tie-down, to complete the preflight, is too infinitesimal to mention.

There are circumstances under which a pilot feels a complete check is unnecessary. *"Don't believe it!"* Preflight and cockpit procedures have been adopted for the specific purpose of discovering discrepancies, preventing malfunction, and, in the end, preventing accidents. They are as necessary to the flight as adding power for take-off or lowering the gear for landing. Time must be taken in which to make thorough checks.

Down, Down, Down

Flying a helicopter in mountains and in high density altitude conditions means operation under critical conditions. *Choosing a landing site on the leeward side of a mountain is hazardous.* Loss of rotor RPM is dangerous. Add them together and you have the following situation.

A pilot was flying his H–13E on a reconnaissance mission in a mountainous region. Upon completing the mission he selected a landing site which was situated below the crest on the leeward side of a mountain, and at an actual altitude of approximately 6,000 feet.

The weather at this particular time was clear, visibility unlimited, temperature 50 degrees, dew point plus 8 degrees, wind West at 11 knots, and the altimeter setting 29.70. Load consisted of

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The Gray Hair department is prepared by the ARMY AVIATION DIGEST *staff with information obtained from the files of the world-wide Aircraft Accident Safety Review Board. The views expressed in this department are not necessarily those of the Department of the Army or of The Army Aviation School.*—The Editor

the pilot and passenger. Density altitude, computed from information in the weather report, was approximately 7,000 feet.

An approach to the landing site was established, into the wind with 40 miles per hour air speed at 300 feet above the ground.

Suddenly the pilot encountered a downdraft and lost altitude. In attempting to stop the rate of descent he applied maximum power and although the engine maintained 3,100 RPM, the helicopter continued downward. The pilot decided that he could not control the descent and now the landing site was an obstacle in his path.

In an effort to fly out of the downdraft he chose another landing site which was located about 75 feet below the first. But while aligning the helicopter onto the new site, he also came in line with the sun. The glare on the bubble obscured the landing area.

He finally emerged from the downdraft upon reaching the final part of his approach. As he neared a hovering altitude he increased collective pitch and the RPM dropped. Apparently because of the turbulent air and the slope he could not pick up the ground cushion in order to regain RPM. The pilot realized that a landing was inevitable. The left skid touched; but, as he reached for the ground with the right skid, the left skid came up. Because of the sun glare, the pilot could not determine the steepness of the slope. However, he realized that the slope was too steep for a landing and, with RPM still dropping, swung to the right, off the slope and down parallel to the hillside.

He continued downward, flying a few feet from the ground and reduced pitch in an attempt to regain RPM. Then a deep gully loomed ahead of him. He avoided the gully by turning right, but RPM had dropped too low to maintain flight and the right skid touched down. Sliding downhill on the right skid, holding the left in the air with practically full right cyclic, he headed for a rough jeep trail.

The helicopter hit a bump and the left skid touched down. Then as the helicopter slid onto the jeep trail, the pilot lost directional control. RPM at this point, according to the pilot, was 2400. The left skid dug into a mound of dirt and broke off, swinging the helicopter to the edge of the gully. It tilted over the edge, turned 180 degrees, and crashed tail first into the gully then turned over on its left side.

Poor planning and judgment were the causes of this accident. The pilot was, comparatively speaking, inexperienced. He had accumulated a little over 100 hours pilot time since graduating from the Army Helicopter Aviation Tactics Course.

Flying in mountainous terrain requires good knowledge of winds, density altitude, and terrain evaluation. Terrain is very important when planning an approach route. Wind and density altitude are factors that the pilot must evaluate accurately. Load and planning are variable factors which the pilot can, and must, control. This pilot's initial error was in selecting a landing site on the downwind side of a mountain. If basic principles for pinnacle operation had been applied, i.e., avoiding operation near the leeward side of a hill, approaching over a ridge line on the upwind side and selecting a route that affords a ready exit, this accident would have been prevented. In approaching the selected landing site, the pilot had obviously given little thought to a take-off from such a position.

For instance, at 6,000 feet there was only 78 per cent of sea level horsepower available. The approach was *into* the mountain, without a "loop-hole," or exit route, in case of engine failure or a go-around. Although the approach was into the wind while above the ridgeline, the let-down entered downdrafts caused by the wind burbling over the leeward side. Then, with a 22 per cent loss of sea level power, there was not enough power to compensate for the downdrafts, maintain RPM, or later, hold the helicopter in a hover.

Sound planning and good judgment, supplemented by a thorough knowledge of winds, density altitude, basic principles, and procedures, provide the solution for safe flying in mountainous terrain.

Supervisory Error?

We pilots have enough trouble with accidents caused by our own hand, and certainly do not need outside help in keeping the accident curve going up on the charts. Presented below are two examples of accidents caused by non-flying personnel.

One

A pilot completing a local training flight parked his L–19 by the pump for servicing and walked into the operations building.

Two mechanics serviced the aircraft, then one of the mechanics climbed into the pilot's seat, intent on taxiing the aircraft to the tie down line.

He was not qualified to taxi aircraft, and the other mechanic warned him not to taxi it. However, he started the L–19 and began to taxi. He started off rapidly, and, becoming excited and confused, he was at a complete loss as to how to stop the aircraft. It traveled approximately 150 feet and crashed into a hangar.

Two

Prior to a night flight, an L–19 pilot was taxiing from the parking area down a line of parked aircraft to the hard surfaced taxi-way. As no taxi-way was marked from the parking area, the pilot used extreme caution, making "S" turns and utilizing his landing light properly. He chose a path 20 yards from the aircraft on his left and 100 yards from parked aircraft on his right.

Suddenly headlights from a gas truck turning around nearby temporarily blinded the pilot as he straightened out of a "S" turn. He rolled about 5 feet straight ahead and crashed into a 50-pound CO_2 fire extinguisher which had been left in the taxi area.

Responsibility in these two accidents falls on supervisory personnel. But let *us* be realistic about it. A set of rules and a strict, thorough air section commander alone cannot prevent this type of accident. When such accidents do happen, we are all responsible. We should each see that the rules, regulations, and policies are complied with *in the spirit* that they were intended. Exercise of common sense and good judgment is necessary at all times, but only air section teamwork will reduce accidents caused by neglect, thoughtlessness, and human errors. We cannot "pass the buck." The person who witnesses an unsafe condition or practice and does nothing to correct it is as guilty as the person committing or causing it.

In the examples cited, the mechanic who taxied the aircraft and the person who left the fire extinguisher in the particular area knew better. It is up to us all, officers, NCO's, privates, and civilians alike, to pay strict attention to all that occurs around our airstrips. We must report immediately or make on-the-spot corrections of irregularities, breaches of safety, and direct violations of the rules before they can cause accidents.

(INCIDENTS WHICH PREVENT ACCIDENTS
continued from page 26)

accident report. If the hole is still there the next time he flies from or over the strip, he is not likely to bother with another near-accident report. Each report received must be considered promptly and action taken to alleviate the condition so that the individual making the report will not hesitate to report the next near-accident incident he sees or experiences.

After the accident has happened it is often too late to get reliable data on its cause. Near-accident reports must be analyzed to secure data on the most prevalent causes of aircraft accidents, mechanical weaknesses likely to result in accidents, hazardous conditions occurring in training or operations, and other accident causes. On the basis of these data, the three E's of accident prevention (education, engineering revision, and enforcement) can effectively attack the accident pyramid from the bottom, thus eliminating unsafe acts and conditions before they result in accidents. A near-accident reporting system is adaptable to any air section operation.

Two points should be remembered in instituting a system. Keep it simple, making it easy for personnel to report all near-accident incidents observed or experienced. Follow up every report as promptly as possible to insure that personnel will continue to report incidents.

(BOUNDARY LAYER CONTROL *continued from page 13)*

What other avenues of approach are to be opened? Should we subject them to high frequency ultrasonic vibrations in order to shake loose particles of air clinging to the surface, causing them to slide toward the trailing edge and produce a more favorable pressure distribution associated with so called "slip flow?" Shall we re-examine our present concept of aerodynamically smooth surface? Does it exist in nature, for instance, as a surface of a crystal or a pool of mercury or will it always be a man-made surface such as optical glass or sprayed plastic lacquer?

The scientists and engineers have to answer these questions and to carry on with the problems of boundary layer control.

(ARMY AVIATION AND RADIOACTIVITY
continued from page 16)

During previous tests at the Nevada Proving Grounds, aerial monitoring experiments were conducted with larger fixed wing aircraft and rotary wing aircraft. Results of these experiments are contained in reports submitted following Exercises Desert Rock III, IV, V, and VI.

The recent atomic exercises have proved the value of Army aircraft, both fixed and rotary wing, in aerial monitoring. Valuable experience was gained by both aviators and radiological safety personnel at Desert Rock.

The nature of this work does not permit discussion of the many details involved such as exact procedures used, air speeds and altitudes flown, equipment utilized, and safety precautions against radiation exposure. However, details of this operation are contained in the Sixth Army Chemical Officer's report on Exercise Desert Rock VI, which will be available for official use. Also, it is reasonable to assume that in the near future, Army aviators can expect to receive instruction in aerial monitoring procedures as a part of their training.

6-TON VANS PROTECT AIRCRAFT

Here's one answer to the problem of inadequate hangar space for single-engine aircraft, as devised by the Army Air Section, Fort Carson, Colo.

When foul weather warnings—winds of 22 knots and up in gusts—are received by the Air Section, a call for 6-ton vans goes out to the 7th Transport Battalion. The trucks are driven up, 8 to 12 of them according to need, and parked to the windward of the moored planes to sit out the storm.

Officials at Fort Carson credit these wheeled "windbreaks," which are over 33 feet long and stand more than 6 feet tall, with having saved thousands of dollars in plane damage.

BOOKS

For the Army Aviator

SCIENCE AT WAR—Crowther, J. G., and Whiddington, R. (The Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1948. $6.00).

Here is an authoritative, but technically simple, account of some of the most important aspects of the contributions of British scientists to World War II. Because of the close collaboration between the American and British forces, this book should be of interest to both the American scientists and the layman interested in science.

Unquestionably science played a much larger part in World War II than in any earlier war. The fact that scientists of the Allied Nations were able to overtake those working for the enemy, and then to keep ahead of them, played a very important part in ultimate victory of the Allies.

Science at War is a simple, somewhat historical account of the who, what, when, and how in the development of radar, operational research, and the atomic bomb. For those with naval interests, it contains a chapter on submarine detection through ocean echoes, magnetic and acoustic mine defense, and underwater explosions. Material is based on the official archives of, and documents assembled by, the Scientific Advisory Committee to the British Cabinet. The book is well illustrated with photographs and drawings.

BAUGHMAN'S AVIATION DICTIONARY AND REFERENCE GUIDE—Revised by Ernest J. Gentle and Charles E. Chapel (Aero Publishers, Inc., 2162 Sunset Blvd., Los Angeles 26, Calif., 1951. $7.50).

Book reviews in this department are compiled by the ARMY AVIATION DIGEST staff. Views expressed are not necessarily those of the Department of the Army or of The Army Aviation School.—The Editor

Helicopters, jet aircraft, atomic energy, guided missiles, radar, and rockets are some of the fields which have been added to the third edition of this aviation reference book. Over 2,000 new definitions in these and other fields have been added, making a total of 7,000 terms on all phases of the aviation industry. In addition, the aeronautical reference guide has been revised and brought up to date to help meet the demands of this rapidly changing industry.

Although the originator of the *Dictionary*, Harold E. Baughman, is no longer connected with the project, his name has been retained in the title so that users of previous editions can identify the text. The third edition has been revised under direction of Ernest J. Gentle and Charles Edward Chapel, president and associate editor of Aero Publishers, respectively.

For those working daily with the nomenclature of the aviation industry, this book offers over 600 pages of information in ready reference form.

THE NEW MILITARY AND NAVAL DICTIONARY—Edited by Frank Gaynor (The Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y., 1951. $6.00).

Although not an official publication of the Armed Forces, this revised dictionary is a helpful reference book for clarifying the fine points of military and naval terminology. For the newcomer to a military career, it gives simple, concise definitions of a host of terms.

Many common abbreviations, operational terms, and even military slang are included in the 7,000 terms. Extensive unclassified data pertaining to guided missiles and rocketry, atomic and radioactivity weapons, chemical and bacterial warfare, radar, sonar, loran, and other electro-magnetic ranging and detecting systems make this dictionary a rather complete reference.

The Army user will find it particularly helpful in acquainting himself with terms of other branches of the Armed Forces since Air Force, Navy, Marine Corps, Coast Guard, and Civil Defense, as well as Army, terms are included.

HOW OUR ARMY GREW WINGS — Chandler, Charles de Forest, and Lahm, Frank P. (The Ronald Press Company, 15 E. 26th St., New York 10, N. Y., 1943. $3.75).

Almost an aviation classic as the age of books is judged, *How Our Army Grew Wings* is a book every Army aviator will find absorbing and, in some instances, familiar reading. This story of airmen and aircraft before 1914 is a long record of "firsts": the Army's first balloons, its first airplane, its first airplane machine gun, its first flight surgeon. Through the story move figures now famous: Arnold, Brereton, the Wright Brothers.

Here is the authentic story for historians and all who would participate in the adventures of the Army's first fliers. Precise, impersonal, accurate, it gives the facts and figures as to persons, dates, machines, altitudes, speeds, horsepower, performance records, contracts, specifications, and military orders. Even more, here is knowledge which the military airman should have as part of his professional background.

OUR NEIGHBOR WORLDS — Firsoff, V. A. (The Philosophical Library, 15 E. 40th St., New York 16, N. Y., 1953. $6.00).

In his own words, the author has not written "a fanciful account of what the exploring Earthlings will find on other planets" nor "a straitlaced scientific treatise." Rather, here is a "marrying" of present astronomical information to the rapidly expanding science of space flight, plus a few glimpses of its future prospects on a scientific basis.

A survey of the solar system in conformity with the most recent information is used as a basis for a careful investigation of interplanetary travel. The book covers a wide field of modern research and speculation, but the author makes it clear when he is presenting theories of his own as contrasted with those generally accepted and taught.

For those who believe that within a few decades man may take his first step outside the earth to the moon and from there attain Mars, Venus, and the remoter planets, *Our Neighbor Worlds* will provide several hours of interesting informative reading.

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NG: State AG (2); Units–None

USAR: None

For explanation of abbreviations used see SR 320-50-1.

ARMY AVIATION SCHOOL CREST

When reproduced in full color, the colors red, blue, and yellow are used in the crest to indicate representation of all branches of the Army in The Army Aviation School. The school's aviation training mission is symbolized by the perched falcon denoting the art of falconry with its patient training of swift, keen birds for hunting. The mailed fist depicts the military ground arm which exercises the control, training, and direction of the flight.