AEROSPACE

SAFETY • MAGAZINE FOR AIRCREWS

AUGUST 1980

This Thing Called DENSITY ALTITUDE

■ What really is this thing called density altitude? It obviously has something to do with air density or mass per unit volume. To be specific, density altitude is altitude corrected for changes in temperature, pressure, and humidity. Air density will be decreased by a rise in temperature, a drop in pressure, or an increase in humidity. This last effect is due to the fact that while water is obviously more dense than air, water vapor is a gas which is less dense than air. A mixture of dry air and water vapor is therefore less dense than an equal amount of dry air.

These effects can be appreciated by considering an aircraft equipped with a barometric altimeter attempting to maintain a constant absolute altitude over flat terrain. Should the aircraft fly into a low pressure area, or into colder air, or into drier air, a decrease in absolute altitude will result even though the altimeter indicates no change. The remedy here is a simple one involving no more than up-to-date altimeter settings.

The effect of nonstandard density on aircraft performance is a little more complicated. Since density enters into the calculation of airfoil lift, it follows that a decrease in density will result in a decrease in lift produced. The exact amount varies with atmospheric conditions and type of aircraft, but, as an example, the difference between flying in humid rather than dry air equates to a degradation of engine performance of a few percent.

There is also a direct effect on engine performance. Less dense air reduces the pressure ratios through an engine, resulting in a loss of power. In a turbine engine, this loss is about 3 to 4 percent, while in a reciprocating engine, the loss can be as much as 12 percent.

Once the problem is thoroughly recognized, corrective action can be taken. During mission planning, the effects of nonstandard pressure and temperature can be taken into account while using the performance charts as indicated earlier. The effect of humidity is harder to measure.

As the temperature of air increases, so does its ability to hold moisture, and thus it becomes less dense. Density altitudes obtained from sources such as Air Force weather stations include the effects of humidity. The standard density altitude formula, the dead reckoning computer, and most density altitude charts are based on dry air. If the air is hot and the relative humidity is high, the error can be 1,000 feet or more.

The steps to take then are:

- Check weight and balance.
- Use performance charts to determine mission allowable gross weight.
- Make an approximate correction for humidity. If the air is cold and dry, the correction is negligible. If it is hot and humid, add 1,000 feet (or reduce allowable gross weight by 200 pounds, or reduce maximum torque available by 1 psi).
- Repeat above steps for each point of intended landing (or hovering).
- If the result is marginal, reduce the load still further since the charts are inaccurate, and other parameters have not been considered, such as load factor due to angle of bank or deceleration, engine condition, winds, and nonstandard lapse rate.

Sound by-the-book planning results in power margin, and power margin keeps you in the air— summertime or any time. — Adapted from *Flightfax,* Vol. 8, No 36, 25 Jun 80. ■

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SPECIAL FEATURES

REGULAR FEATURES

DEPARTMENT OF THE AIR FORCE • THE INSPECTOR GENERAL, USAF

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Near Disaster

In May of this year the National Transportation Safety Board issued a report on an incident in which a B-727-25 came within 375 feet of disaster. The aircraft, with 71 passengers and six crewmembers, was approaching Hartsfield Atlanta International Airport when it flew into a heavy rainshower with vertical and horizontal windshears. The report contains important information for airfield managers and aircrews, particularly those of transport aircraft. Following is an abbreviated version of the NTSB report.

■ Flight 693, a regularly scheduled passenger flight, was en route to Atlanta from Indianapolis, Indiana, with 71 passengers and six crewmembers on board. According to the flightcrew, the en route portion of the trip was routine, and as the flight approached Atlanta, it was cleared to descend and vectored into position for an instrument landing system (ILS) approach to runway 27L. The first officer was flying the aircraft.

According to the flightcrew, they had received Automatic Terminal Information Service (ATIS) information MIKE which stated in part, ''Atlanta weather, three thousand five hundred scattered, estimated ceiling one three thousand broken, three zero thousand broken, visibility eight (miles), temperature eight-nine, wind two three zero degrees at seven (knots), altimeter three zero zero zero. ILS approaches runway 26. ILS approaches runway 27L. Simultaneous ILS approaches in progress . . . Advise on initial contact you have information MIKE.'' The flightcrew did not inform the controller that they had received ATIS information MIKE.

As Flight 693 approached the Atlanta area, the flightcrew said that they observed thunderstorms in the vicinity of the airport both visually and on the aircraft weather radar, and they monitored the storms during the descent. According to the pilots, the storms were ''scattered'' and were located to the north and to the south of the

approach course to runway 27L. The captain said that there was one cell south of the approach course and three cells, aligned on a north-south axis, to the north of the approach course. The southernmost cell of the three northern cells appeared to be located on the approach course to runway 26, which is 5,500 ft north of runway 27L.

The captain said that he placed his radar set in the contour mode to examine the cells while the flight was inbound to the outer marker of the ILS approach to runway 27L. However, he could not recall what he saw in great detail. He said that he was not concerned with the three "little cells" to the north which resembled "three little bubbles . . . about the size of eraser heads"; he was more concerned about the cell to the south.

Atlanta approach control continued to vector Flight 693 toward the ILS approach course. At 1508:09, the controller cleared the flight to cross Anval – an intersection located 3.5 nmi east of the OM and 8.5 nmi east of the threshold of runway 27L – at 3,500 ft, to maintain 170 kns indicated airspeed (KIAS) to the OM, and to contact the tower. At 1510, Flight 693 reported over Anval. The local controller cleared the flight to land on runway 27L and added, "the winds are calm and keep your speed up as long as feasible on final, sir. You'll break out of that rainshower in about 3 miles, and there is rain down the middle of runway 27 left right now." Flight 693 acknowledged receipt of the transmission. The local controller said that the rainfall was of moderate intensity.

According to the captain, he monitored the communications between the local controller and the two flights which were ahead of his aircraft on the approach – Delta Airline's Flight 1154, a Lockheed 1011, and Delta Flight 452, a Boeing 727. At 1509:24, the local controller cleared Flight 452 to follow Flight 1154 for landing and informed the flight that there was a shower on the "approach end of runway two seven left." At 1509:54, Flight 1154 told the local controller that it was "clearing" the runway "in that shower that's (un-

Near Disaster continued

intelligible) end of the runway now.''

Flight 693 intercepted the glide slope outside of the OM at 3,500 ft. The first officer said that he used his fuel flow meters to establish the desired thrust settings for the descent, and accordingly, established a fuel flow of about 3,500 to 3,800 pounds per hour (pph) on each engine. Except for minor adjustments to keep the aircraft on the desired descent path, he said he maintained those thrust settings until the aircraft encountered the intense rainshower. According to the engine manufacturer 3,500 pph fuel flow would produce 4,650 lbs thrust at 2,000 ft and 4,580 lbs thrust at 1,000 ft.

The aircraft was placed in the landing configuration at the OM and the final landing checklist was completed before the heavy rainshower and wind shear were encountered. The landing flap setting was 30°; and the computed missed approach or go-around engine pressure ratio (EPR) setting was 1.93. The reference speed for the final approach was 120 KIAS; however, the first officer said that he attempted to hold 135 KIAS after passing the OM. He also said that he kept about a 2° to 3° nose up pitch attitude to stay on the ILS glide slope, and that after leaving the OM, the rate of descent was about 500 to 700 fpm.

The flightcrew said that the ground was in sight as the aircraft overflew the OM. The aircraft was flying in light rain, light turbulence, and experiencing ''a little bit of airspeed fluctuation.'' At 1,000 ft agl, the rain and turbulence increased. The crew said that the turbulence became ''moderate'' and remained at that level until the aircraft flew out of the precipitation. The rain became ''heavy'' and, according to the flight enginer, it was heavy enough to increase the noise level within the cockpit. Ground visibility was lost and was not regained until after the aircraft flew out of the area of precipitation. The flight engineer said that the aircraft reentered a cloud layer as the rain and turbulence increased; however, the pilots were unable to confirm this, because of the amount of rain on the windscreens.

About 1,000 ft agl and simultaneous with the increased levels of rain and turbulence, the indicated airspeed began to fluctuate. The first officer said it decreased from about 135 KIAS to about 120 KIAS, increased to about 140 KIAS, and then, a few seconds later, decreased to between 108 and 110 KIAS. When the airspeed began to decrease, the first officer noted that the rate of descent had increased to 1,000 fpm. At 800 ft agl, he rotated the aircraft to a 10° noseup pitch attitude, advanced the thrust levers, and called for takeoff power. The captain then refined the thrust setting to the missed approach or takeoff power setting.

According to the first officer, the pitch correction and added thrust had no effect. The descent rate increased to 1,500 fpm and then to 2,000 fpm. The first officer then rotated the aircraft to a 15° noseup pitch attitude and advanced the thrust levers to their forward stops to obtain whatever thrust that was ''available at that time.'' The captain again ensured that the thrust levers were against their forward stops.

At 500 to 600 ft agl, and at an airspeed of between 105 KIAS and 110 KIAS the stall warning system's stickshaker activated. Almost simultaneous with stickshaker activation, the ground proximity warning system (GPWS) activated; the below glidepath light illuminated; and the audio ''pull-up'' and whooper warnings began. The captain said that the stickshaker and GPWS warnings continued to operate until the descent rate was arrested and recovery began. He estimated that the stall warning system operated for about 10 to 20 sec.

When the stickshaker activated, the first officer said that he reduced the aircraft's noseup pitch angle from 15° to about 12° noseup and that the stickshaker stopped shortly thereafter. However, the captain said that he believed the first officer ''overreacted'' to the stickshaker when he lowered the nose. He told the first officer to pull the nose up when the pitch angle reached ''about ten to twelve degrees.'' The first officer estimated that the stall warning operated about 5 to 10 sec. At this point, the flight engineer said that the instantaneous vertical velocity indicator (IVSI) depicted a 2,100 to 2,200 fpm rate of descent.

According to the flightcrew, the aircraft flew out of the precipitation at 375 ft agl in a right wingdown attitude and began to accelerate. The descent was arrested and a climbout was begun. The landing gear and flaps were raised during the climb, and the aircraft accelerated to 200 KIAS.

The flight engineer said that the thrust levers were against their forward stops for about 30 to 35 sec. The N_1 compressor rpm's and exhaust gas EGT of all three engines had exceeded their limits and were operating within the red bands on their respective gages. The highest readings were noted on the No. 3 engine. However, the engines operated satisfactorily during the 30- to 35-sec overboost period and for the remaining 50 min of flight.

At 1512:44, the local controller told the flight that the tower had received a "low altitude alert, check your altitude," and then asked if the crew had the airport in sight. At 1512:52, the captain answered, " . . . No sir, we kinda missed out here." At this time, the aircraft was climbing and was accelerating away from the stall regime. The captain then told the local controller "There's quite a bit of rain . . . a wind shear out there. I don't see how anybody could make an approach to the left one," (runway 27L).

At the captain's request, approach control then vectored Flight 693 to a clear area south of the airport to hold until the weather cleared. At 1542, landing traffic at the airport was switched to the east, an approach clearance to runway 9R was offered and accepted, and the aircraft was landed on runway 9R without further incident.

> There were numerous thunderstorms in the Atlanta area and at 1454 the surface observation for the airport was estimated ceiling 3,000 ft overcast, visibility 4 statute miles, thunderstorms, light rainshowers, temperature 79°F, wind 360° at 04 kts gusting to 32, altimeter 30.01, thunderstorm began 1450 overhead moving northeast, rain began 1433, lightning cloud to ground northeast.

Air Force crews still occasionally expect the air traffic controller to keep them out of violent weather. That is not always possible and our crews should know it. According to the report, the WSR-57 S-band weather radar is not capable of measuring air motion within a cell. Furthermore, ATC controllers "indicated that these displays were of little value for furnishing information to a pilot about the storm's intensity or its distance and direction from an aircraft."

Although a Low Level Wind Shear Alert System was in service at the airport, and was capable of detecting surface level wind shears within the airport boundary, it had little or no capability to detect wind shear aloft or outside the airport's boundaries.

Among the board's 10 conclusions were these:

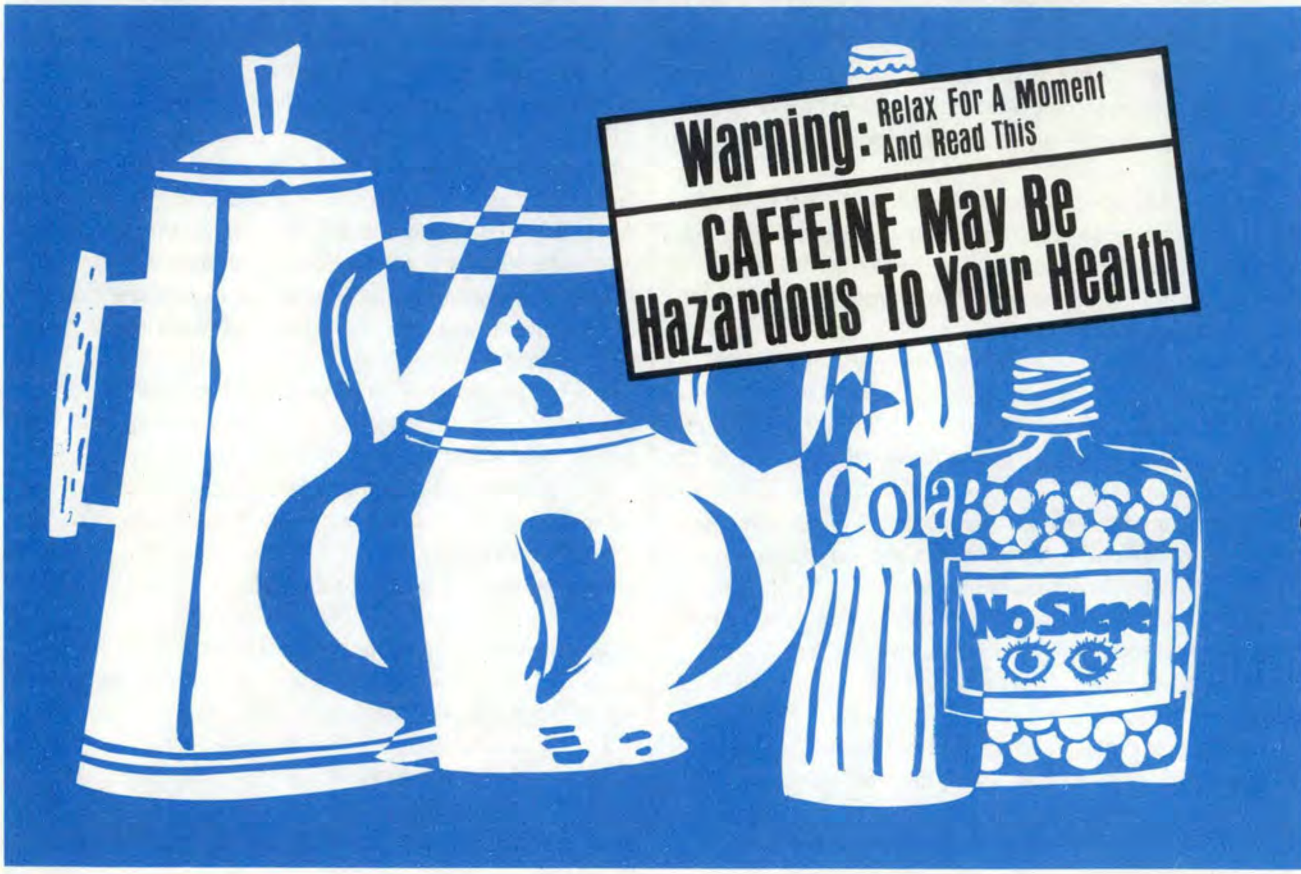
- The Low Level Wind Shear Alert System's wind sensors on the airport did not detect the wind shear condition. The remote weather radar displays at Atlanta and the WSR-57 radar at Athens did not have the capability to measure the motion of the air within the cells. Therefore, the wind shear condition was not detected until Flight 693 traversed the area.
- The flightcrew was unable to assess the intensity of the rainshower and its associated wind shear before they entered it.
- The flightcrew maneuvered the aircraft in accordance with the procedures contained in the company's wind shear training program.
- The wind shear training program conducted by the company, in accordance with the FAA training requirements, contributed to the ability of the flightcrew to maneuver their aircraft through the shear area successfully.

The last three are included here because they emphasize the value of effective procedures and training in the application of those procedures.

The board determined the probable cause of this incident to be the unavailability to the flightcrew of timely information concerning a rapidly changing weather environment along the instrument landing system final approach course. The unavailability of this data resulted in an inadvertent encounter with a localized but heavy rainshower with associated wind shears which contained changes in the horizontal and vertical wind velocities which required the flightcrew to use extreme recovery procedures to avoid an accident. Contributing to this incident was the lack of equipment for the airport terminal area that could have detected, monitored, and provided quantitative measurements of wind shear both above and outside the airport's boundaries. ■

Caffeine 80's

Drug Of Abuse In The Eighties?



. . . Interest in preparing an extract of coffee was initiated in 1838 when Congress substituted coffee for rum in the rations of soldiers and sailors. Thus the beginnings of instant coffee . . .

■ For quite some time now during AFR 50-27 Aerospace Physiology Refresher training, students have responded to lectures relating to drugs and "self-imposed stress" with the question: What about caffeine?

Subsequently, we embarked upon a two-phase study to review available scientific information in relation to the toxicology, and physiology of the drug caffeine, and to determine the actual caffeine practices of our students by means of an objective questionnaire. The results of this survey will provide the readers an opportunity to examine their practices in relation to our sample population of aircrew members.

We found that about eighty percent consumed coffee in some form with about 26 percent at the 3-4 cup per day level, 17 percent at 5-6 cups per day and about 8 percent at over seven cups per day. The majority consumed regular coffee brewed at average strength sweetened with sugar. Only 7 percent were regular saccharin users,

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Cartoons by MR. AL YOUNG
SAM Graphics Art Section

and less than 2 percent used cyclamates.

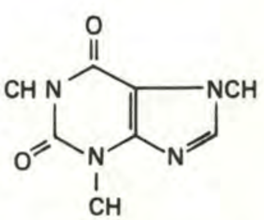
Like our crewmembers, many people regard caffeine as a safe, legal stimulant without great regard for the quantity of their consumption. While the caffeine-loaded beverages, food and drugs they ingest are an expensive part of their lifestyles, most of the "users" have paid little attention to their daily dose, or the degree of their (addiction) involvement. There is no need to be sanctimonious, or presumptuous about the possible hazard of using too much caffeine. Moderation has always been regarded as an important rule for all practices.

Modern biochemists identify *Xanthines* as a family of compounds comprising man's oldest stimulants.

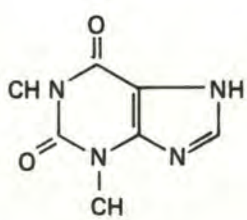
When extracted in pure form, caffeine, a member of the Xanthine family, is a shiny white powder. This weak base alkaloid is closely related biochemically to morphine, nicotine, cocaine, purines, and strychnine. The structural formula:

$$C_8 H_{10} N_4 O_2$$

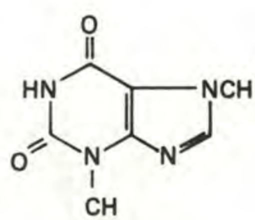
with minor arrangement of the methyl groups, accounts for the three principal forms of methylated xanthines or caffeine shown below:



Coffee
Molecular Weight: 194.19



Tea



Cocoa
(Lesser effect on CNS)

Of these forms, caffeine, and its most prevalent source, coffee, is popular throughout the world.

The Physiology of Caffeine

CAFFEINE This drug is described as non-adaptive (regular use does not diminish its stimulating effects). It is not physically addicting *in the sense that withdrawal will harm,* or produce violent symptoms. It does seem to be psychologically addicting, and not easily discontinued. Some tolerance is evident in that it takes more to get the same effect with continued use. Humans tend to increase its use with age.* Many use it to keep their weight down.

A POWERFUL CNS STIMULANT Here are Key Descriptive Characteristics:

Antidepressant

Stimulant, analeptic

Maintains wakefulness (antihypnoid)

Affects muscles by central affect (theobromine [cocoa] has greatest affect on isolated skeletal muscle)

Causes increased peripheral blood flow by vasodilation and *decreased cerebral blood flow* (cranial vasoconstrictor, and reduction in cerebrospinal pressure).

Does not significantly affect objectively measured intellectual performance.

Does affect speed of accomplishment of motor tasks significantly, up to an individual dose level.

Tolerance is slow to develop, and slow to disappear (may require more than two months of abstinence).

Exactly how caffeine works is largely unknown, but one theory holds that it inhibits phosphodiesterase with a resultant increase in tissue 3′-5′ AMP. 3′-5′ AMP is an intracellular intermediate which increases the rate of hormonal reactions. While the mechanism is not entirely clear, it also plays a role in the vigor of muscular contraction by affecting the release of calcium from intracellular stores.

HOW CAN YOU TELL IF YOU'RE REALLY HOOKED?

If you find this article with coffee stains on the first page untidily stashed in the trash can, it may mean that you or the reader, undesirable of being objective about coffee, is *really* hooked. There is also a strong possibility that the individual also smokes, consumes alcohol regularly, and finally, is not a small percentage of the population!

*By one survey, American coffee consumption at over 7 cups/day is higher in 40-49 year olds.

Caffeine 80's
Drug Of Abuse In The Eighties? continued

But that individual is not you; you are still reading! You are a rational, objective person willing to appraise your own caffeine consumption practices. The next step will be considerably tougher however. It should *not* be attempted when you face a situation that demands your top performance (i.e., before a long drive at night on the highways or similar flight in the airways).

If you consume five cups (or more) of coffee every day (or equivalent), are blessed by a vacation-like pause in your routine (no great demands on your performance), try absolute abstinence from caffeine. This means no coffee, coke, tea, APC's, cold pills, chocolate, or foods containing caffeine, for at least 24 hours. After this time of abstinence, subjectively note your symptoms, and set out for another caffeine-free 24-hour period. It will take about seven days of this to "clear" the caffeine from your system. The drug withdrawal symptoms are not widely known because very few people have tried the experiment, and fewer yet have completed it! If you find that you can go long periods without caffeine, you were probably not physiologically addicted. One word of caution, however, when withdrawing from caffeine count your calories because you may tend to put on weight!

After 12-18 hours you may note headache (widely reported) and a general restlessness, disquiet, anguish, or even aching pains. Dysphoria describes the variable human response to caffeine withdrawal.

Some will complete the withdrawal with very little ill-effect, but they are of the minority in belonging to a group who partake of caffeine only on an occasional basis. (Their total previous caffeine consumption during 24 hours has probably averaged less than about 100mg, or the equivalent of one cup of coffee).

If you regularly suffer from any of the following symptoms, you have even greater cause to evaluate your caffeine intake practices: (All of the following symptoms have been attributed to regular consumption of large doses of caffeine):

*Insomnia
Sense of dread, depression
*Anxiety
*Fatigue
*Loss of balance
*Faulty thinking
Finger tremor
*Increased reaction time

(Those marked with an asterisk are more directly related to safety.)

In Terms of Performance Today, or Longevity Tomorrow, How Much is too Much?

For Americans in general, the rank order for contributing caffeine to their systems are coffee, tea, and colas. The drug is routinely removed during the processing of all coffee. The greatest to the least amount of caffeine among the various forms of coffee can be listed as follows:

Regular
Instant
Decaffeinated Regular
Decaffeinated Instant

Ironically, the caffeine that people pay to have removed from their coffee is purchased by themselves or others in drugs that have caffeine added, since decaffeination provides a major source of caffeine for the chemical and drug industries. It is also made synthetically.

The approximate values of caffeine per average size cup (6 oz) are:

HOW MUCH IS TOO MUCH?

Coffee	100 mg/cup*	*For 6 oz cup. (It is realized that some variations will occur in relation to strength of brew.)
Instant Coffee	60 mg/cup	
Decaffeinated	3 mg/cup	
Tea (Theophylline)		75 mg/6 oz cup
Instant Tea		30 mg/cup
Cocoa		6-40 mg caffeine 200 mg theobromine
Cola		60 mg/cup

In regular coffee the method of preparation causes considerable variation in strength:

Automatic	15 mg/cup	In general, caffeine content relates to the highest grind or the smallest leaf parts (tea).
Dripolator	142 mg/cup	
Electric perk	104 mg/cup	

Although probably benign when used in low dose levels, there is increasing interest that caffeine in accumulated high ingestion levels may be related to a variety of acute and chronic nervous and physical conditions. It is also possible that at relatively low doses it serves as a cocarcinogenic agent. Because so many people ingest caffeine from a variety of sources, and because there are also more artificial flavors and colors in foods, additional work is needed to more clearly define possible interactions. Environmental factors involving radiation, air and water pollutants, and industrial biproducts, add to the complexity of the problem.

Finally, because drugs are used so widely, it is important to realize that there is great interaction between the xanthines and other drugs. It is possible that some of these at low dose levels have beneficial effects. While it could probably be said that ideally, in a regime of natural living, we would live and enjoy better health without caffeine, it is possible that since caffeine is a natural compound, and because we have most likely adapted to it, it may be that it exerts beneficial physiological effects at low doses.

Since the mid-seventies, there has been increasing interest in caffeine's possible mutagenic effects. At levels of caffeine possible as a result of high content beverage consumption: (or dose equivalent amounts provided to animals in feed or water), caffeine has been studied with regard to possible effects on DNA or the chemical substance of chromosomes.

It may slow the repair of DNA damaged by ultraviolet radiation, or it may affect change of DNA by other carcinogens (cocarcinogenesis). How caffeine might affect repair, or rate of synthesis of DNA is related to the structural similarity of caffeine to adenine and quanine. Both are important building blocks of the DNA molecule. It does not form a stable bond in DNA substitution, but its potential for cocarcinogenic interaction is real.

While little is known of plant caffeine physiology, high doses cause chromosomal breakage in plant cells, microbes, paramecium aurelia and others. Caffeine affects older cells more rapidly than younger. While en vitro culture results cannot be directly attributed to en vivo, it has been observed that humans tend to consume more coffee with advancing age.*

Dose levels are extremely important to these relationships and results are as yet inconclusive. There is reason for concern, however.

How Does the Use of Caffeine Relate to Performance, Safety, and Mental Health?

If individuals become depressed because of work, or other environmental factors, the result may lead to the initial use of caffeine and other drugs. With the present condition of the world, and the uncertain stresses encountered, it is no wonder that the American adult population is about 85 percent involved with caffeine. The degree of the problem, probably as throughout all of toxicology, relates to the dose and the total time of involvement. The average plasma level then, and the length of involvement, would relate to the possible pathology. Because we are constantly bombarded with "take this for pain," take that for indigestion (i.e., Excedrin 65 mg/tab., Antacids 50 mg/tab., Bromo Seltzer 32.5 mg/cap), so that the total daily caffeine intake may increase to the point where it affects performance (safety) and mental health.

Coffee, Smoking and Alcoholing

There are great difficulties in attempting to isolate caffeine as an affector of human physiology (and

*There is a positive correlation for coffee drinking (women more than men) and cancer of the bladder in people over 60. There may be a risk associated with even small amounts of caffeine. This applies to the urinary tract and the prostrate gland.

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A Boot Full Of Rudder

By CAPT JIMMY CARTER
356 TFS
Myrtle Beach AFB, SC

■ "Nice shot, lead." Stopped him in his tracks. . . . I'll get the next mover . . . slight bump. Push over aim a little high, got a left crosswind too . . . track-shot-track. Saw sparks-off with the ZSU break . . . back into the weeds. Whoops, got a Master Caution Light. The Hog's pulling to the left. Level off and climb with a boot full of right rudder. "Wart 41 knock it off . . . got my left engine windmilling, let's head for the divert base. . . ."

Well, another single engine in the Warthog . . . seems to happen a lot . . . probably gun gas ingestion. Got to be careful so this thing doesn't depart on me.

Our friend sure has his hands full, working a high threat mission, and now he's got an IFE – a single engine Warthog. There has been much discussion recently about single engine flight in the A-10. Two accidents, several incidents and the bevy of safety sups, dash one changes and FCIF's that followed. But, many pilots are not satisfied that enough information is available concerning flight characteristics of the A-10, while operating single engine.

The following discussion is one person's attempt to consolidate some of the available information and offer one opinion on the departure modes of the A-10.

First of all, the track record of the TF34 engine and the A-10 has been good. But there have been many occasions when a pilot has found himself single engine. Let's look at some statistics. Of the first 80 reported single engine incidents:

- Fifty resulted in single engine landings.

- Of the 14 that flamed-out because the aircraft was flown out of the envelope, 10 were successfully restarted. Most of these occurred during early test flight when the envelope was purposely explored.

- Six were listed as possible gun gas ingestion including the double engine flame-out while testing a different bullet.

- Of the mechanical or maintenance related incidents:

- Ten were due to fuel control.
- Fifteen were due to structural failure and subsequent FOD.
- None were attributed to bird strikes.
- Over 20 were due to some sort of oil pressure problem, including six incidents of improperly or non-secured oil caps.

- Only two incidents involved use of the fire T handle, and only one of those was due to fire. The engine has burned on occasion, but shutting off the throttle is usually enough to put out the fire.

- None flamed-out from ice ingestion, although blade damage has occurred.

- Five happened in the traffic pattern or while configured for landing.

- Only two required stores to be jettisoned (9 MK-82 inerts/2 fuel tanks).

From this data some trends can be seen. The TF34 is resistant, in varying degrees, to fire, ice, birds and gas. It needs oil, proper maintenance on the ground, and pilot attention in the air when operating at the outer edge of the envelope.

In addition, if you lose an engine you have close to a fifty-fifty chance of restarting it, depending on the malfunction. More successful restarts could have occurred if the engine had been cooled properly and the caution related to the automatic start systems observed. That is, keeping the throttle out of idle position (e.g., off) so as not to provide fuel and ignition inadvertently to an engine that is overheated.

This is nice to know information if you're sitting around the coffee bar and happen to be discussing the pro's and con's of TF34 reliability with your flight commander. But Wart 42 will need some information about how to get home with a single engine, not why he got one.

Well, he's got over 50 miles to go until he lands. He's got the right throttle at max, and he's climbed to a safe altitude. He disengages the SAS, goes to crossfeed, and pulls the emergency brake handle. While he starts the APU, lead has declared the emergency for him and is getting out the checklist to discuss the options. Wart 42 has things under control, but he's concerned about the possibility of a departure.

While they are busy with the checklist, we'll open the dash one to page 6-11, Side Slip Departure, the only departure mentioned in the dash one.

Below 240 knots you have 25 degrees rudder authority. If you apply all of that, the aircraft yaws the full 25 degrees. You experience light air frame buffet and high lateral acceleration. As advertised, the yaw continues with no more input on your part, and the A/C will rapidly roll in that direction. Attempts to counteract the roll once it is developed have minimal effect until the aircraft is nose low. Neutralize the control and the A-10 is flying again, but you will probably have to recover from a nose low attitude. All this occurs below stall AOA. Above that, the aircraft might spin but more than likely it just stalls and reacts as depicted on page 6-6 of the dash one.

This is not a mysterious aerodynamic phenomenon, nor is it a case of stalling the inboard wing. The secondary effect of rudder or yaw is roll. This is much more pronounced in swept wing aircraft than in a straight wing aircraft like the A-10. Our roll is produced by the slight positive dihedral of the wing when yaw is produced. It becomes a departure because the amount of yaw needed to cause the rapid roll off is uncommanded by the pilot.

So what's this got to do with single engine flight? The two single engine accidents in the A-10 were very similar to each other and were basically side slip departures.

Both aircraft generated a *yaw rate* which allowed the aircraft to overshoot into the region of uncommanded yaw. This yaw overshoot, transient

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A Boot Full of Rudder continued

or divergent (or however you label it) is much like the side slip departure described earlier. That is, for whatever aerodynamic reason, the yaw continues, insufficient rudder authority is available to counteract it, and in fact, opposite aileron actually increases the side slip because of adverse yaw.

The important thing for Wart 42 and all of us to remember is that the yaw that was generated in both accidents was the result of pilot inputs.

This is how it could happen. Because of asymmetric thrust and the corresponding drag of a dead engine, the aircraft will seek a certain side slip angle if not corrected for by rudder into the good engine. Asymmetric stores may add or subtract a significant amount to the side slip angle the aircraft will seek, as will the offset nose gear. An increase in angle of attack decreases airspeed and also increases the side slip angle sought.

If you release some or all of the correcting rudder while slightly increasing the AOA, you will generate a yaw rate in the direction of the dead engine.

Your SAS kicks off at this time and adds a yaw transient as mentioned in the note under Yaw SAS on page 1-56. Now the SAS is off, as it should have been, and the aircraft overshoots the side slip angle sought (because yaw dampening is no longer available). The severity of this overshoot will depend on the *yaw rate* generated.

This overshoot puts you into the region of uncommanded yaw and roll. If you have speed brakes open slightly, your roll rate will be increased. If you attempt to roll out with aileron only (no Aileron Rudder Interconnect is available), adverse yaw increases the yaw in the direction you were already going. In addition, the decrease in airspeed has decreased the authority of all your control surfaces. Briefly stated, you have generated enough yaw to do a slow speed rudder roll. But you may not have enough control authority to roll out and you are probably aggravating the yaw with these roll out attempts. All of this occurs well above stall speed.

The side slip departure is real. Early flight tests, two accidents, computer simulations and accident verification flights attest to this. The common denominator seems to be the yaw rate that is generated. Asymmetric thrust, airspeed, AAS, configuration, rudder and SAS inputs can all contribute to an undesirable side slip that would allow the A-10 to roll. Further research is necessary to isolate the specific aerodynamic characteristic of this departure, especially those that may have involved uncommanded input from the SAS.

But for the present time Wart 42 and the rest of us Hog drivers need to refamiliarize ourselves with the basics of single engine flight in an aircraft that does not have center line thrust. As the pilot, you have control over most elements essential to safe single engine flight: Airspeed, AOA, configuration and especially rudder. The description of the departure in this article would be academic if proper rudder were used.

The dash one states that at least half rudder down to stall speed is necessary for coordinated flight with gear down and no flaps. It may take up to 180 pounds of pedal force to achieve full rudder depending on airspeed and how much side slip angle the aircraft is attempting to seek. This may mean engaging the good yaw channel to give you 10 degrees of rudder trim. So regardless of airspeed configuration or AOA, center the ball . . . almost (a slight – approximately 5° – bank into the good engine – ball deflected slightly toward good engine – will result in zero side slip. Tape a yaw string to a lightning strip to prove this).

Here are some other things you can do:

- Read the dash one (SS-7 is the best discussion available on single engine flight characteristics).
- Know the checklist procedures cold.
- Single Engine Flight (already accomplished by Wart 42).
- Single Engine Restart.
- Single Engine Failure/Fire During Takeoff.
- Avoid turns into the dead engine.
- Shallow turns, away from the dead engine will take additional rudder to be coordinated.
- Fly the checklist airspeed. (150 kts plus 1 kt per 1,000 lbs above 30,000 lbs.)
- Remember, your day isn't done once you are on the ground. Be aware of hot brakes.
- Temperature and pressure altitude should be discussed in the flight brief when they would make safe single engine flight critical.
- Use your imagination in discussing single engine emergencies. Use your head when you find yourself in single engine flight. Use your foot to stay flying. ■

Runway Conflicts

■ Seems in the past few months that we have had an unusual number of vehicles on active runways in conflict with aircraft. The latest occurrence had some interesting facets that indicate just how such situations can occur.

An aircraft had just cleared the active after making an emergency landing and another aircraft was cleared to takeoff. While it was on the roll, an ops vehicle entered the runway. The pilot saw it at about 130 kts, was committed and continued takeoff, clearing the vehicle by about 50 feet. The circumstances were reported as follows:

The driver thought the runway was closed because he had seen fire trucks following the emergency aircraft. Actually, the fire trucks used an adjacent access road and the runway was never closed. Part of the problem was the ops vehicle was held at a point about 1,000 feet from the access road and 1,500 feet from the runway. At that distance it was difficult to tell which road or runway was used by the emergency vehicles. An illusion can be generated by heat waves, standing water, snow or vegetation making it difficult to accurately perceive the real location of an object 1,000 – 1,500 feet distant.

When the ops vehicle was cleared to cross one runway, the driver continued on to the active, thinking it was closed.

The driver was not a newbie but a recent graduate of UPT and familiar with airfield environment. His basic mistake was to make an assumption that he did not check out on the radio. A call to the tower would have prevented the incident.

While we're on this subject, several of the individuals involved in occurrences similar to the one related above should have known better. They probably did, but one lapse, a faulty assumption, a garbled radio call not rechecked could have had catastrophic results.

All commanders and safety officers should be aware that a similar incident could happen at their base. One of the things evident in recent occurrences is that it is not just the young, inexperienced airman or a newly hired civilian who makes the mistake but some highly experienced, rated people. Keep that in mind when reviewing your airfield vehicle operations program. ■

OPS topics

Lightning Strikes 3

■ A flight of three F-111s had just entered IMC with no weather on their radars when all three aircraft were struck by lightning. There was a momentary interruption of flight instruments, then all systems returned to normal. Shortly afterward, the flight broke up for separate approaches and one aircraft was hit by lightning again, that time losing all instruments except standby and getting an engine overheat light. Landings from that point were uneventful. The flight was at a level where the temperature was very near freezing. Also a thunderstorm was within five miles.

Timeless Bird

". . . at 500 ft AGL and 480 KIAS, the crew saw a *bird with insufficient time to take evasive action.*" That's what the sentence said, but is that what it meant? Could be. The bird and the left engine of the F-111A collided. Needless to say, the bird got the worst of the encounter; however, damage to the aircraft amounted to more than $45,000. Now if the birds had more time, perhaps they wouldn't hit so many airplanes.

Ear Pains

A C-130 with 30 passengers was climbing after takeoff when the cabin pressurization system was found not to be working correctly. The decision was made to return to base for maintenance. During the descent, the majority of the passengers suffered pain in their ears. In several cases, the pain was described as severe. Two individuals also had sinus pain. After landing, 19 out of 30 passengers requested medical treatment. The flight surgeon examined the 19 passengers and the crew. None of these passengers were familiar with the valsalva maneuver. Eight of the passengers had one or both ears which were "injected" (bright red blood vessel). These same eight people were unable to valsalva due to blockage. Two of the eight reported previous upper respiratory congestion, but the other six reported no previous problems. The flight surgeon advised the eight passengers to discontinue their trip until their ears recovered. After 24 hours the condition of all patients was improved. But five of the eight were scheduled for follow-up exams. The flight crew didn't experience any pain nor did the flight surgeon note any signs of trauma to their ears. Maintenance found a flow control valve stuck open on the cargo compartment air conditioning pack. Not all pax, obviously, are familiar with the valsalva maneuver. Perhaps it would be a good item to include in the pax briefing.

Paratrooper

At 12,500 ft MSL the loadmasters of a C-141 were accomplishing post drop duties. One of the loadmasters was walking toward the rear of the aircraft. Passing the ramp hinge area, the loadmaster felt that the aircraft accelerated and encountered some turbulence. Those two factors plus the fact that he was walking toward the rear provided enough momentum to

eject him. Assuming a free fall position, he observed the paratroopers that had just departed his aircraft. Keeping his eye on them while free falling, the loadmaster pulled his ripcord when the paratroopers pulled theirs. He landed in the DZ unharmed (but slightly nervous, no doubt).

Believe It

The report reads like a Ripley "Believe It or Not." An F-4 belonging to another country was taxiing after landing when both crewmembers were inadvertently ejected. The aircraft continued to roll. The pilot, after making a safe descent, ran to the moving aircraft and shut down the engines. All in a day's work.

FODDER For F-15

781 Forms seem to be a favorite (FODDER) for hungry jet engines. The latest eater was an F-100 engine in an F-15C. The forms were placed in the nose wheel well. The pilot apparently never looked at them and there they remained. Sometime, probably when the gear was lowered for landing, the forms found their way into an engine. Remember—ONLY YOU CAN PREVENT FOD!

Volcanic Ash Caused Mishap

Shortly after the Mt. St. Helen's eruption, an Air Force helicopter was sent on a rescue mission to a site near the volcano. As the chopper approached landing, it was suddenly engulfed in a cloud of ash. The pilot slowly lowered collective until the rear skids touched the ground. The landing was fairly firm which caused some damage to the front crossover tube and skid tubes. The loose ash caused a slight skid; otherwise there would have been no damage. The landing was made with no outside visual reference under very trying conditions.

Airport Lighting Change

At all civilian airports effective 1 July, the FAA changed the existing airport lighting criteria. Specifically, the visibility requirement to operate approach lights increased from less than 3 miles to 5 miles or less. Additionally, the ceiling criterion of below 1,000 feet for operation of the sequenced flashing lights (SFL), commonly referred to as strobes, was deleted leaving only the visibility requirement of less than 3 miles. While this criterion will exist at all civilian airports, the Air Force policy to operate SFL when the ceiling is 1,000 feet or less (regardless of the visibility) will remain in effect at all Air Force bases. Pilots still may request that the SFL be turned on or off regardless of ceiling or visibility; however, keep in mind the differences between the civilian and Air Force criteria for operation of the strobe lights.

Whether Weather

Two aircraft were damaged by hail in separate episodes but with a common thread. Each expected Air Traffic Control to pass a warning.

A T-37 got some dents in the leading edge of the wing. The pilot was briefed of isolated T-storms enroute. After descent to 15,000 for penetration, the aircraft entered clouds with no turbulence encountered. After about 45 seconds hail and rain hit the aircraft and continued for 20 seconds. The pilot reported he was not advised by either Center or Approach Control of any heavy weather or hail.

An A-10 was more severely damaged with both intake ducts, vertical stab, strobe lights and nose cone receiving hits. The weather briefing indicated an isolated storm far north of the route that should not be a factor. No weather was forecast at

flight planned altitude. The flight leaped off, the IP assuming that Center would keep him notified of any severe weather. The flight entered an embedded thunderstorm and ran into hail.

All pilots should know, and presumably do, that air traffic controllers have limited capability to identify hazardous weather and are not required to routinely offer weather avoidance assistance. Usually they will, when workload permits, but pilots should ask for the service if they want it. It only takes a few words. That's better than explaining all those dents in the airplane. ■

Air Discipline, Brains, Roe, Mindrolling, And Wallbangers

By MAJOR GARY L. SHOLDERS
Directorate of Aerospace Safety

■ Air discipline – what is it? I've read a lot of words about air discipline violations of late. It seems like every Tom, Dick, and Harry who has ever flown an airplane has his own personal interpretation of the meaning of the term.

What, then, is discipline? It just so happens that I have a little war story that may get this discussion off on the right foot. I was fortunate to have had some expert tutelage in the art of flying fighters. One day I was flying on the wing of one of my teachers when we were about to get wrapped up with a couple of blue bandits in Bannana Valley. I could almost see my leader's fangs hanging out of his mask, as he had the upper hand, and was seconds away from distributing the Bandit all over the countryside.

It was at that very moment that my trusty steed decided to go ape – a screwdriver in an aileron bellcrank caused a few moments of sheer terror as the machine did its best to scrape off the top of a nearby mountain. I punched the mike button and calmly (?) uttered a prearranged code word which meant, "Boss, I gotta go home." There was no discussion; we separated from the impending victory as briefed in a proper military manner. That, guys, is discipline.

To my flight leader, the temptation to continue the engagement for a few more seconds must have been nearly irresistible. Believe me, there were a lot of guys who succumbed to those temptations; oftentimes they didn't come home.

Okay, the war story is over and discipline remains undefined. Here's one way to define it: *A concentrated application of brainpower*. A disciplined fighter jock is and always will be a thinking man. You see, anybody can lean on the bar with 6 G and tell war stories. Almost anybody, with enough practice, can turn his ham fists into gold. Anyone who is smart enough to read simple sentences can remember regulations to the letter. None of these things, singularly or in combination, add up to a real live disciplined fighter pilot. To have discipline, to be one of those guys who is worthy of calling himself a fighter pilot, one must possess the will and the physical faculties to plan for and concentrate on the task at hand.

The two key words in the above dissertation should be easy to recognize: *Planning and concentration*. Let us look at planning first. In the little war story, my flight leader was smart enough to look ahead while *on the ground* at some of the problems that could come up. He devised a plan based upon the overall environment that we faced. When a problem reared its ugly head, he was prepared to deal with it.

It should be obvious to the reader that planning can't solve all flying problems ("The best laid plans," etc) but it sure gives a jock a fighting chance. Time has a way of compressing itself during times of stress – everything that was all rolled up in a tight little ball one second seems to scatter itself all over the street in the next. A well thought out game plan that deals with the possible contingencies makes common sense and is the sure indicator of a well-disciplined fighter pilot.

Let's expand on this idea with another example that may hit a little closer to home for those folks who never have seen Bannana Valley. In the title of this article you saw "ROE" and "BRAINS." Here's why those two words are there. Imagine yourself planning a simple 1 vs 1 BFM mission. You decide to do some vertical stern intercepts and a couple of visual perch setups. You look through the ROE and see that there are several rules that apply directly to your mission. Good, sensible rules like: "Don't go within 2,000 feet of the defender's altitude during intercepts without a tally ho." "Don't get any closer than 1,000 feet to the defender's aircraft." "Don't go within 2,000 feet of a cloud." These rules are fairly standard around the world; it shouldn't be any problem to comply. But wait a minute – instead of just memorizing the rules and letting it go at that, perhaps you should *think* a little bit. *How* do you plan to comply?

Suppose you are right in the middle of your first intercept and find yourself nose straight up, 600 knots on the clock, 5,000 feet below the defender, and *no tally*. What now? Well, pardner, you have just broken your first ROE. There is no way that you are going to keep yourself from smartly busting right through the defender's altitude. This very thing has happened about 5 million times; at least four airplanes complete with people have bitten the dust after the "big sky" no longer took care of them. A little prior planning would lead you to the conclusion that you'd best run that intercept on the cold side until tally ho. A little more thinking will lead you to a surefire way to keep the thing cooled down and maximize your chances for a tally *at the same time*. I'll leave the method for you to figure out.

What about some of the other ROE? I'd sure like someone to tell me how to do a high deflection, high line of sight rate gun shot in an F-4 without ending up closer than 1,000′ to the defender. Tell me how, while looking at high six, you plan to judge your distance from clouds. I have never been able to do that; 2,000 feet, 2 miles, or 20 feet – it all looks the same to me when somebody's trying to gun me. More than once I've ended up inside of one of those fluffy white things. You know, we could have thirty eleven pages of examples about rules that are more complicated than they seem on the surface – compliance isn't always that easy.

The point to be made here is that the disciplined fighter pilot does one hell of a lot more than stuff sixty-nine thousand rules in his computer bank. He thinks through the flying situations that he is about to face, figures out *why* the rules are there, *how* to comply with them, and *what* to do if he goofs up and ends up in the very situation that the rules try to prevent.

If you have never tried the little planning exercise outlined above, you will be pleasantly surprised at the results. As you sit down and really start *thinking* about airplane driving (possibly for the first time in your life) you'll find that all kinds of great revelations start appearing in your head. All kinds of "what if?" type questions come and go. As you answer each question to your own satisfaction, you take one more step toward becoming the perfect fighter pilot. As you practice and refine your game plans while airborne, you can watch yourself enter a learning curve that is steeper than you've ever experienced before. There will come a time in the learning curve when you find that your knowledge of a particular task outstrips the simple guidance contained in the ROE. Rules become common sense; they no longer are things that you commit to memory, but things that are integral to your flying behavior. How's that for a bit of heavy philosophy? Try it, you'll like it.

Now let's talk about *mind-rolling*. As an air-to-air instructor, I learned very early that the average jetjock has great difficulty leaping into a ☞

Air Discipline continued

big, complicated hassle after droning along for 20 minutes under IFR control to get to his working area. It seems that after a great big complicated hassle, the average jock's brain goes TDY. We have all seen about a trillion dumb, dumb, dumb mistakes made right after knocking off a fight or completing some other demanding phase of the mission. Why? Probably because most guys just haven't figured out that fighter flying demands that your gourd be moving along at about a thousand miles an hour (mindrolling). In combat, the transition from ho hum straight and level was easy – all one needed was a tally ho on the Black River or a Bandit call. The throat dried up, and the adrenalin started moving right now. In peacetime it's not that simple – there are few natural inducements for the jock to put his gourd in gear.

You see, thinking fast is integral to the business – constant adjustments to the game plan, quick, correct decisions and rapid recognition of changing situations are characteristic of a good, disciplined fighter pilot. In peacetime, you have to train yourself to get that mind rolling. There are a bunch of devices that you can use to do that. For example, some of us have somehow developed a Pavlov-like response to 100 percent oxygen. Before engine start, I reach down and switch that lever to 100 percent – it's like magic. I know that 100 percent oxygen doesn't do that in itself, but I have conditioned myself to respond to that particular stimulus.

In any case, it's up to you, the jock, to consciously develop a way to start mindrolling. Keep yourself busy all the time, *every time,* from the moment that you lower your Grecian bod into the cockpit until you climb out. You need to consciously fight any tendency to relax anytime that you're in that airplane.

Let me digress for a moment and tell a short story about that. It was a 4 vs 3 DACT flight. We all blasted off and leaped into one of the most satisfying fights that I've ever had the pleasure to be associated with. After 20 minutes airborne, hair on fire, soaked with sweat, feeling good and still mindrolling about a million miles an hour, I pulled off the runway. At that exact moment, my gourd decided to go nite-nite. The upshot of the whole thing is that I left every switch in the cockpit on, owed the crew chief about 40 cases of beer, and was thoroughly disgusted with myself. It is scary to think of the possible consequences of a letdown like that while airborne.

There is just one more subject that we should talk about with respect to air discipline. It's called *wallbanging*. First, another war story. Once, while flying on a MIGCAP mission up north with a brand new guy flying in the number 2 position, we got wrapped up with a bunch of SAMs, MIGs, and I can't remember what all else. The new guy panicked. He started hollering unintelligible stuff over the radio, flying erratically, etc. To make a long story short, he darn near got a couple of guys killed. We had to beat feet out of there and couldn't do our mission. There is just one point to that story – panic (wallbanging) has no place in a fighter pilot's vocabulary.

If you are one of those guys whose heart leaps into his throat and whose brain turns into peanut butter every time that you see a fire light, someone is liable to get fatally hurt – you or somebody else someday unless you embark upon an active program to stop being a wallbanger. Like mindrolling, a conscious effort is required to deal with stress situations. The particular device that worked for me is a variation of the old cavalier attitude. For example, in combat I just told myself that I deserved to die if I couldn't dodge that crummy old SAM 2 with my name on it. After all, dodging SAMs is part of the job description. This same attitude has worked when it comes to fire lights and all that sort of stuff. Like the pilot who never gets lost because he doesn't care where he is, you can never get hurt if you develop a state of mind which allows you to dispassionately analyze and deal with the threats that confront you.

What all of the above boils down to is a simple, single thought: AIR DISCIPLINE IS USING YOUR HEAD – ALL THE TIME. ■

Caffeine 80's
Drug Of Abuse In The Eighties?

continued from page 9

pathology), in that smoking and drinking habits are covariates—persons indulging in one are more likely to partake of the other. The role of cocarcinogens is biochemically very complex, and an important role of future science will be to determine inner actions among substances.

It is interesting that only about 4 percent of heavy smokers drink no coffee. Among individuals smoking better than a pack a day, about 40 percent drink more than six cups of coffee per day.

There may be an underlying physiological reason for this pattern. It has been noted that coffee-drinking cigarette smokers take more nicotine into their systems when they ingest no caffeine. Also, as measured in saliva and urine, this increased clearance of caffeine, is seen in smokers. This process has been tentatively identified with induction of an enzyme in the liver (hepatic arylhydrocarbon hydroxylase). Since caffeine is a circulatory dilator and nicotine a constrictor, the pharmacological reciprocal relationship may somewhat mechanically explain one affecting clearance of the other. Both relate to increased catecholamine production when taken independently. Also, withdrawal from caffeine or nicotine lowers epinephrine—norephinephrine levels which results in lassitude, headaches or irritability.

There seems to be a synergism between cholesterol levels in simultaneous users, but coffee drinking alone does not appear to significantly affect blood lipids.

The relationship of caffeine to heart disease and cardiovascular problems seems to be a weak one when considered by itself. While more than three drinks (alcohol) per day is significantly correlated with hypertension, this is independent of age, race-ethnic, sex, smoke, coffee, adiposity, or education.

While it has already been stated that people who use alcohol also use coffee and smoke, there is a stronger association between alcohol and smoking than alcohol and coffee use. Also, the use of tea seems to stand entirely by itself. (Little old ladies and people who put ice in it when it's hot.)

While it has been noted that caffeine may be related to cardiovascular problems or accidents because of sleep deprivation, this would tend to identify with caffeine addicts more than alcoholics, who more frequently arise early, drink coffee until about 2:00 p.m. and shortly begin their evening alcohol participation.

The physical symptoms of cardiac arrhythmias, ectopic beats atrial-tachycardia, are more likely to occur in individuals who are tired and also under the influence of stimulants.

Summary

Air Force people should realize that coffee is not a harmless beverage that can be safely consumed in unlimited quantities. They should review their present caffeine consumption levels and set realistic goals of abstinence or moderation.

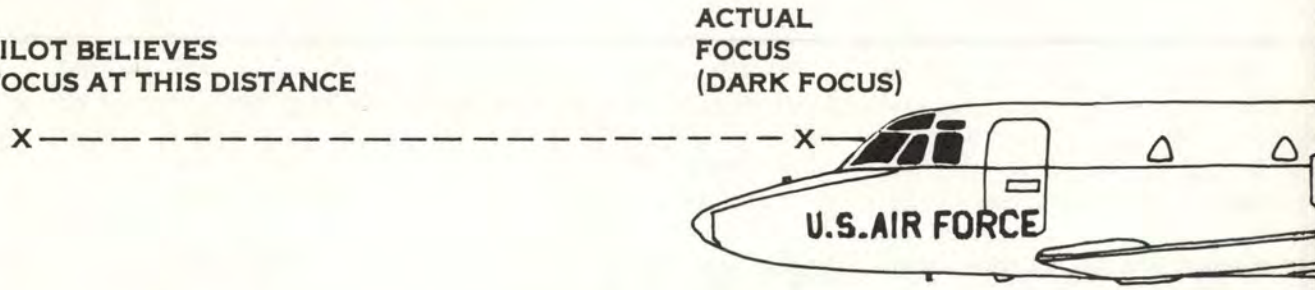
More than four cups per day or over 400 mg in a 24-hour period has been reported as beyond the upper safe limit. For a pregnant woman in her first 12 weeks of gestation, over 100 mg in 24-hours or less may be unsafe for her baby.

A great deal more needs to be known about caffeine as a possible cocarcinogenic substance. It is highly probable that we will learn more about how serious this problem is during the eighties.

For aircrew members it should be emphasized that coffee could be a life saver when moderately consumed at times demanding optimum vigilance. On the other hand, overuse after missions, might impair adequate rest and contribute to unnecessary fatigue on the next day's flight. Like most things we associate with the "good life," coffee and caffeine are just being added to the list of things that are probably harmful if abused. Because overuse has been reported to cause loss of balance, decreased cerebral blood flow and slower reaction capabilities, it is possible that aircrew members should re-evaluate their coffee drinking practices (or total caffeine consumption) before flights in high performance aircraft.

While we know of no studies which relate to spatial disorientation and coffee drinking, it is possible that overuse will be considered as a part of the more general enviromical transition into the predicted wellness revolution of the eighties. At any rate, check it out. Physiological check rides are just as important to the quality and quantity of your life as that cockpit niche you inhabit concerned with Aerospace Safety. ■

What You Think You See



...sometimes isn't

By **PENELOPE NELSON** • New Mexico State University • Las Cruces, NM

■ Beware the dirty or scratched windscreen. It could lead to calamity.

According to New Mexico State University aviation psychologist Dr. Stanley Roscoe, a dirty or scratched windscreen, especially when it is reflecting glare, or in combination with other factors, could cause distorted size and distance perceptions. And the pilot wouldn't even be aware he was experiencing an optical illusion.

Roscoe established one of the earliest human factors research and engineering programs at Hughes Aircraft, founded the Aviation Research Laboratory at the University of Illinois, and recently opened a behavioral engineering laboratory at NMSU. He has been studying optical illusion for many years.

Even a perfectly clear windscreen could present problems. Roscoe describes a study in which a group of pilots, using a simulator, were asked to judge the threat of midair collision with various intruding aircraft. When the pilots sat in the flight engineer's seat— about two meters from the window aperture— they judged intruders to be more threatening than when the same pilots sat in the pilot's seat, about one meter from the window, viewing the same intruding planes. They were experiencing optical illusion.

For a better understanding of the phenomenon, sit across a room from a window and close one eye. Extend your thumb toward the window. Focus the open eye on your thumb, draw the thumb toward you and observe the window change size. Apparent size of an object changes with shifts in the distance at which the eye is focusing or "accommodating."

The windscreen problem hinges on something called the *dark focus,* Roscoe says. The eye focuses or accommodates to objects at varying distances. It follows that there also is a point at which the eye is *unaccommodated,* or relaxed. This is the point the eye prefers, and effort, conscious or unconscious, is required to move the eye's focus in or out from that point. This is called the dark focus because this is where the eye will focus in the dark or when there is no object or texture on which to focus. At this point, focus requires no effort at all.

Until recently this point, the dark focus, was thought to be at *optical infinity,* any distance beyond seven or eight meters from the eye. Years of research now verify, however, that the dark focus is at a distance that varies with the individual but averages

Glare, dirt or scratches on a windshield can cause a pilot's eyes to focus improperly which in turn alters the apparent size and distance of other objects.

one meter—the distance of the pilot's seat from the windscreen.

Twenty years ago a scientist by the name of Mandelbaum stumbled upon an unexpected phenomenon. From the screened-in porch of his summer cottage, he found he could not read a sign located on the beach when he was a certain distance from the porch screen, although he could read the sign at all other distances.

Mandelbaum then conducted an informal experiment. He asked other people to read the sign through the porch screen. For each observer he found a critical distance from the screen at which the sign at the beach couldn't be read. The subjects realized they couldn't help focusing on the screen when they were at the critical distance, but could focus on the sign by moving nearer or farther from the screen or by moving their heads quickly from side to side. He decided that the effect, later to become known as the "Mandelbaum effect," was due to involuntary accommodation, or focus, on the screen, even though the observers were trying to focus on the sign.

This critical distance from the screen, at which the sign couldn't be read, varied from person to person with an average of one meter—the distance of most pilot's seats from the windscreen. Almost any textured visual stimulus at that distance, says Roscoe, could be a powerful focus trap.

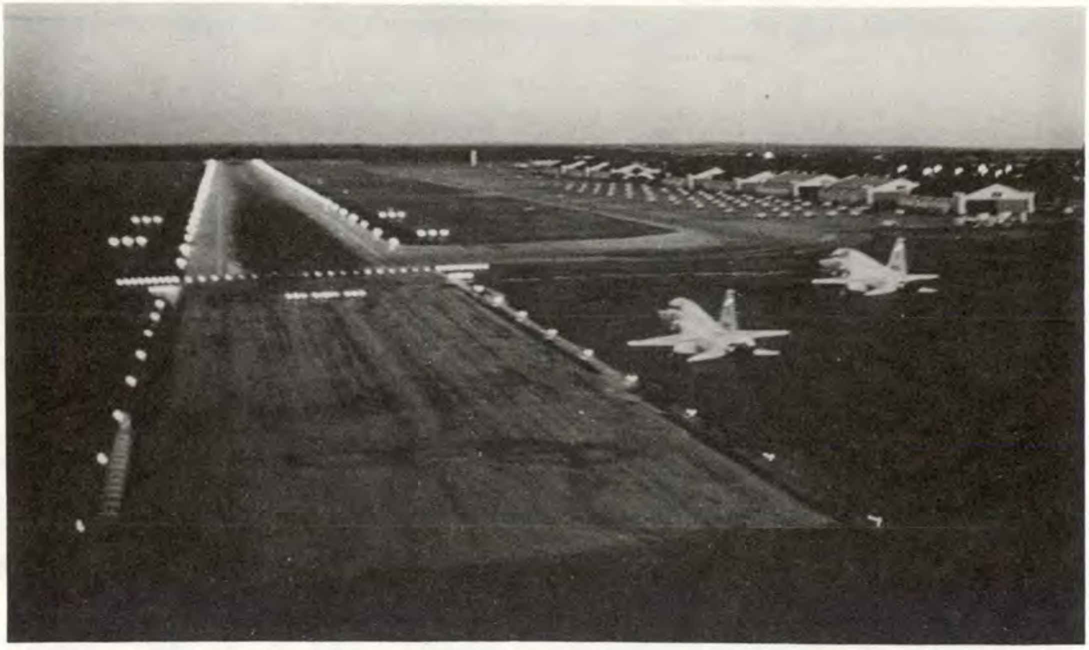
Roscoe also cautions pilots about several other visual illusions they may unknowingly experience, which are involved in various possible pilot "errors."

When pilots make approaches and landings with any type of imaging flight display projected at a magnification of one, they tend to come in fast and long, round out high and touch down hard. The imaged runway appears smaller, farther away and higher in the visual field than when it is viewed directly.

When pilots make landing approaches over water on a dark night toward a brightly lighted city the opposite happens. The runway may appear larger, nearer and lower than when viewed directly from the same flight path on a clear day. Several commercial airliners have landed in the water short of the airport when making a night, "black hole," approach. Researchers have discovered pilots will systematically misjudge the height and "tilt" of the runway and tend to make below glidepath approaches under these conditions.

(Also affecting pilots' perception of the runway environment are such things as runway width, lighting, horizon [e.g. city lights] runway slope.—ed)

Bias errors in depth discrimination have been independently discovered by designers of such optical equipment as submarine and tank periscopes, laboratory microscopes, one-power shotgun scopes and tiny helmet-mounted TV displays. All require some optical magnification for objects to appear at the same distance ☞



Visual illusions associated with the landing environment have caused numerous accidents. Several factors may influence a pilot's interpretation of what he "thinks" he sees.

What You Think You See . . . sometimes isn't continued

as when viewed by the naked eye.

Scientists studying this mystery found the eye doesn't respond obediently to the accommodation distances called for by these lenses. The eye is lazy, Roscoe says, and reluctant to be drawn away from its resting position. The brain, however, seems quite willing to accept an amazingly out-of-focus image without conscious recognition that it is out of focus.

In one test, pilots made two judgments along the final approach: the first at 1220 meters, the second at 610 meters. With unity magnification, they indicated an overshoot on the first judgment and an undershoot on the second. If they had been flying manually, they would have tended to overshoot the aimpoint.

There are countless possible explanations for this curious reversal in judgment. But the important thing is: it happens. If a pilot is late in recognizing his low position or is slow in adding power, he may land short.

The accommodation of the eye, Roscoe says, can be forced or misled by several phenomena that can occur in flight. When the eye's focusing ability is thus disturbed, both size and distance perceptions are distorted and the pilot's responses can be biased.

Optical illusions were recognized and remarked upon by the early Greeks and Egyptians, but few correct explanations were made until this century, most of them in the past decade. And along with the explanations of the "old" illusions have come discoveries of "new," more subtle visual illusions.

Among these have been the recently discovered effects of emotion on eyesight. Anger, fear, and anxiety, can alter visual perception. Even physical discomfort, pain, possibly depression and certainly dizziness have their effects.

While this can be dangerous for anyone, for pilots it could be and probably has been disastrous. Roscoe believes optical illusions have played a part in some plane crashes, almost always attributed to pilot error, in which a skilled and experienced pilot apparently made an unaccountable error.

Scientists have documented measurable shifts to farsightedness— or nearsightedness— when people are under stress. These shifts from a person's usual eyesight

. . . Anger, fear and anxiety can alter visual perception. Even physical discomfort, pain, possibly depression and certainly dizziness have their effects.

can last from a few minutes to several days.

It appears, says Roscoe, that sudden, brief or acute stress elicits some degree of

The brain seems quite willing to accept an amazingly out-of-focus image without conscious recognition that it is out of focus.

farsightedness. Such responses, he says, are probably individually tempered by personal experiences and can be controlled with training. Chronic, longer lasting emotional states such as anger, revulsion, and apprehension or anxiety seem to cause some degree of nearsightedness for varying lengths of time.

Despite the frightening implication that pilots cannot always trust their eyesight, these factors can be somewhat alleviated.

Several researchers, Roscoe among them, have recommended that pilots routinely wear bifocal lenses at night and when making instrument approaches in daylight conditions. The lower section of the lenses would optimize vision for instrument panel and chart-viewing distances. The upper section, with suitable correction prescription, would help remedy night and open-field myopias. These were discovered long ago, but most pilots are unaware of the effects of this distortion and prefer to believe their "perfect" vision is perfect.

To combat the possible problems in *black hole* approaches over water at night, Roscoe recommends that lead-in light buoys be considered for use at those major airports that have this approach problem. He suspects that the pilots who tend to make low approaches at night and occasionally land in the water are those who happen to have an extremely distant dark focus. The wearing of corrective lenses at night could alleviate the problem.

The use of head-up displays for night and instrument approaches, Roscoe says, needs a lot of further investigation. Advocates have tacitly assumed that such displays prepare the eyes to see, immediately and clearly, whatever is out there to be seen. Recent research findings don't support that assumption, says Roscoe. This type of image doesn't necessarily call the eyes to a far accommodation distance. A pilot breaking out of the clouds requires a very rapid shift to distant focus, and the scene "explodes."

In addition to basic eyesight and color vision, the dark focus or resting accommodation distance should be considered when selecting and assigning pilots. A distant dark focus might be a basis for assignment to military air combat duty; those people should be less troubled by empty-field myopia. Pilots with a nearer resting position should wear corrective lenses, he says.

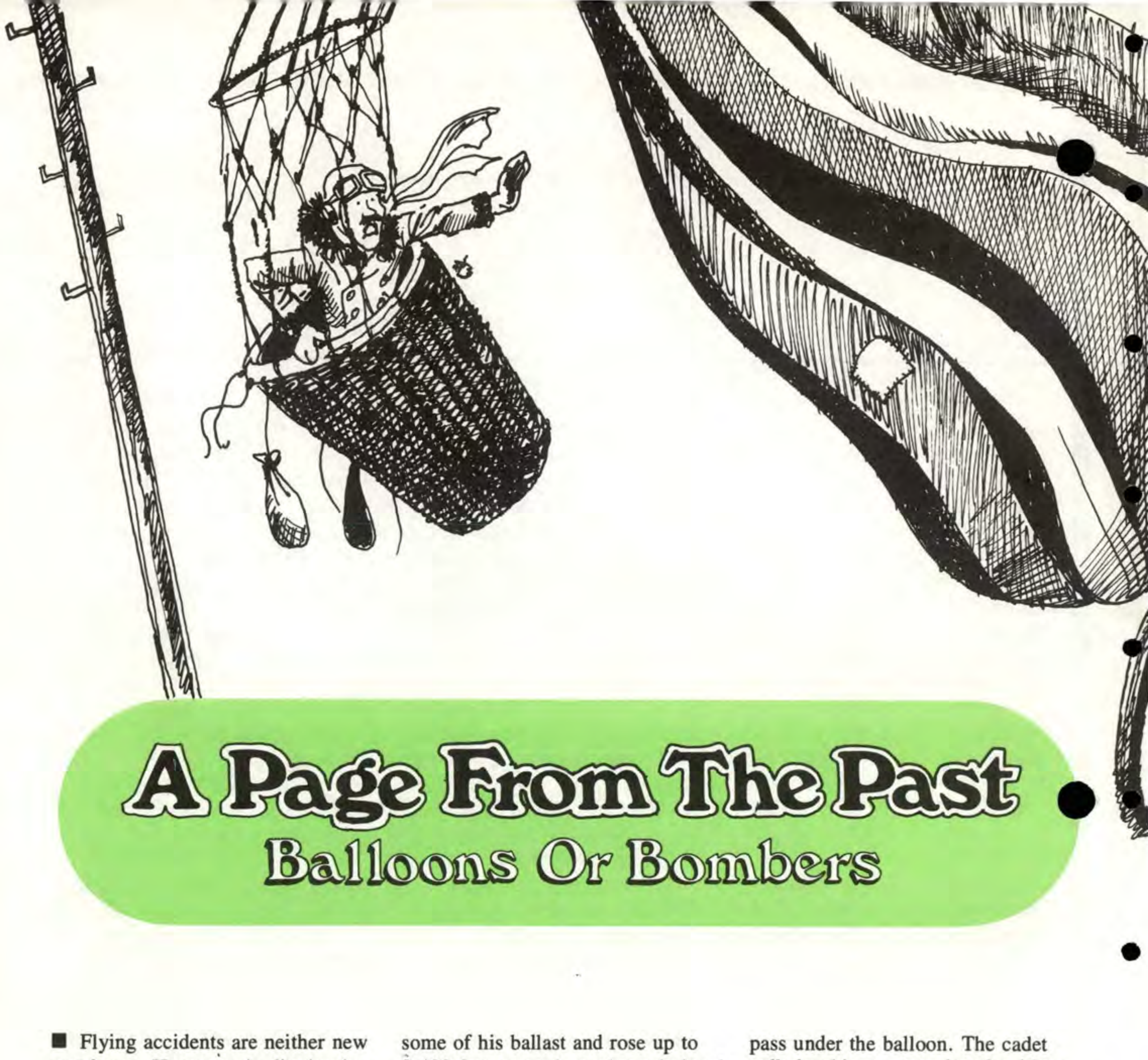
As pilots get older their resting accommodation may retreat into the distance. In some cases it retreats far enough that a pilot, who previously has had no difficulties, would have serious problems in making the black hole approach.

Pilots undoubtedly learn to compensate for the biased distance judgments they experience in flight. They obviously have had to adapt to perceptions altered by speed and height above the earth. Roscoe says a pilot, once he realizes he can't always trust his eyesight, can learn to recognize the circumstances under which he should suspect altered vision; he can learn to compensate and even to gain some voluntary control over his eyes' accommodation.

Learning to control accommodation is similar to learning to wiggle one's ear or move one's scalp. The most successful accommodation training experiments have used biofeedback in which the pitch of a tone automatically changes as the eye focuses at different distances, making the participant aware of his accommodation. Several studies show good transfer of this training to other situations.

Specific training to recognize when visual illusions are likely to occur, and how such illusions are likely to distort the actual scene would expedite and improve the pilot's natural ability to compensate for the occasional differences between "what it looks like" and "what it really is."

(For further information on this subject there are several audiovisual products such as TS1414 "Visual Illusions," TF6140 "Landing Illusions," and a MAC series depicting landing illusions at a number of bases.) ■



A Page From The Past
Balloons Or Bombers

■ Flying accidents are neither new nor funny. However, in digging into old accident records there can be found cases that would give today's flying safety officer or accident investigator many a headache. And the problems that some of the early flying machines gave the embryo pilots approach the fantastic when considered in the light of our present day thinking and flying.

Take, for example, in 1918 when balloons were still an important part of military aviation, a claim was put in against the government for a twenty-dollar bill. It seems that during a routine training flight, a cadet found himself being carried out toward the ocean. He dropped some of his ballast and rose up to 8,400 feet to catch another wind and reverse his direction. Arriving inland he valved down to 2,000 feet, spotted an open field and decided to land. When close to the earth he was picked up by a 25-mile-an-hour ground wind which carried him toward some high tension wires. He tried all deflationary measures but these functioned too slowly and the basket caught on a telephone wire, with the balloon, partially deflated, bobbing around in the center of the road.

About this time a "horseless carriage" came whipping down the road at a fast 15 mph and the driver hesitated and then decided to try to pass under the balloon. The cadet yelled at him to stop, but the driver either did not hear or disregarded the warning and went on. As the auto came directly under it, the balloon, driven by a gust of wind, completely enveloped the car. Three occupants of the car jumped out and headed for safety while the driver tried to cut the machine free. A moment later the gas in the balloon ignited, either from contact with the hot radiator or from an engine spark, and an explosion occurred. The car caught on fire and was completely burned. The driver sustained first and second degree burns on his face and hands. He placed claims against the

government for the twenty-dollar bill which happened to be in a pocket of a coat in the car, the coat, the car, a fur scarf, a wool sweater and three baby pillows. How would today's accident investigator figure that one?

Another cadet was at 3,600 feet in a balloon when he heard an explosion and noted that he was rapidly descending. He jumped from the basket, but in doing so caught his parachute ropes on the map board and found himself dangling about a foot below the basket. He climbed back into the basket, but by the time he had untangled the ropes, it was too late to parachute. He stayed where he was and rode safely to the ground in the balloon, which had fallen approximately 1,000 feet and then, with the deflated bag acting as a canopy, had become a parachute in itself. Out of this came a recommendation that students be instructed during training not to put their map boards on the side of the balloon from which they must jump, should an emergency arise.

High winds frequently played havoc with the balloons. A gale in Southern California caused the destruction of one, while two others broke completely away from their moorings. The one destroyed was ripped by a large piece of metal which the high wind carried through the air. The other two, although securely tied with ¾-inch rope and ballasted with heavy sand bags, were torn right out of their beds. Another time a sudden gust of wind caught a balloon that was anchored to a winch by a steel cable and snapped the cable, allowing the balloon to float free. An energetic lieutenant chased it on a motorcycle and was finally able to catch its drag rope and bring it back to earth.

Balloon problems were strange enough, but when the airplane came along it brought new angles which at times were even more odd. Unique in its way was a crash that happened in those early days that found the pilot dazed but unhurt, with his engine in the tail of the plane, it ☞

A Page From The Past

continued

having passed under or over him in a manner still unexplained.

Another crash occurred after two pilots had spotted a large number of ducks in a certain area. They returned to the base, secured shotguns, and took off in a two-seater. Apparently they flew too low or slow, because they crashed during their airborne duck hunt. The accident was chalked up to a stall with insufficient altitude.

The ground crews had their troubles, too. In fact, mechanics were killed test-flying and crashing the planes on which they were working. They did not have the problem of jet exhaust but quite a few were hurt by revolving props.

Two reports can be found of pilotless crashes. The custom was for the crew chief to warm up a plane and then leave it idling while he placed it in position to taxi. On a certain type of plane, the lifting of the tail to turn the plane about could cause the throttle to advance. On one occasion the plane "took off" and then ground-looped on a nearby road. Another time the pilot standing near the plane was knocked flat. This plane also ground-looped and ended up on its back.

Wording of accident reports was often very brief and *not* to the point. "Machine turned over and fell into a lake." "Unauthorized attempt to change from rear seat to front." "Fell out of plane." "Stick or prop broke," are some of the examples.

Accident boards had a knack of coming up with some unusual recommendations. Here are a couple of samples:

"A speedometer or airspeed indicator is one of the worst things to put on a training machine, as a pupil very soon relies on his instrument, which is generally wrong (none are accurate), and becomes a mechanical flyer, rather than a pilot with the proper 'feel' of the machine"; and "hard helmets interfere with the use of goggles and the turning of the head."

Another recommended the use of mirrors to enable the pilot to see behind and to the side, but this was later rejected when it was decided that it was better for the pilot to put his head on a swivel rather than rely on gadgets. One suggestion called for the placing of enlisted men on pilot status in order to take some of the glamour and thus some of the recklessness out of flying.

One man wrote to the President suggesting that the structural iron workers' rule of quitting work for the day when a man was killed, be taken up by the Air Force. He stated that he had noted that death came in bunches of three and four in the same day at the flying schools.

One of France's chief pilots during World War I recommended his safety principles of excess speed, excess altitude and a constant lookout for places to land. At least the last of these principles is still considered a good one.

Some of the board findings were much more practical. One was a device which would throw a student off the controls if he became frozen on them. Others were hard helmets, this in contradiction of the earlier board's findings; an indicator to show maximum speed limits; landing and takeoff patterns, strengthening of a structural design, and that students be given training in forced landings while in flight school.

In the period from 1908 to 1920 there were 2,080 hours flown for every fatality, with 506 killed during the 12 years. On the field which showed the worst record, 20 pilots were produced for every one killed. Even so, the overall safety record was better than that of any other country flying at the time. Considering the equipment used and the little that was known about weather, safety devices and aviation as a whole, the safety records were not so bad. They would be alarming today, of course.

Then, as now, the main causes for fatalities were carelessness and the disregarding of safety rules. Every year since airplanes came into being, some crash causes have been buzzing; acrobatics with insufficient altitude; failure to wear parachutes; exceeding limits of the aircraft; rate of speed too great on landing, and so on.

The men who flew airplanes when flying was a brand new game had to learn their safety lessons through the hard knocks of experience — trial and error. Today we can profit by their mistakes and by the mistakes of all those who have followed. The rules of safety have been written for us . . . sometimes in blood. Let's not disregard them.

(This article appeared in January 1952 when there were 2,274 major aircraft accidents for a rate of 29 per 100,000 hours flying time. In 1979 we had 94 class A mishaps [roughly equivalent to major accidents] and a rate of 2.92. We've come a long way baby. — Ed) ■

THERMAL STRESS

■ The flightline is getting hotter and hotter and the cockpit is becoming a regular Dante's Inferno. All that heat generated by the summer months can affect you to the point where it becomes dangerous. Exhaustion can set in causing fatigue and mental confusion. Symptoms are moist skin, profuse sweating, increased pulse, slightly decreased blood pressure, and shortness of breath. In some cases, cramps or even a stroke could occur. In order to avoid these dangerous and sometimes fatal results of thermal stress, there are several things you can do.

First, slow down. Don't try and keep the same pace you're used to. Give yourself extra time to accomplish a slow preflight. Also, avoid sitting in the cockpit with the canopy closed for a long period of time. Be extra careful if you spare out and spend more time than usual on the ramp. That extra time sparing out can sneak up on you and dangerously affect your performance in the cockpit. Equally important is the accumulation of ramp time during two or three turns in one day. All this extra time could lead to overexposure.

Just as important as overexposure is dehydration caused by sweating and evaporation. To avoid this, drink plenty of water. You should drink a minimum of two or three quarts of water per day. It doesn't increase sweating and as long as you're thirsty, you will not overhydrate.

A proper diet is another consideration. If you eat a normal diet, salting your food is much better than taking salt tablets. If you think additional salt is required, see your flight surgeon. Protein can cause an increase in your heat production and can contribute to thermal stress, so a low protein diet is best.

Finally, don't press! Heed your body's warning signs. If you feel you're overdoing it, call it quits. Seek a cool place to rest and drink additional fluids. If you really feel bad, see the Doc!

Your body can become used to the heat providing you take it slow initially and avoid overdoing it. It will normally take two to three weeks but, if the above steps are followed, it should help your body to become fully acclimatized in a safe manner. – Major Brower, HQ ATC/IGF. ■

MAJOR

Robert G. Little, Jr.

CAPTAIN

Steven J. Austin

48th Tactical Fighter Wing

■ On 12 December 1979 Major Little, Aircraft Commander, and Captain Austin, Pilot Weapon System Officer, took off from RAF Lakenheath in an F-111F on a night low level sortie. On return to base, Captain Austin flew the aircraft through a GCA approach to a normal touchdown. After a short landing roll, the crew heard a loud bang, the left wing dipped, and the aircraft careened left toward the edge of the runway. Both pilots countered the yaw with full right rudder. Major Little decided the only way to regain control was to take off again so he selected full afterburner and initiated a go-around before the aircraft departed the runway, thus preventing probable catastrophe. The crew were informed by the Runway Supervisory Officer that an explosion had occurred. Major Little left the aircraft in landing configuration and requested emergency inflight refueling due to high fuel consumption in this configuration. A KC-135 tanker on final approach to RAF Mildenhall was diverted and rendezvous at 4,000 feet initiated. Poor visibility in rain and snow showers made visual contact extremely difficult and, during join up, Major Little's aircraft lost all utility hydraulic pressure and the left generator. Moderate turbulence seriously hampered refueling operations and, combined with reduced maneuverability of the aircraft in the landing configuration, caused several disconnects during the half hour ordeal. A visual inspection of the F-111 by the Aircraft Commander of the KC-135 confirmed that the left main wheel was missing and that only the broken strut remained. No emergency procedures existed for landing with the loss of a wheel, and it was unknown whether the aircraft would cut the barrier, cartwheel after touchdown, or veer off the runway. All possible precautionary actions had been completed and a 3,000 foot strip of fire retardant foam had been laid. Major Little flew a perfect approach to touchdown in the center of the runway in the foam strip and short of the BAK 12 barrier. Despite efforts to keep the left main gear strut off the runway until past the barrier, the aircraft began to settle and drift left. Believing he may have missed or severed the barrier, and with control inadequate to prevent the aircraft from continuing to drift left toward the runway edge, Major Little used afterburner and flight controls to right the aircraft in preparation for a go-around. This action stopped the drift and resulted in barrier engagement without severing the barrier. A fire erupted as the F-111 slid to a stop. Major Little and Captain Austin egressed the aircraft as soon as the engines were shut down, and firemen extinguished the flames within seconds. The professional competence, skill, and superior crew coordination displayed by Major Little and Captain Austin contributed to the successful recovery of this aircraft. WELL DONE! ■

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UNITED STATES AIR FORCE

Well Done Award

Presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Accident Prevention Program.

CAPTAIN

Wilbur R. Hamilton

SECOND LIEUTENANT

John C. Peterson, Jr.

27th Tactical Fighter Wing
Cannon Air Force Base, New Mexico

■ On 9 October 1979 Captain Hamilton was instructing Lieutenant Peterson, a student aircraft commander, on his first flight in an F-111D. Shortly after takeoff, as the slats were being retracted by the student, the aircraft began to roll sharply to the right. Captain Hamilton immediately assumed control of the aircraft and continued the climb to a safe ejection altitude while analyzing the control problem. The flap and slat indicators indicated that the slats had failed to retract but that the flaps were fully retracted. Given this particular flap and slat configuration, there was no explanation for the right rolling tendency. Attempts to lower the flaps and slats by normal and emergency means were unsuccessful. Captain Hamilton quickly determined that 270 knots was the optimum airspeed for lateral aircraft control. He placed the right throttle in afterburner to help counter the right rolling moment and the left throttle near full military power to maintain the desired airspeed. He was required to hold full left stick to maintain wings-level flight. The resultant high fuel consumption rate severely decreased the time available to plan a course of action. Cannon supervisory personnel meanwhile had coordinated with Strategic Air Command to scramble a KC-135 alert tanker from Carswell AFB, Texas for an in-flight refueling. Thirty-three minutes after takeoff, another F-111D joined with them and reported that the left flap was still partially extended while the right was fully retracted. The crew climbed to a higher altitude to perform a controllability check, and found the right rolling tendency uncontrollable below 230 knots. With less than 15 minutes of fuel left and the KC-135 still 30 minutes away, Captain Hamilton elected to land and engage the approach end barrier. After lowering the landing gear, he determined that the aircraft could be controlled down to an airspeed of 180 knots. On final approach, Captain Hamilton used full left control stick and nearly full left rudder to maintain a wings-level attitude. A successful landing was made with an approach end cable arrestment. Captain Hamilton and Lieutenant Peterson's decisive actions, superb flying skill, and cool inflight analysis were instrumental in the successful recovery of a valuable aircraft. WELL DONE! ■

KC-10
First Flight