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FLYING Safety

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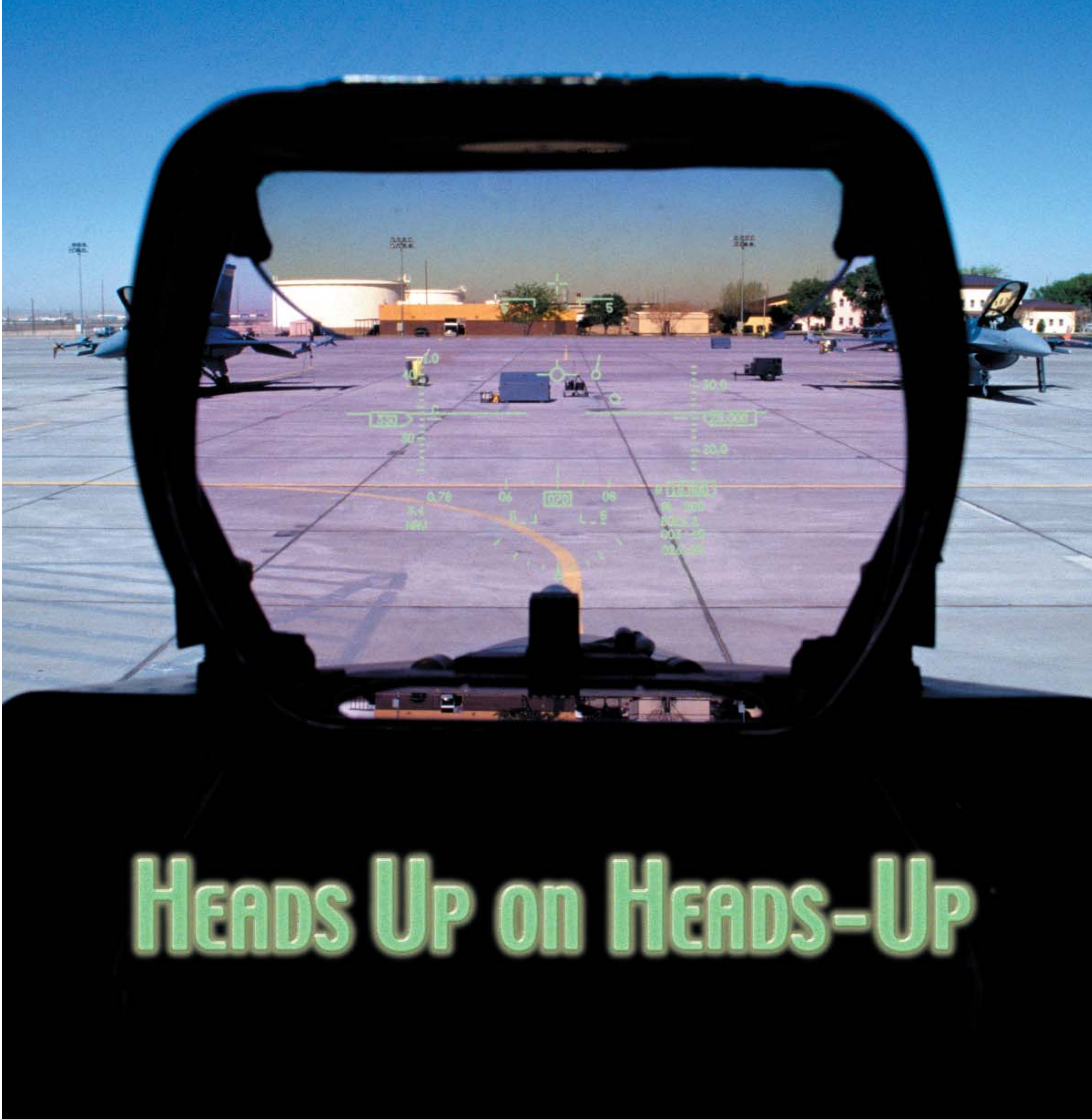
June 2002



HEADS UP ON HEADS-UP

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Cover: HQ AFSC Photo by TSgt Michael Featherston
Photo Illustration by Dan Harman

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CRM: *CELLULAR* RESOURCE MANAGEMENT

Courtesy ASRS *Callback* #249, Mar 00
NASA's Aviation Safety Reporting System

Commercial airline passengers are reminded during every preflight briefing to turn off electronic devices that may interfere with aircraft systems—including cell phones. Now here's a report that suggests what's good for the cabin, is good for the cockpit, too.

The Captain filed the flight plan late so I could not pick up the clearance until just before the passengers showed up. We were issued the SID with transition. I did not have time to look up the SID because the Captain was in a hurry to taxi. He was making calls on a cell phone while he taxied out so I still could not talk to him. Tower put us in position and hold on Runway 30L while I yelled for the Captain to turn off his cell phone. He finally did when they cleared us for takeoff. We never did brief the takeoff or the SID.

Once airborne, the Captain asked me what we were supposed to do. I tried reading the text and gave him some of the instructions as I read them. I got confused at one point about how to join the transition and told the Captain. He turned the wrong way. ATC asked what radial we were trying to join. They told us to turn right 140° to continue the SID and to call Approach once on the ground.

This would never have happened if the Captain had not been in such a hurry to get going, and if he had been paying attention to flying duties while taxiing out, instead of talking on his cell phone.

We're sure this type of event is rare, but it nonetheless illustrates the importance of effective cockpit management skills (and training). In effective CRM, flight crews make flying duties their first priority, and First Officers participate constructively in resolving problems.

HEADS UP ON HEADS-UP

SDO HAZARDS FROM MOVING-TAPE HUD SYMBOLOGY

HQ AFSC Photo by TSgt Michael Featherston
Photo Illustration by Dan Harman

MAJ JEFF LONG
12 FTW/SEF
Randolph AFB TX

Spatial Disorientation (SDO) has been killing fighter pilots for many years. This time it claimed a student of mine (for his family's privacy, let's call him Steve, a completely fictional name). Steve died at night in an F-16 shortly after takeoff. Although he had planned to accomplish night intercepts, he died before his Flight Lead even said "Fight's On." The Flight Data Recorder shows he became spatially disoriented during a benign navigational turn and remained so all the way up to his belated ejection attempt.

It saddens me when I hear about any fatal accident, even more so when the fallen aviator is a peer or acquaintance. The emotion reaches a different level, I've found, when the victim is someone you've taught to fly. At SUPT graduation, Steve's class presented me a plaque with a class photo on it. Now, whenever I look at it, I wonder what my fellow instructors and I—or the Air Force as a whole—could have done to save his life.

Reducing SDO Mishaps

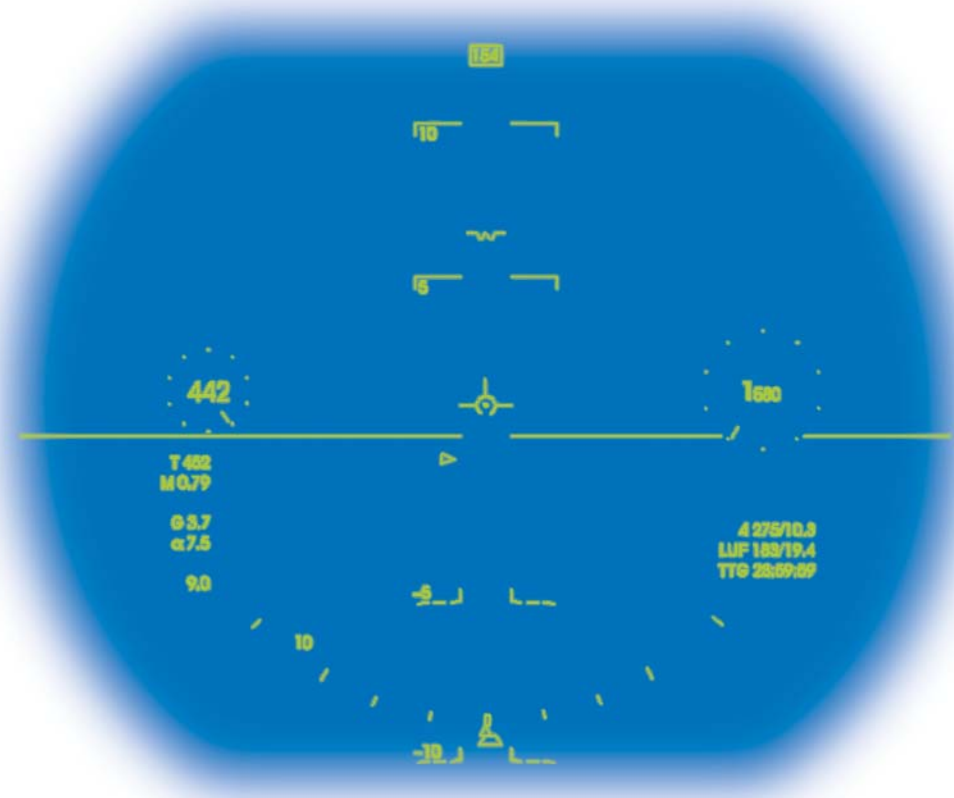
From a training standpoint, the Air Force already does much to minimize the effects of SDO. Aerospace physiology specialists train students in equipment that produces vestibular illusions. Instructor Pilots teach unusual attitude recoveries in both the T-37 and T-38, not only in the aircraft but also in the simulator. We use vision-restricting devices in the aircraft to safely give students experience in trusting their instruments more than their inner ear. The Air Force is currently looking into buying newer and better SDO trainers. Given the impressive efforts already being made, there don't appear to be easy any ways left to make huge strides via training.

Another approach through which the AF is striving to reduce SDO deaths is by improving how we *equip* our fighter pilots. This article will focus on that effort by explaining how improvements to the way Head -Up Display (HUD) airspeed and altitude information is displayed should make the F-22 and F-35 safer than the older-technology aircraft they replace. These new aircraft use Counter-Pointer (C-P) displays rather than the Moving-Tape (M-T) displays found in the F-15, F-16 and A-10.

Like most groups of people, fighter pilots can be resistant to change. Resistance is usually fiercest when people don't understand the reasons the change was initiated. My objective in writing is to inform fighter pilots and fighter/bomber-track SUPT instructors about why the "Military Standard" HUD found in the F-22, F-35 and T-38C looks different from older HUDs (see F-22 HUD in figure 1).

Before I begin, let me add one caveat: My comments are intended to relate primarily to combat aircraft and to the training of pilots who fly them. I know very little about the air mobility business, but enough to point out that mobility aircraft are not designed to fly at extreme attitudes, to pull high-G turns, or to be flown by only one pilot. All three factors make mobility pilots' SDO risk experience different. Some mobility aircraft now have HUDs, and I will defer comment on what symbology is appropriate for them to people more knowledgeable about the mobility business.

Many readers may be asking, "If it ain't broke, why fix it?" In answering, I'll cover both general flight safety information and Human Factors (HF) information, and then I'll tie the two areas together by examining a mishap in detail.



F-22 HUD
Figure 1

Flight Safety Information

Shortly after I learned of Steve's death, I started the Flight Safety Officers' Course at The Air Force Safety Center at Kirtland AFB. I resolved to use the resources of the safety system to learn more about this mishap. While there, I met AFSC's leading Aerospace Physiologist, Lt Col Don White, who, as it turned out, had already done a relevant analysis. His examination of long-term mishap trends (see Table 1)

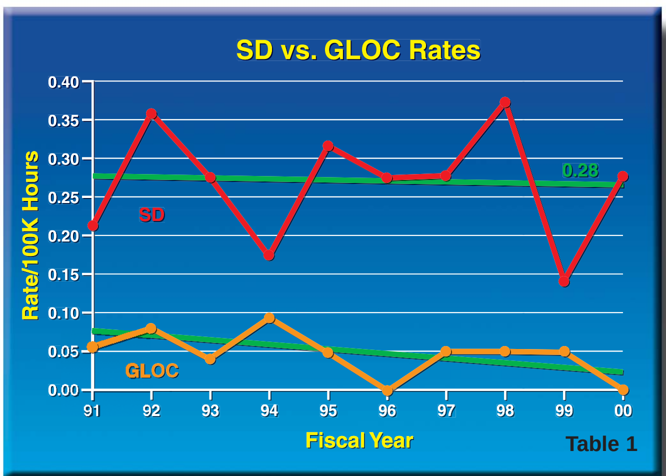


Table 1

reveals a downward-sloping trend for G-Induced Loss of Consciousness (GLOC), but an essentially flat one for SDO. This suggests that the aggressive campaign the Air Force has been waging against GLOC is meeting with some success, and that we need a similarly aggressive campaign on SDO.

Lt Col White's study, combined with the fact that Steve had died in an F-16, motivated me to review every fatal F-16 mishap from 1 Oct 1991 to 1 Jul 2001 (see Table 2).

I found two things particularly noteworthy. First was the large proportion of fatal mishaps caused by SDO. In fact, SDO turns out to be the number one killer of F-16 pilots. Second, although most of those SDO mishaps occurred during "tactical" phases of flight such as night delivery of Laser-Guided Bombs, an alarming number (12 of 36) occurred during "admin" portions of the mission—benign events such as a fluid turn prior to "fight's on," or an instrument approach. Some things fighter pilots do are inherently dangerous; that list shouldn't include admin.

Speaking of deadly admin, let's get back to Steve. He entered a fluid turn. He looked too long through his Night Vision Goggles (NVGs) at his flight lead and failed to adequately cross check his HUD or head-down instrument panel. He became disoriented, and eventually reached approximately 70 degrees nose low and 150 degrees of left bank.

F-16 Fatal Mishaps (01 Oct 90 - 01 Jul 01)	
SDO*	13
Midair collision or one F-16 landing on another	8
GLOC*	6
Loop, Split S or Vertical Notch too low	4
None of the above	7
Total	36

* Two mishaps listed both SDO and GLOC as possibilities.

Table 2

continued on next page

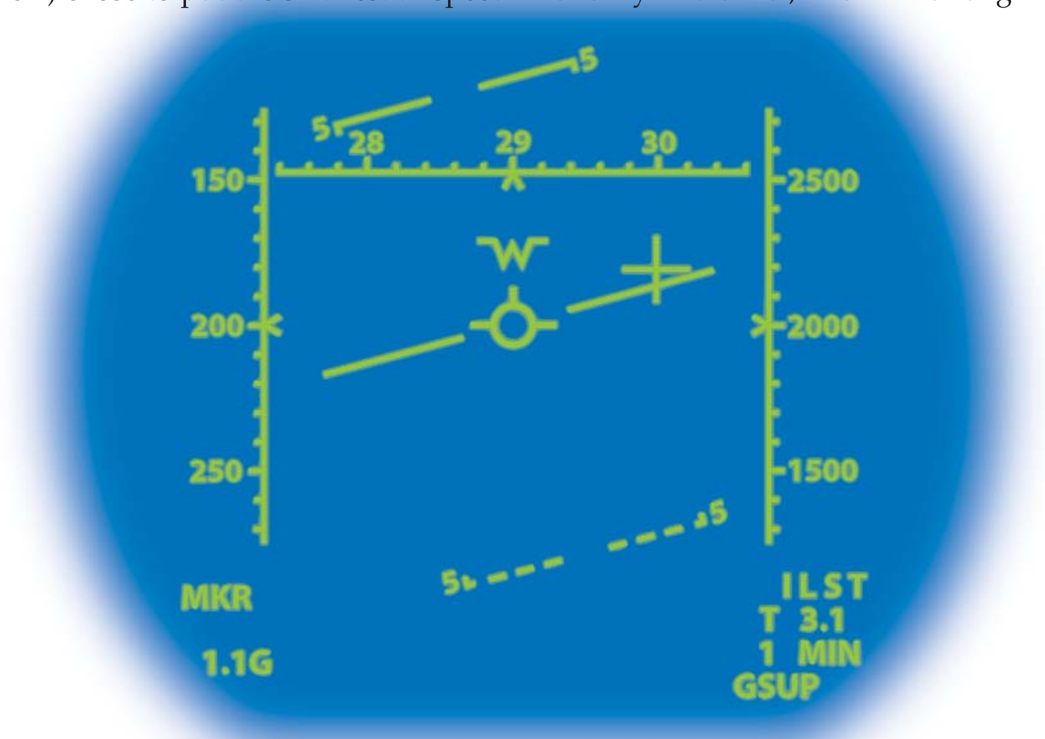
Fortunately, an auditory altitude warning brought his attention back inside the aircraft. It did so at such a high altitude that recovery to level flight was easily within the jet's performance capabilities. Although the NVGs played a large role in getting Steve to this undesirable situation, from then on it should have been a simple unusual attitude recovery—not much different than the countless ones he had done since the beginning of SUPT. Why, then, did this not end in a "There I Was" story in the squadron bar? Why did it end in a funeral? That is a mystery that the NVG factor alone cannot solve. To understand it, let's start by examining the body of work produced by HF experts.

Human Factors Information

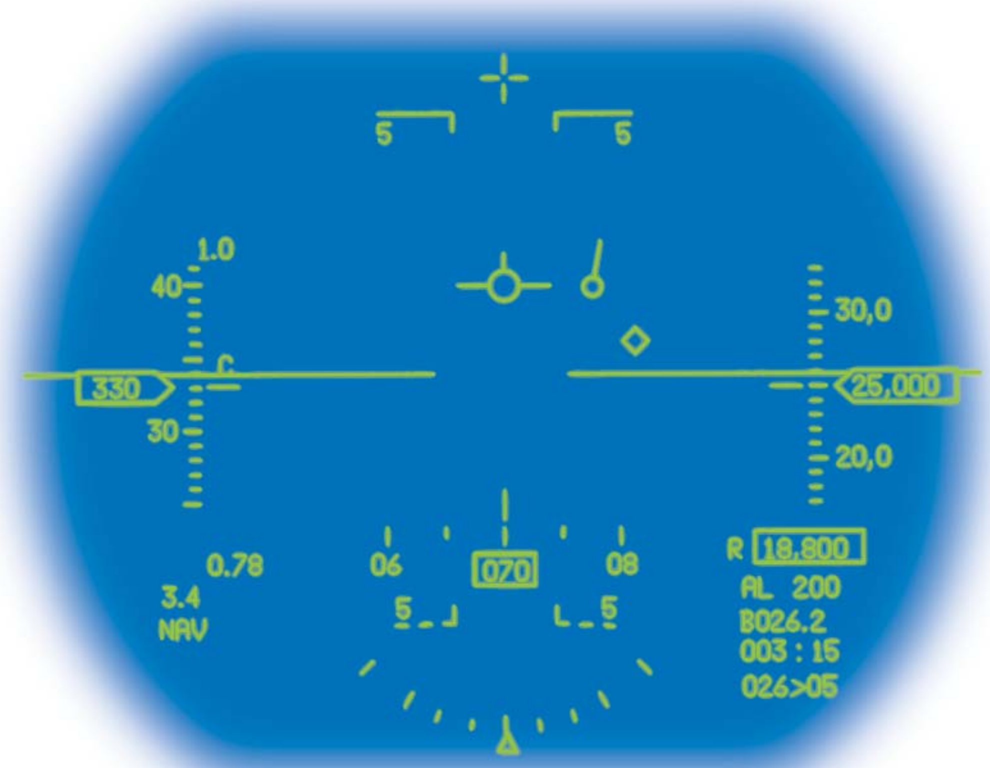
The HF community now knows vastly more about the best way to display HUD information than it did in the 1970s, when the F-15, F-16 and A-10 HUD formats were designed. During that period, most designers chose M-T displays, but there was no standardization of exactly how to implement the M-T. The builders of the A-10 and the F-15 (see figure 2) chose to put the smallest airspeed numbers on the top of the tape. The F-16 folks selected the opposite solution (see figure 3). A decade or so later, the designers of the F-15E decided that trend information was not worth the cost in HUD "real estate," so they chose to omit it entirely.

By the end of the 1980s, the AF-wide HUD situation was far from standardized. Pilots transitioning from one fighter to another had to waste training time learning a new symbology set, and also had to work hard to "unlearn" deeply-rooted habit patterns (such as which direction to move the throttle in response to upward motion on the left side of the HUD). Decision makers recognized how undesirable that situation was, in terms of both wasted dollars and flight safety. They chartered a Flight Symbology Development Group (FSDG) to examine not only existing HUD formats but also research concepts and to assemble the best elements into a single Military Standard (MILSTD) format. In 1989, the Chief of Staff of the Air Force signed a memo[1] directing all agencies to comply with the FSDG recommendations and to adopt the MILSTD. The other services agreed, and the directive acquired "thou shalt" status at the Joint level—new DoD aircraft and upgrades to existing aircraft now incorporate the MILSTD.

Given that it's not easy to convince all four services to change, readers won't be surprised to learn that there is a wealth of objective, quantitative data underpinning the MILSTD effort, not mere subjective opinion. In 1992, DoD, NASA, FAA and NATO jointly published a HUD State of the Art Report (SOAR). It reviewed the HUD literature since 1946, summarizing, "Moving tapes are bad news."[2] Shortly thereafter, the Armstrong Laboratory at Brooks AFB published a particularly well-designed set of studies comparing HUD formats, studies that collected data in both simulators and aircraft. They found performance with C-P displays was better ($p<.01$ for you statistics majors out there) than both the M-T format and the pure digital format.[4] (As a former F-15E pilot, I found it particularly interesting to note that pure-digital format gave the worst performance of all five formats and that this inferiority applied to both airspeed and altitude tracking performance.) By the late 1990s, the weight of sci-



F-15 HUD
Figure 2



F-16 HUD
Figure 3

entific evidence in favor of the MILSTD was such that the DoD Joint Cockpit Office (JCO) pronounced its official position: Counter-Pointer format is superior.[5,8] To quote the JCO:[5]

These evaluations indicate that the counter pointer format significantly enhanced pilot performance when compared with conventional vertical tape and pure digital presentations. The relative merits of the counter-pointer format are as follows:

a. It takes up less space (causing less clutter) than the vertical scale.

b. The moving tape-fixed pointer scale is inherently harder to read because the numbers on the tape are moving and not always in the same place.

c. There is some evidence that the scales might be interpreted as horizontal pitch lines when viewed by a disoriented pilot in a 90-degree bank.

d. The dial format provides trend information clearly, with no confusion about direction (clockwise is more), and is directly analogous to the round dials with which pilots learn to fly.

e. During extremely rapid descents, rate and direction of movement of vertical tape scales can be hard to distinguish.

Clutter

Note JCO paragraph (a). It tells us that you have to illuminate more pixels to show trends with M-T displays than with C-P displays. Consider two reasons such clutter is bad:

(a) Objects in the real world can "hide" behind HUD symbology. Not only is this phenomenon exceptionally well-documented in the HF literature, it has appeared in the findings of USAF mishap investigations. For example, there was a pilot who landed on another airplane because he failed to notice it. The Safety Investigation Board concluded that the other airplane was hidden behind HUD symbology, and named this clutter as one of the "causal" findings.[11]

(b) At night, some of the light from inside the cockpit internally propagates through the canopy and gets reflected back into the pilot's eyes.[6] Many have reported such reflections as disorienting. The more pixels illuminated on the HUD, the more light there is to reflect, hence the more chance of disorientation.

90° Bank Confusion

JCO paragraph (c) speaks to this phenomenon. A disoriented pilot who has gotten into a near-90° bank has enough to worry without "latching onto" the airspeed tape, confusing it with the horizon line or a pitch ladder marking, and then wondering why that symbol doesn't roll despite the lateral stick pressure they are applying.

Trend Direction/Trend Rate Confusion

To understand JCO paragraphs (d) and (e), imagine a disoriented pilot pointed nearly straight down, moving at over 600 knots, and getting dangerously close to the dark ocean below. If this pilot were flying an F-15E or F/A-18, there would be no trend direction information on the HUD—perhaps the first noticed indication of the crew's predicament might be the wind noise over the canopy bow. (A few years ago, one F-15E aircrew member died in circumstances very similar to this.[11]) In an F-15C or F-16, the M-T displays might be moving so quickly as to make them just a blur, with no discernible information about the direction or rate of motion. In an F-22, however, these flight parameters would cause the altitude C-P to "unwind" at a

continued on next page

rate of about one rotation per second.[12] Not only would the rate be discernible, the direction would be unmistakable. (In every airplane I know of, counterclockwise motion of an airspeed or altitude pointer means the parameter is decreasing.)

Roll Vection

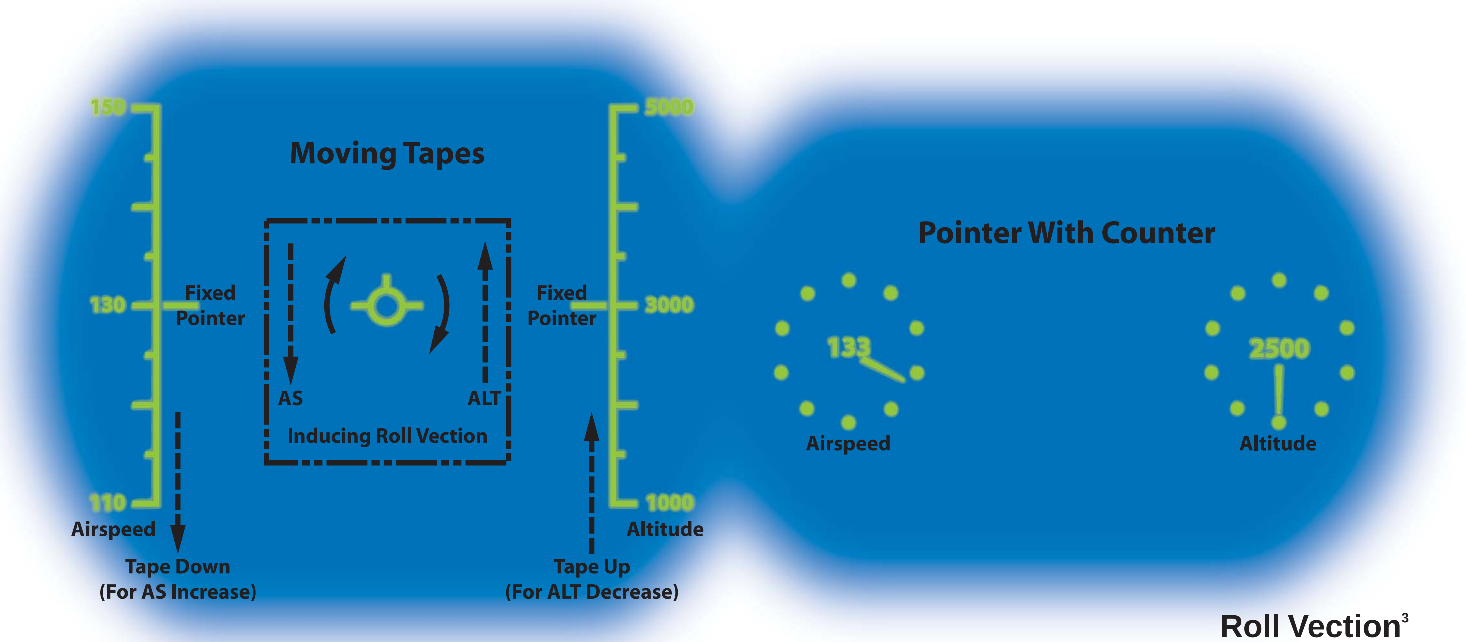
The concept of roll vection can be found in a different section of the same JCO document.[7] It also appears in the HUD SOAR. See figure 4 for a graphic borrowed from the SOAR.[3] Like the example HUD found there, the F-16 HUD puts the largest airspeed and altitude values at the top of the tapes. Suppose an F-16 pilot flying IMC looks away from the HUD for a moment (reading an approach plate, pressing buttons, etc.) and unknowingly enters a slight descent. The descent would probably be accompanied by an increase in airspeed. The left tape (airspeed) would slide downward, and the right tape (altitude) would slide upward. The pilot would detect this motion in his peripheral vision and might interpret it as movement of the horizon line caused by a right roll. If so, the pilot may subconsciously input left aileron to "compensate." Given the shortcomings of the human inner ear, such a scenario may very well lead to spatial disorientation.[9,13] Note that F-15C and A-10 HUDs can also cause roll vection, but would be likely to do so for a shorter portion of a typical sortie. This is because those HUDs put small airspeed numbers at the top, leading the M-T displays to move in opposite directions during accelerating climbs (e.g., immediately after takeoff) and in decelerating descents (e.g., final approach). Counter-pointer format is not susceptible to roll vection.

Summary of Four Hazards Posed by HUD M-T Displays

We've covered a lot of information already, so before we move on to Steve's mishap, let's recap. There are at least four major mechanisms by which M-T displays can contribute to mishaps:

1. Clutter
   a. Obstructing pilot's view of outside world
   b. Worsening canopy reflections at night
2. 90° bank confusion
3. Trend direction/trend rate confusion
4. Roll vection

Now let's apply that information to Steve's last flight.



Roll Vection[3]
Figure 4

Mishap Narrative

Steve's was a night sortie, and more than one F-16 pilot has commented that internal canopy reflections are an issue in that aircraft. During part of the time during which Steve was struggling to regain his spatial orientation, his F-16 was near 90° of bank.

Steve left his power at an inappropriately high setting for a very long time. In fact, a Wright-Patterson AFB PhD who examined the information taken from the flight data recorder estimates that for almost 10 seconds, Steve failed to act on the need to pull back the throttle.[14] The high power setting contributed to a massive sink rate, and that sink rate was a major reason Steve's ejection attempt proved fatal. Had his HUD been equipped with C-P displays, perhaps he might have perceived the increasing airspeed sooner.

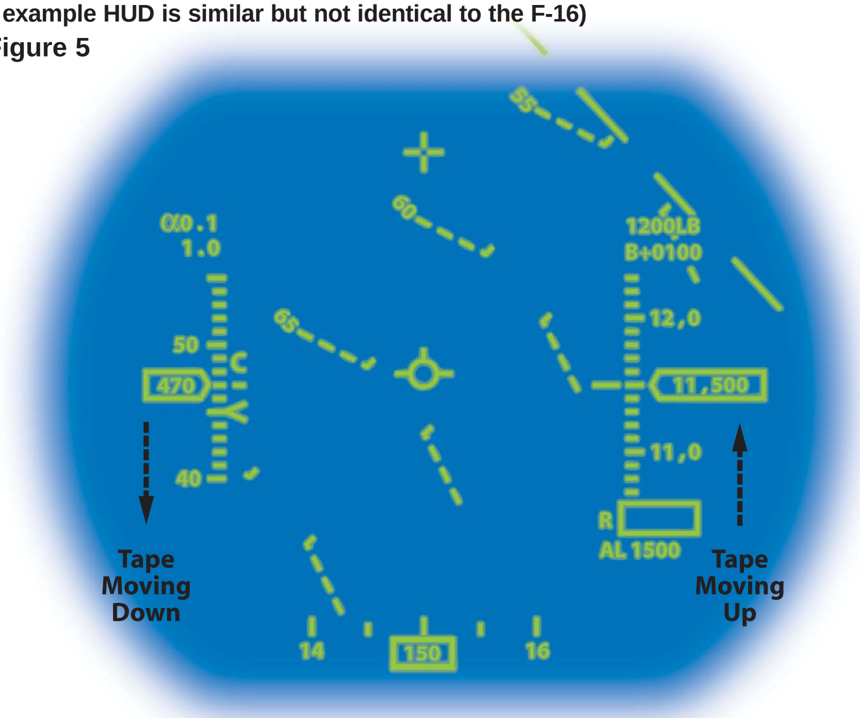
Steve's initial roll was to the left. It may well have led to at least three separate illusions (two vestibular, one visual). The roll rate was slow, probably below the vestibular detection threshold. The fluid inside his inner ear would have acquired momentum in that direction. As Steve began to realize his peril, he initiated a rapid right roll but set his wings without eliminating all of the left bank. When he stopped the roll, the fluid in his semi-circular canals kept moving, providing a compelling sensation his aircraft was rolling to the right, toward the desired wings-level attitude (somatogyral illusion). Moving his skull to look away from his flight lead and inside his cockpit may well have caused the motion in the fluid of one canal to carry over to the remaining canals (coriolis illusion), compounding his disorientation.

Now let's tie in roll vection. In his rapidly-accelerating descent, the left tape would have been moving upward and the right tape downward (see figure 5 for a general idea of what his HUD probably looked like). Viewed peripherally, this motion might have provided a compelling sensation of right roll—a sensation consistent with some of the false information that may have been coming from his inner ear.

Estimated HUD view during SDO

(Note: example HUD is similar but not identical to the F-16)

Figure 5



Operational Risk Management

I do not mean to infer that anyone can say with absolute certainty what contributed to any of the 13 SDO mishaps I referenced. Tragically, none lived to warn their fellow pilots. It is possible that HUD format never played a significant role. No one, however, can be sure it *didn't* contribute to at least one mishap.

The first principle of ORM is "Accept no unnecessary risks."[10] Both Human Factors and Flight Safety data give cause to be concerned about the moving tape format of the F-15C, F-16 and A-10 HUDs. Those same sources also give reason for concern about the complete lack of trend data on the F-15E HUD. DoD is already applying these lessons learned by purchasing the F-22, T-38C and F-35 (USN, USMC and USAF versions alike) with the MILSTD HUD installed.

Might it be time to consider retrofit of "legacy" fighters? Perhaps. I recommend that readers whose duties might include membership on a Safety Investigation Board (SIB) be aware of the reasons we are moving away from the M-T and pure-digital formats. If the facts of a future mishap suggest one of the four mechanisms outlined above played a role, then the SIB should say so in their mishap report. Over time, the data collected will allow decision makers to perform ORM, asking: "Would the potential savings in lives and equipment gained by retrofitting the fleet justify the money and effort needed to do so?"

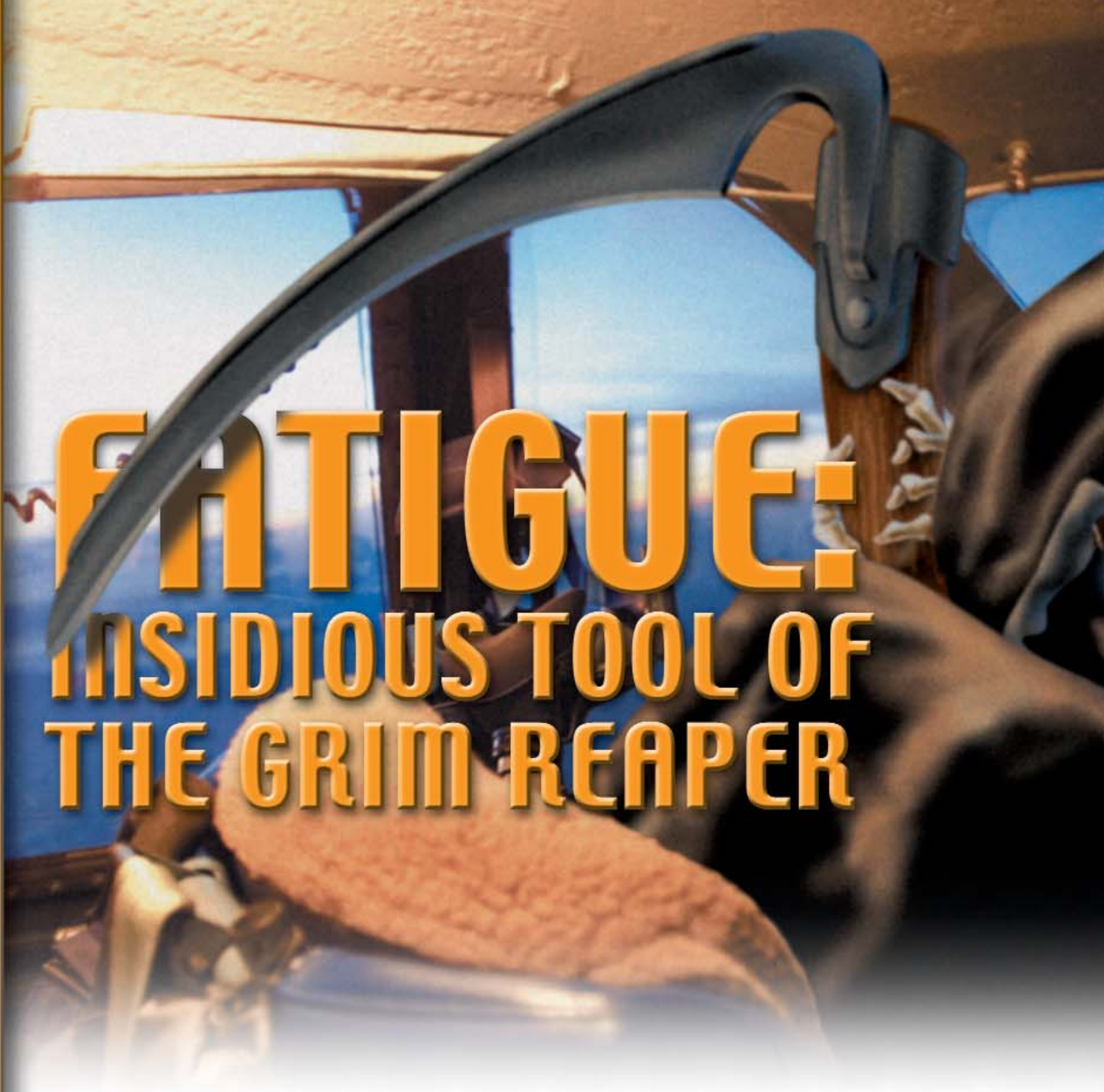
For the average reader, however, my recommendation is more succinct: know that the MILSTD is coming and realize that there are compelling flight safety reasons behind the change.

It's too late to save Steve, but we may save others.

(Maj Long is a Senior Pilot with over 1700 hours in the F-15E and T-38. He has both a B.S. and an M.S. in Human Factors Engineering, and he holds the HF AFSC. His thesis work on HUD and glass cockpit design has been published nationally. He is assigned to Randolph AFB, where he teaches T-38 Pilot Instructor Training and serves as a Wing Flight Safety Officer.)

Footnotes

1. Memo dated 10 Aug 1989, signed by Gen Larry D. Welch, CSAF.
2. Crew Systems Ergonomics Information Analysis Center SOAR 92-2, Human Factors Issues in Head Up Display Design: The Book of HUD. Weintraub, D. J., PhD. and Ensing, M. Jointly published by DoD, NASA, FAA and NATO, 1992, p. 125.
3. Ibid., pp. 125-127.
4. "Standardization of Aircraft Control and Performance Symbology on the USAF Head-Up Display." Weinstein, L. F., Ercoline, W. R., McKenzie, J., Britton, D. F., and Gillingham, K. K., Armstrong Laboratory, Brooks AFB, TX, 1993, page 20.
5. Military Standard 1787C, Aircraft Display Symbology. DoD, 5 Jan 2001, p. 56.
6. Ibid., p. 41.
7. Ibid., p. 59.
8. Military Standard 1472F, Human Engineering DoD, 23 Aug 1999, p. 24.
9. Aviation Safety: The Human Factor. Alkov, R.A., PhD. Endeavor Books, 1997, p. 11.
10. AF ORM Pocket Guide https://rmis.saia.af.mil/tools.asp
11. This privileged mishap data is available from your Wing Flight Safety Officer.
12. 600 knots = 600 NM/ hr = 600 NM/ 3600 sec = 6 NM/ 36 sec = 36,000 ft/ 36 sec = 1000 ft/ sec = 1 C-P revolution/ sec
13. Gateway, Volume XII, Number 3. DoD Human Systems Information and Analysis Center, 2001, page 3.
14. Telephone conversation with Michael Snow, PhD, AFRL/HEC, 13 Mar 2002.



FATIGUE: INSIDIOUS TOOL OF THE GRIM REAPER

I was very tired and I could feel the effects of fatigue working on me.

LT COL ROBERT BEISWENGER
514 AMW/SE
McGuire AFB NJ

I fell asleep behind the tanker!

Sky conditions were clear and the air was calm as I gradually approached the pre-contact position behind the KC-135. With over 6000 flying hours in the C-141, I was comfortable with my surroundings. My last refueling behind a ’135 had gone rather well, giving me personal satisfaction and renewing my confidence. However, I learned long ago that the flying game has a way of humbling pilots back into reality, and I was determined to avoid the pitfalls that come from being overconfident. Besides, I was very tired and I could feel the effects of fatigue working on me. Our briefing at 0800 seemed a long time ago as I entered the dim conditions associated with dusk.

The previous day I watched a videotape on fatigue produced by the NASA Ames Research Center. It was about a sleep study conducted by scientists using airline pilots as their subjects. While flying long, through-the-night trips, these professionals were continuously monitored with sensitive electronic equipment. As their duty day came to an end, these experienced pilots were periodically caught falling asleep from descent to landing! The duration of their sleep was only three to five seconds, therefore labeled "microsleep." (I viewed this as a more tactful way to describe simply *falling asleep behind the wheel*.) But when flying close to the ground, three to five seconds count! My subconscious ego comforted me. That was about *them*; I, of course, was above such failings.

As I moved closer to the tanker, I struggled to stay alert. I mentally talked to myself as part of an effort to safely

USAF Photo by MSgt Bill Kimble
Photo Illustration by Dan Harman

approach the tanker that loomed gracefully in front of me. "Trim, trim, trim… still need some nose-up trim… keep the eyes moving, don't fixate on one point… move in slowly… small power adjustments," I said. Finally in the pre-contact position, I worked to stabilize everything before moving in for the contact. But my eyes were moving slower as fatigue set in; my eyelids felt like heavy weights were attached to them. I consciously used the muscles surrounding my eyes to hold them open. "Still needs some nose up trim," I told myself.

That was the last thought I remember. The next thing I recall was seeing the tanker—still in front of me, but about a hundred feet or more above me! It was still stable, like a rock; I had obviously fallen out of position, big-time. But how?

I was stunned that this could possibly have happened to me, but the evidence was clear—I had fallen asleep behind the tanker! I had been in the precontact position and was attempting to stabilize; my next view of the tanker was far from there. "Microsleep," that tactful term for falling asleep behind the wheel, was the true explanation for this gross deviation. Like the pilots in the video, I had fallen asleep for a few seconds, allowing the still out-of-trim plane to drift out of position.

Fortunately, no one was physically hurt, though my self-confidence received some damage. In fact, there was nothing but silence in the flight station, leaving me free to critique myself and the events that had just transpired. I was grateful there would be no repercussions resulting from this experience. It was not a check ride; no hazard report would be filled out to broadcast my error. This time it would simply be a "lesson learned," free of injuries and public humiliation. "How could that be?" you ask. Because I was in the ARPTT, the air-refueling simulator.

Two months previously, I agreed to participate in a sleep deprivation study developed by Dr./LtCol Michael Russo and implemented with the help of his technician, Dr./Capt. Sandie Escolas, both from Walter Reed Army Institute of Research. Together they were performing a study designed to reveal, in measurable terms, the mental and neurophysiological changes that occur when one is deprived of adequate sleep.

"Microsleep," that tactful term for falling asleep behind the wheel...

I had successfully demonstrated my own limits and shocked myself in the process. However, this was a very valuable lesson, even though I received it late in my career. It quickly reminded me of my own fallibility. Falling asleep under these conditions was NOT something that just happens to "others"—it can happen to me, too. More importantly, it made it easy for me to understand and clearly see the consequences of a mind and body that has been degraded by the lack of proper rest. My limits would have to be reset and, without a doubt, be at the more conservative end of the gauge.

I hope that those with whom I share this experience will also benefit from it. Fatigue is insidious—it approaches quietly and without fanfare, but the consequences can be fatal. Whether flying, driving or working on the flight line, it is important to learn our *true* limits and take action to mitigate the power of fatigue. Don't wake up wondering what just happened, or you may not wake up at all.

USN Photo by PH1 (SW/NAC) Spike Call

CRM, Anyone?

When I released the cyclic, the aircraft rolled to about a 30-35 degree angle of bank.

LCDR JON BRADY, USN
VR-54

It was a calm, moonless night in the Adriatic Sea. More than half of our six-month cruise was over, and we had just had the opportunity to shore-base our SH-60B while the guided missile frigate was in port for two weeks. Through work-ups and the first half of cruise, we had become very familiar with the habits and skills of each of the other pilots in our detachment. We had the added benefit of practicing emergency procedures while shore-based. And so, there we were…

We were engaged in the demanding task of querying passing vessels to ensure they were not breaking the embargo against the former Republic of Yugoslavia. I was flying, and the OIC was sitting in the Airborne Tactical Officer's seat. Not too many ships were passing through, and we had gone about 60 miles south of the ship when there was the sudden bright flash of the Master Caution light, and the master caution panel lit up like a Christmas tree. I found myself struggling to maintain control of the aircraft. Based on the forces required to manipulate the collective and the rudder pedals, I knew that the hydraulic-powered pilot-assist servos had failed. In the Replacement Air Group, this had proven to be my most difficult practiced emergency. Even practiced at an airfield, this was a tough one for me. The pilot assist servos hydraulically boost rudder and collective inputs and provide elements of the Automatic Flight Control System (AFCS) and the Stability Augmentation System (SAS). Without them, collective forces are significantly increased and rudder inputs may require as much as 75 pounds of pressure.

With the flashing lights and increased control force requirements, I found myself struck dumb and unable to communicate with my copilot as to exactly what was happening. Fortunately, he knew. He secured the flashing Master Caution light (which seemed somewhat redundant at the time: I was pretty sure we had a problem!). We settled down and immediately called the ship for emergency flight quarters and had them start driving toward us. They were agreeable, and we began to close the gap.

On the way, I decided that I needed to have the pedals a bit closer to me for landing when the rudder forces would be the greatest. So, I released the cyclic and reached up to grab the rudder release handle and allow the rudders to move to a closer, more comfortable distance. *Mistake!* Without the aid of the AFCS and the SAS, there was nothing to stabilize the flight controls. When I released the cyclic, the aircraft rolled to about a 30-35 degree angle of bank and led to some curious remarks from my fellow flight crewmembers. I stabilized the aircraft and explained what I had done to my somewhat skeptical crew.

We considered and discarded the idea

of landing at a distant airbase in Italy. The ship was in sight, and we discussed (in somewhat sketchy details) how the landing would be conducted. As the ship approached, we instructed them to turn, giving us winds slightly to the port. They turned at the perfect distance, and we lined up right on final. We instructed the Landing Signal Officer to remove the Rapid Securing Device (the normal method for landing an SH-60B) from the flight deck, giving us a clear deck for landing. I flew the approach to the deck with a momentary hover to stabilize and then continued to the deck in an anticlimactic conclusion to a challenging emergency. My copilot treated me to a pat on the back and a "Nice job!" We secured the aircraft and retreated into the hangar, never so glad to be back on the ship.

There are elements of this story that were well done and some that obviously were not. The most striking element missing from this event is my lack of communication and crew coordination. At the onset, I did not alert my crew that I had an emergency (although it was certainly obvious) or specify what the emergency was. Under the circumstances—wrestling with the aircraft for control—this may have been excusable. However, I knew what the problem was, and my copilot quickly determined its exact nature as well. That left the aircrewman in the back without a clue as to what was happening in the front. Again, this was not a huge obstacle because we are to fly the aircraft first anyway, but this was just the beginning.

We move now to preparation for landing on the ship. Here is yet another example of a self-induced problem exacerbating an already stressful situation. As if I were in a single-piloted aircraft, I took it upon myself to maintain control of the aircraft while attempting to adjust my rudder pedals (notifying no one of my intentions). A simple application of CRM would have remedied this situation without upsetting the aircraft or surprising the other members of the crew: "Hold the cyclic while I adjust my pedals." Crew coordination and communication eliminate this situation by sharing the workload and keeping the crew informed of what's going on now and what's coming up next.

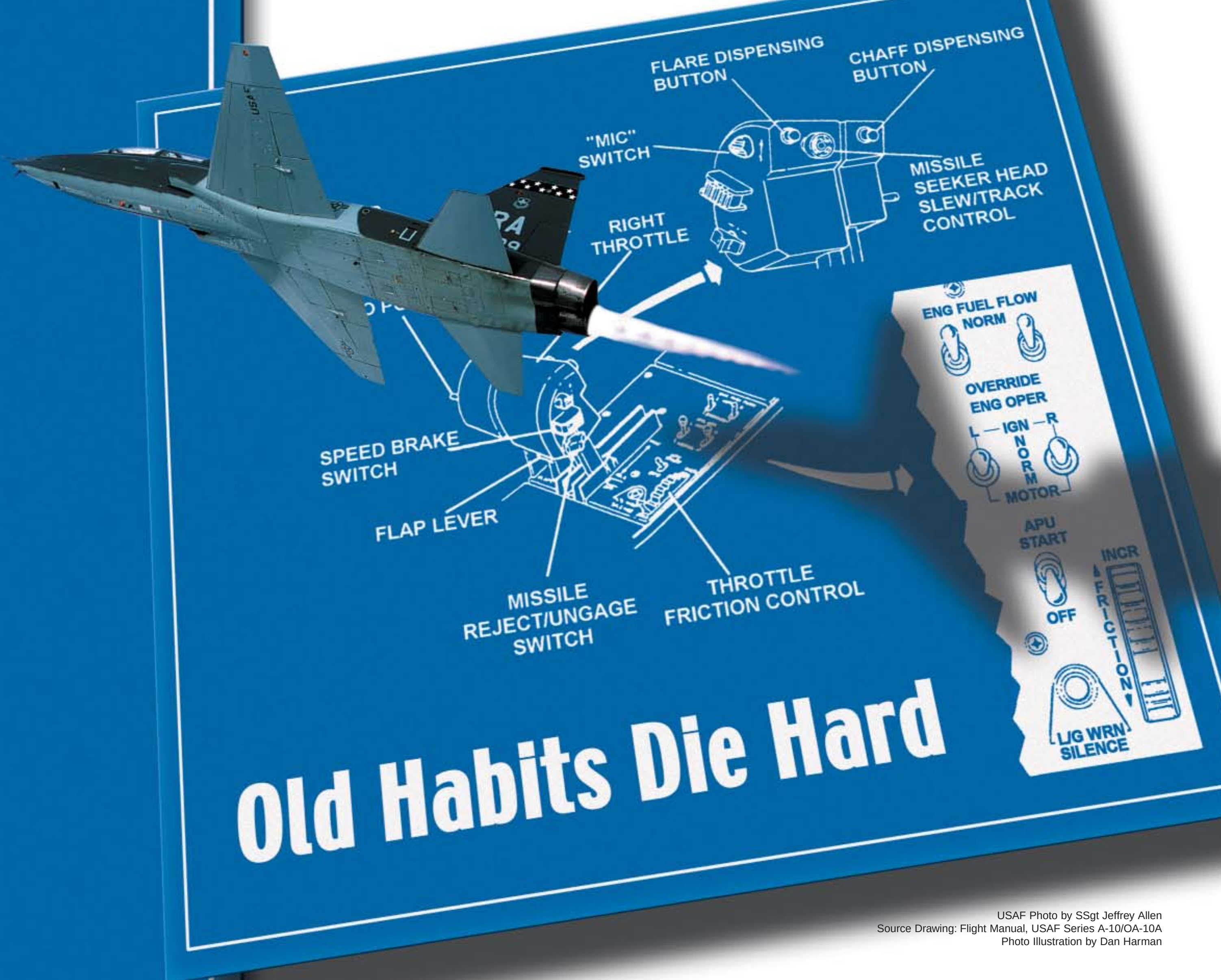
The approach briefing was incomplete. We decided against going to the beach because of the calm sea state, and we discussed how to close the distance to the ship. We also chose to do a clear deck landing. The approach briefing was not much more inclusive than that. The descent to landing is the least stable aspect of flying without the pilot-assist servos. On the beach, the idea is to allow the aircraft to drift slightly forward while landing to lessen the inputs required. This was not an option landing on the ship because the parking brake must be on. While an unstable approach, hover or landing may develop during any approach to the ship, the possibility was much more likely on this occasion, due to the nature of our emergency. Even so, we neglected to brief how we would handle that eventuality should it occur. Further, we never discussed how we would complete the wave-off should that have become necessary. These are essential elements of the before-landing brief that should be completed prior to each approach, and especially prior to an approach during an emergency. We were fortunate not to encounter either situation.

Repositioning the helicopter to the beach for the two-week ship-maintenance period was a significant factor in the successful outcome of this emergency. The ability to practice emergency procedures at an airport that cannot be practiced underway gives the aircrew recent practical experience in aircraft controllability and response under various system degradations. This experience increases the aircrew's confidence in their ability to handle the aircraft with a malfunction and greatly increases the probability of a successful outcome.

As a whole, this was a fairly uneventful emergency situation. Better communication and more complete planning would have led to an even *less* eventful emergency return to the ship. CRM cannot be overemphasized. Crewmembers must continuously communicate with each other to ensure there are no surprises. One crewmember may know or sense something that the others don't, and that may be a critical element in bringing a situation to a successful conclusion.

Also, letting the crew know what you plan to do prevents boneheads like me from releasing the controls when there is no stabilization in the flight controls!

I took it upon myself to maintain control of the aircraft while attempting to adjust my rudder pedals.



USAF Photo by SSgt Jeffrey Allen
Source Drawing: Flight Manual, USAF Series A-10/OA-10A
Photo Illustration by Dan Harman

When under stress, many aviators revert to habits.

MAJ BRUCE "FM" EDWARDS
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The old adage says "train the way you fight." This sounds like a good idea, but it means that your training had better be squared away and it should be reflective of the way you want to perform in a crisis situation.

This article examines the way some design and training practices may have contributed to loss of aircraft. The shutdown or pullback of the wrong engine in twin engine aircraft during an emergency procedure can be corrected in some instances, but can lead to total loss of the aircraft under other circumstances.

The story about how we set ourselves up for this human factors problem is a three-part one: design, training and interference.

The design issue is one that we have recognized for many years. The throttle quadrant on twin-engine USAF aircraft is pretty standard and has not changed despite many different jets and many different missions. This design is found on the A-10, A-37, AT-38, FB-111, F-4, F-5, F-15, F-22, F-101, F-111, OV-10, T-37, T-38 and SR-71. The issues relate to the placement of the microphone button and speedbrake switch. The buttons are found on the right throttle only—this means single-engine flight and approaches are much easier with the left engine shut down or in idle and the right engine being manipulated for flight. The difficulty arises when you shut down the right engine. You now have to adjust the throttle with the left control and move to the right throttle for radio calls and speedbrake usage. Pilots are generally quick to figure out that one method, flying with the left engine shut down, is much easier than the other. This leads directly into the training aspect.

The way that we currently train and stay proficient in single-engine operations is to log events for currency purposes. Being the intelligent type, we tend to do most of our single engine ops in the way that makes sense—the easy way. We typically simulate the left engine as failed and conduct a flawless single-engine approach and landing. We go back to the squadron and log sim single-engine on the event tracker, and everyone is happy. Here is where the interference plays a part.

Habit pattern interference is where habit patterns interfere with some procedure. "Sounds simple enough," you say, "What does this have to do with emergency engine shutdown?" If you have been paying attention, you can answer the question yourself. If not, here you go. The critical actions that must be quickly accomplished under times of severe stress tend to revert back to learned behaviors—habits. These habits can be very helpful because they require little conscious thought and can be quickly carried out. They can be deadly if applied to the wrong situation. This is habit pattern interference.

When a pilot sees a fire light during low level flight ops, multiple actions must occur almost simultaneously to safely recover the aircraft. Ground avoidance and flight path deconfliction are just two, but the proper boldface procedure must also be applied to the affected engine. When under stress, many aviators revert to habits; in this case they have practiced pulling the left engine to idle/off and also pushing or pulling fire buttons/agent discharge, firewall shutoff, etc., to accomplish the boldface. When you have an engine on fire and you shut the other engine off, you don't produce a lot of thrust, and you don't keep flying very long. If you have enough altitude or smash, you might be able to fix the problem before resorting to the silk descent. If you are out of thrust and options, you may have to give the jet back to the taxpayers in its primitive form—molten metal.

Now that you know how you can be set up to make this mistake, you might want to know why and how I know about it. Well, I saw some mishap data and I also noticed that sim single-engine approaches were almost always flown with the left engine in idle. I began to wonder (and I needed a research topic), so I went to the Safety Center and looked at the database. My hypothesis was that if this never occurred, the improper engine shutdown would show an equal amount of left and right engines accidentally shut down, leading to loss of the aircraft. There was no data on the times when pilots recognized the problem and shut down the correct engine, or the times when they figured out the mistake in time to recover the good engine and shutdown the bad one, because these events are not tracked. I looked at 2095 USAF class A mishaps from 1971 to 3 April 2001. Of the 994 mishaps which met the aircraft criteria, 99 were engine-related. Out of the 99, three were found as "definitely" and three were found as "probably" having the wrong engine shut down. So this was a rare occurrence, but it still caused the loss of life and six USAF aircraft.

Now here is where it gets interesting. All six airplanes had the left engine shut down or pulled back when the right engine was the one that was affected. So this means that perhaps there is a link between the design, training and habit pattern interference.

Now you ask, "How can we fix this rare but preventable error?" Well, you can attack any of the three factors: design, training or habit pattern interference. The design is one that we are stuck with. It would cost enormous amounts to retrofit the fleet with microphone and speedbrake buttons on the left throttle, and how likely is that? I think the term "obese probability" fits. The training issue is easily tackled—just practice an equal amount of left and right sim single-engine procedures and make aviators aware of the reasoning behind the change. Do this from the earliest phase of twin-engine pilot training and continue throughout the flying career.

The interesting part is this: If you fix the training issue, you eliminate the habit pattern interference. You cannot rid yourself of the habit pattern interference without changing the design or training; the habit patterns are a direct and predictable result of the two.

Old habits don't *have* to die hard.

All six airplanes had the left engine shut down or pulled back.

The NVG Factor

US Marines/AF photo by Carlos Cintron

MAJ NATE KELSEY
HQ AFSC/SEF

The pilot was definitely enamored with the NVGs' incredible image.

Since the USAF began using night vision goggles in earnest in the late '90s, we've experienced 14 NVG-related Class A mishaps. As I attempted to find root causes or factors relating to these NVG mishaps in the Air Force Safety Center's extensive database, I realized several things. But before I get to that, let me give you some of my background.

The first time I flew with NVGs was back in the early '80s. I flew various aircraft with large rotating fans on top of them in another branch of the Armed Forces. To say night vision technology was crude back then would be an understatement.

The two things that impressed me most about NVGs back then was the amount of weight I could tolerate on top of my cranium for long periods of time, and how well I could see the ground every time my IP rolled the throttle to idle during the final approach phase of landing. Practicing my touchdown autorotations at night was actually more enjoyable to me than during daytime training. Looking back, however, the reason I liked doing "autos" at night was I don't think I was seeing things as well as I thought I was.

Fast forward 16 years to the latter half of the '90s. At that time I was a Cat III LANTIRN instructor at Luke AFB in the 310th FS (Cat III is self designated Laser Guided Bomb low altitude loft deliveries). The motto of the LANTIRN community was "Turning Night into Day." Well, the system was good...but not *that* good. The squadron eventually started flying with the newer generation NVGs during LANTIRN training missions, and life was good! The synergy of the two systems more than made up for their individual weaknesses. It got to the point that anytime any of the IPs were flying at night, either in the front seat or "riding in the pit," we'd wear our NVGs. That included the initial "nay-sayers" who thought NVGs were "no value added."

The more I flew with NVGs the more I liked them, but the more I began to realize their limitations. Rewarding NVG sorties started with the preflight and the focusing. Not the time to pencil-whip procedures. Then while flying, it was absolutely imperative to keep your head on a swivel. We humans tend to move our eyes until we reach our Mk1 eyeball "gimbal limit," then we'll move our skull to maintain visual contact with whatever object has our interest. Not the best technique while wearing NVGs. Consciously forcing yourself to do a deliberate overlapping scan pattern gives your brain the opportunity to fill in the blanks that monocular vision is providing you. Real basic stuff here. Several times I was lulled into thinking I was seeing better than I really was.

I remember one night instructing from the pit and my "stud" was rejoining in the working area to RTB. The flight lead was about 40 degrees left with zero aspect and about four miles ahead of us. Well, junior started the rejoin without a radar lock—not the best move, day or night. After some prodding from me in the backseat, he established a radar lock on lead. Well, this young fighter pilot was so amazed at the visual clarity provided to him by the NVGs that he stopped referencing his radar and HUD airspeed! As we got within a mile of lead, I asked "Studly" what his overtake airspeed was. After a pregnant pause, he said, "About 450." Since the briefed rejoin airspeed was 300 knots, we were closing fast and the words "excessive overtake" come to mind. I took control of the jet at 3000 feet and maneuvered our jet away from lead, winding up about 9000 feet in line-abreast formation.

The lesson learned that night was always back up what you think you see with another on-board sensor, whether DME or FCR data. By keeping my Situational Awareness of lead from the backseat, I was able to let this upgrading NVG student learn a valuable lesson. That young student, by the way, was a major with over 1700 hours in the F-16. Channelized attention? You bet. The pilot was definitely enamored with the NVGs' incredible image. A potentially catastrophic situation complete with fatalities was avoided, not to mention adding a few more gray hairs to my nugget. My going-in position with this article is: No one intentionally flies into the ground or runs into another airplane on purpose, whether wearing NVGs or not.

Let's look at some NVG-related mishaps and try to glean some lessons.

• The mishap aircraft (MA) was lead of a two-ship NVG syllabus mission to accomplish Cat-1 NVG currency. The flight entered the working area at 200 feet AGL with the IP in a 2-3 NM trail. The mishap pilot (MP) was describing several geographical features and manmade targets to his wingman IP. While overflying and describing a target, the MP inadvertently entered IMC conditions. While attempting to determine the MA attitude, the MP became spatially disoriented and ejected. The MA was destroyed upon ground impact.

Two things come to mind initially. First of all, it is very difficult at times to recognize when you are flying, or are about to fly, into certain atmospheric conditions like clouds while wearing NVGs. Secondly, it may be surmised that the MP may have been overconfident in what the NVGs were providing him as far as visual acuity is concerned.

• The MP of an A-10 did not properly execute a planned climbing safe escape maneuver. This resulted in a shallower climb angle and lower-than-intended recovery altitude prior to a turn off-target. The result was an undetected overbank and descent during a turn. The MP did not attempt to eject, and the MA impacted the ground in a near-vertical attitude.

There should be no doubt that spatial disorientation and perhaps G-excess, combined with an inadequate instrument crosscheck, was the most probable reason for this tragic loss of a fellow fighter pilot and a valuable combat asset. Once again, that great image NVGs provide you has some severe limitations.

• Just after entering the area, a pair of F-16s had a midair. MA1 collided with MA2 with about 180 knots of overtake. MA1 experienced dual hydraulic failure and entered into an unrecoverable stall. Both pilots successfully ejected. Remember my story? Sounds very similar.

• The mishap sortie was a two-ship NVG upgrade sortie. During the mishap sequence, the MP had a closure speed of 350 knots. During the last portion of the intercept, the MP had his attention on the radar tube for 6-10 seconds. No, this is not a reprint of what I just said; these are two completely different events.

• The mishap sortie was planned, briefed and flown as a night basic surface attack mission with NVGs. During the sortie, the NVG case fell off the left panel and the NVG case strap snagged on the unguarded Manual Flight Reversion Flight Control Switch. The mishap pilot ejected and the MA was destroyed upon ground impact.

Some pilots might initially say "poor cockpit management." I say it gets busy when you're flying single-seat fighters, especially at night.

What can be said about NVGs? They provide you with an enhanced ability to see at night. They also provide you with opportunities to become spatially disoriented while maneuvering, and with the ability to fly into IMC conditions without realizing it and run into other airplanes, if you're not keeping your eyes outside when you're within 10 NM during your intercept. Back up what you think you see with another onboard system. Keep your head on a swivel and check six!

"Deliberate with caution, but act with decision."

NVGs provide you with opportunities to become spatially disoriented.

We've Done This Task So Many Times!

I was shocked to see Craig sitting on the floor in a pool of red fluid.

TSGT JOSEPH RICHARD
USAF Air Demonstration Squadron
Nellis AFB, NV

It was your ordinary day in the inspection section at Nellis Air Force Base, and four of us were getting ready to do a 1200-hour inspection on the landing gear system on one of our elite F-16s. This inspection requires all landing gear and their components to be removed so all the bearings, races, mount pins and such can be checked by machine shop for excessive wear.

So far this year the inspection section has completed seven of these inspections and we felt comfortable with the task at hand. It was a hot Monday in July and we were anxious to start this in-depth, four-day project. We already had the AFTO Form 781 preprints filled out, the new gear and all the consumables were on hand, so we were ready to go!

The team jacked the aircraft and everyone was assigned a section to work on. Scott was working on the left main gear with Chad, while Craig and I worked on the nose gear. We removed the nose gear without any trouble, and the left gear was coming along at a good pace. It was almost noon when we decided it would be a good time to break for lunch. We cleaned the area, put away the tools and went into the office for a needed break. After lunch, we were back to work and ended the day with all three landing gear removed from the aircraft. After we cleaned the area we had our normal end-of-the day section meeting. This is where we review the day's work and brief where we will be concentrating the next day.

We all came in the next morning ready to get the landing gear prepared for the machine shop inspection. Craig disassembled the drag braces and other components of the main landing gear. I swapped components from the old to the new nose strut. Scott cleaned the bearing areas on the airframe, since the machine shop was on the way to perform their inspection.

Later on that day, I started to clean some of the components in the parts cleaner before we took them over to the machine shop. Everything was going well and we were ahead of schedule.

HQ AFSC Photos by TSgt Michael Featherston

Then, there was a thunderous explosion. It was so loud that everyone came from his or her office to see what had happened. I quickly turned around, startled by the noise, and was *shocked* to see Craig sitting on the floor in a pool of red fluid with a stunned look on his face. A million thoughts were going thorough my mind. Was he injured? Was that blood or hydraulic fluid? What had happened?

Craig looked as if he just saw a ghost. I rushed over to see if he was okay and to find out what had happened. It was difficult for Craig to talk, as he was in a definite state of shock, sitting there in a pool of (thankfully) hydraulic fluid. After a couple of seconds of looking at the main landing gear shock strut, I pieced together what had just happened to him. He was disassembling the main landing gear shock strut and was in the process of taking off the landing light bracket. (The light bracket being mounted to the main gear strut has been changed after the Block 30 F-16 aircraft.) He had one of the retaining bolts removed and the second one halfway out when the strut came apart in front of him.

Why did the strut just blow apart? I discovered the strut had *not* been depleted of its 1900-PSI nitrogen charge during the removal process. On page one of T.O. 1F-16-C-2-32JG-10-1 Task 2-4-1, Removal of the Main Landing Gear Shock Strut Assembly, there is a warning before step 3 that states "Shock strut shall be depressurized completely. Failure to comply may result in injury to personnel." There is also another warning in the tech data (prior to step 16) to *make sure* the strut is depressurized prior to removing the landing light bracket from the strut.

Now we had to figure out what went wrong. Were the people involved qualified and did they have a T.O.? Yes. Were they hurried? No. All the workers have done this job plenty of times in the past, and they actually finished the same task just a couple of weeks prior to this event. So what went wrong in this chain of events? Two failures to observe key tech data warnings.

First—A failure to deplete the main gear strut prior to removing it from the aircraft.

Second—A failure to verify that the pressure was depleted prior to removal of the light bracket.

Don't assume someone else followed "The Book."

In either case, maybe they thought someone else had depleted the strut or that they would get to it later. In each situation an important Tech Data warning was *missed.* The missed warning could have caused Craig to be seriously injured.

The lessons we learned (or relearned) from this were:

- Always read and follow the T. O.
- Don't assume someone else followed "The Book" when "The Book" asks you to verify something is done.
- It doesn't matter how many times you have performed a task, *always* review the T. O. for any changes that may have been incorporated since the last time you read the procedures.

The Thunderbirds and the Air Force got lucky this time and avoided a major incident and injury to key personnel, but next time it could be different. Make sure your landing gear maintenance procedures are by "The Book."

Editor's Note: TSgt Richard is currently the NCOIC of the Thunderbird Maintenance Operations Center and at the time of the incident was the Inspection Section Flight Chief.

Communication: Key To Modern

HQ AFSC Photos by TSgt Michael Featherston
Photo Illustration by Dan Harman

G. ARLEIGH DOM
Customer Service Department
The Glenn L. Martin Company
Aircraft and Maintenance Review,
February 1956

The difficulty is not in having time-worn rules replaced by new ones...

Editor's Note: This article is reprinted from the February 1956 issue of Aircraft Accident and Maintenance Review. *Despite the fact that many maintainers today are women, the article shows that some messages are timeless. Communication is still the key to modern maintenance. Maintenance professionals must always communicate with each other, AFETS, MAJCOMs, depots and the manufacturers to ensure our high-tech modern aircraft always fly safe.*

When a new aircraft has been built, and the Air Force has given it final approval, there begin for the product two allied but distinguishable lives. One is the life of operations, the other is the life of maintenance. In both of them, the company that brought the aircraft to you can play an extremely important role, but only if it is helped by you who do the actual operating and maintaining. What I'd like to discuss here are the methods we now use to carry out our functions, and the ways you can help us to improve them.

Let's look at the situation. The manner in which an aircraft is operated and maintained is determined by what we call "rules." By "rules" I mean all the information, orders and policies that surround any work that is done by individual Air Force people. They are the guides without which the aircraft could neither be operated nor maintained. Now, where do these rules come from and what happens to them in actual service?

The rules for *operating* an aircraft or missile are suggested by the contractor, for he knows the best design capabilities of the product and has extensively tested it before sending it out. But when the product reaches the field, these "rules" are modified and strengthened on the basis of Air Force flight experience. So

Maintenance

the rules for operating an aircraft or missile are never exactly what we who laid them down thought they would be.

In maintenance, on the other hand, a company can be pretty sure that the rules it lays down for its customers to follow today will be good ones to follow tomorrow. It looks, on the face of it, as though maintenance men have an easy time of it; but it just isn't so, as many of you can attest. The difficulty facing the maintenance man is not in having his time-worn rules replaced by new ones, but in having so many new rules *in addition* to all the old ones. And not only are these rules more numerous, they are also much more complex than the old standbys. There's a reason for this, and it's related, strangely enough, to the activities of flight personnel rather than to anything done by maintenance personnel.

There are just so many things the pilot and his crew can handle while they're flying; when this limit is reached, the aircraft designer has to turn to automatic controls to do the rest of the work. And when things are done automatically in the air, it generally means that there's a maintenance problem on the ground. Proof that this has happened can be afforded by a look at the automatic and semi-automatic equipment included in today's aircraft, compared to the equipment of 10 years ago. About all that remains, actually, is the 1945 radio. For each of these novelties—LOX, ejection seats, pressurization and so forth—the pilot has some responsibility, but the maintenance man has to take the brunt of the work. So the complexity of modern aircraft and missiles is coming home to roost in the hangar. You maintenance people have to pay for the technical advances we're making.

This probably comes as no surprise to Air Force men, but there are several points which ought to be brought out about it. As this tendency continues, there will be more work, not less; and it's qualitative as well as a quantitative increase. Maintenance people are going to have to expand their horizons, because the Air Force is going to need more men who are both imaginative and technically informed in the new and terrifically complex problems. If it were a case of merely quantitative increase, a greater number of men would solve the problem. But the real problem is in finding men who are ingenious enough to master the new rules that are bound to come up.

This brings us to the central message I want to get across. We in the aircraft industry want to help you improve yourselves and your work, in meeting the challenge of modern complexity. The aircraft company is, I think it's fair to say, the focal point for maintenance information on its product. So it's natural that we should all be interested in the communications between us. The difficulty is that the people who are to maintain the aircraft or missile are hundreds and sometimes thousands of miles away from the information. How do the Air Force and the Air Force's contractors pass the word?

The bulwark of the communications between us, of course, is the *Technical Order*. All the latest information on the aircraft is presented here, and it's in constant revision. Prepared by the contractor and reviewed by the Air Force, this literature gives you complete and up-to-date information.

Supplementary to the official litera-

continued on next page

...but in having so many new rules in addition to all the old ones.

ture are a number of special aids. Courses—offered both by the Air Force and by the contractor—give maintenance men an acquaintance with their aircraft thorough enough to enable them to return fruitfully to their T.O.; Mobile Training units, most often accompanied by Air Force training units, bring modern methods of visual education to bear on particularly knotty problems. Certain publications, such as this magazine, deal informally with problems common to all Air Force maintenance work. Other booklets, often prepared by the manufacturer, help to clarify special difficulties in understanding this product.

But the most personal means of communication is certainly the field representative or field engineer. Constantly available for consultation, he is a walking miniature edition of the company he represents: an educator, advisor and engineer.

These are ways in which we try to improve the lines of communication. But they are not, in themselves, enough to ensure what is most important: That every mechanic be fully aware of what he is supposed to do in a particular situation. Now, I suppose, the producers of aircraft might write more T.O.s. and booklets and send more field representatives to air bases. But this would be missing the point, which is that men who are maintaining modern aircraft need a *quality* of understanding that cannot be obtained from any quantity of information. This sort of understanding can come only through positive attempts to solve these new problems. The question now is, how can we help you? In other words, without swamping you with material, what can we give you to increase your personal efficiency?

Many years ago, this would have been a strange request to make indeed. Aircraft companies were happy enough to sell the equipment they made, without worrying about how the customers got along with it. Now, every reputable company which supplies intricate weapons to the Air Force is glad to provide services in a hundred ways, including those we have already discussed. There are other services which depend on requests from the users of the product, and it's these that you should learn to take advantage of.

The open door is a symbolic invitation to exchange ideas, and this is communication.

The field representative, for example, is someone who is at the base not only to represent his company but also to advise in every conceivable way the men who are taking care of the aircraft. It's up to the individual mechanic to bring his questions to the field rep's attention.

Ordinarily you should find in the T.O. just about everything you need to know, and it is usually correct, but there are times when, for example, the text is unclear or incomplete and perhaps even mistaken. The mechanic's responsibility is to take action, research the problem, ask the field representative, ask other authorities. In short, become an active participant to the solution.

The field representative is the proper authority at the base to represent his company. It may be, however, that a puzzle arises and you want more voices in the discussion. You may be pleasantly surprised at the attention any manufacturer will give to your problem. There are a couple of reasons for this attention.

For one thing, we who manufacture a weapon are as eager as you are to make it a smoothly operating piece of equipment; any of its problems that can be solved is a step towards making it that much better. But there's a second reason, too, and it goes to the heart of the matter we've been discussing.

Have you ever noticed that some supervisors leave their office door open? They're not just circulating air, if my guess is correct. The open door is a symbolic invitation to exchange ideas, and this is communication. Whether it's the door of a supervisor, or figuratively of a large company, I firmly believe it's a good policy to have the work passed up as well as down. There are very real practical reasons for the policy, and one of them is that it's one of the few ways the supervisor (or the company) has of finding out what his people are saying. It's easy enough for us to pass out literature and send representatives around; but it's difficult to find out what effect this communication is having unless there is another line of communication, from you to us.

What I've been trying to say can be boiled down to a few words. We already have some means of getting information to you, but this is not enough. You have to seek information, information which the producers of aircraft are happy to give.

HQ AFSC Photo by TSgt Michael Featherston
Photo Illustration by Dan Harman

A Tale of a Flight Line Maniac
Courtesy *Airclues* (UK), 4/2001

Winter in the north of Scotland, and the weather is living up to a well-founded reputation for its ability to be dreadful. I am on Northern Quick Reaction Alert (QRA or Q) with a well-known F-4 squadron (yes, groundcrew do belong to squadrons as well) for the usual seven-day stint, and it is halfway through the duty. It is 1975, and the flying has been unusually intensive, with Q-birds now lined up outside (no hardened aircraft shelter in those halcyon days) on "the point" in the Siberia-like conditions, with howling winds and driving sleet and snow. The aircraft parked outside are two-tone, with one side covered in a thin veneer of blasted-on ice and snow, and the other in stark contrast, being in the lee of the weather.

To venture into the Q sheds in winter, even with the steel shuttered doors closed, is to invite exposure and goose pimples the size of eggs. The sounds of the storm echo through the dark tin structure of the sheds, even with the hulking presence of two fully-armed Phantoms lurking in the murk. Freezing water is trickling under the closed shutter doors forming puddles, and the doors are rattling and banging as the winds batter and tear at them. It is the fourth day of activity, and we groundcrew are all very tired, having been active for the past four days and through this night launching and recovering Q1 and 2. In addition, we have had to suffer the storms to get Q3 and 4 on line. This has entailed working in the teeth of the weather in darkness, as aircraft were armed with the standard complement of four Sparrow and four Sidewinder missiles, pre-flight maintenance carried out and engines run to check various systems and tune the missiles.

The rest of the crew, including the aircrew, are taking advantage of a lull in the flying to grab some eagerly sought-after hours of shallow sleep, and it is my turn to do the "gases." This is a four-hourly physical check of the various gaseous systems on the F-4, to top up as required and to carry out any minor maintenance required (this in the days when one man could be trusted to carry out aircraft maintenance across trade boundaries and often did so, hence the noble Flight Line Maniacs). I have just checked the left main wheel bay for any leaks, stumbling around in the dark and cold in the weak light from a fast-failing torch [flashlight] and notice that the tyre looks soft. So I dig a pressure gauge out and check the pressure. It is low, so I have to get the tyre inflation kit. No problems; the accumulator will be full and I will not need to drag the nitrogen kit to the aircraft.

Wrong. The kit accumulator is empty, so I now have to charge it via the main bottle set.

The crew room is in darkness and silent save for muffled snores from the main bedroom where my colleagues are asleep, and the crew room heat was welcome on my frozen face and fingers as I gathered the spanners [wrenches] and bottle key. The room smells of cigarettes and sweaty socks, the tables in the darkness covered with the large F700 maintenance documents for each of the four aircraft that are now part of the Q shed inventory. Various games are strewn on other tables, and coffee mugs stand

continued on next page

I dig a pressure gauge out and check the pressure. It is low.

ready for the morning.

Through the heavy steel blast door, being careful not to let it slam shut, down dark steps, through another steel door and into the echoing cavern of the Q1 shed, I duck under the left wing between the Fletcher fuel tank and the outboard Sidewinder, getting my cold weather jacket caught on the fins, ripping yet another ragged vent, struggling free I crouch beside the tyre. Blowing on my fingers for some heat, I connect the bottles up, charge the accumulator and connect the charging kit to the valve on the tyre. The wind continues its blasting, and fresh squalls of sleet are hissing against the tin roof and walls of the dark and cold shed. Wraiths of arctic air seep down my exposed neck, making me shiver. It's surprising how quickly an aircraft can cool down following a five-hour sortie, and the air in the shed must be at arctic levels—if not lower! I am feeling sorry for myself. As usual, some air escapes from the valve as I struggle to fit the damn thing, not helped by the fact that it is still "dark o'clock" hours, I am very tired, and my fingers are numb from the penetrating cold. My nose is running, my breath steams in clouds and my many layers of clothes both under and over my denims are not helping maintain my core body temperature. I am also kneeling in a fresh puddle of melted glacier that has flowed into the shed from the conditions outside.

The tyre now proceeded to collapse as the air escaped with a rush.

To my utter frustration, the inflation valve is now stuck on the tyre valve with the air escaping fast…

…And it was then that I did something that I have not been proud of over the intervening years. I panicked and lost my temper; a lethal and heady brew. I tried to pull the jammed valve off but my fingers slipped and I fell backward, catching my head on the way down on the undercarriage down-lock actuator and had the breath knocked out of me, landing in an undignified lump under the auxiliary air door. Struggling upright, I then caught my collarbone on the undercarriage door and landed on both knees, clutching my wounded shoulder and moaning gently whilst rocking slowly to and fro. The language would have shocked Lucifer himself.

As soon as I was as upright as possible in the wheel well, the reaction to my mounting anger was to lash out with a steel-toe-capped boot. I meant to miss (it being an expression of my angst) but compounded the situation by connecting with the valve, severing it from the tyre with a final determined serpentine hiss.

The tyre now proceeded to collapse as the air escaped with a rush, and I was left with Q1, the primary war bird for the Northern sector, listing to port with a full complement of live missiles on board. Time for rational thought, but all I could do was panic.

It is strange what the human is capable of doing in situations of danger or stress. I even tried to push the fractured valve back into the gaping hole from whence it came. Stupid boy!

There was no choice now but to change the wheel and tyre assembly. Normally a straightforward operation and one that I had carried out almost daily for my six years as a Flight Line Maniac, but at this my darkest hour it suddenly appeared to be the most major operation in the world. The spare wheels and tyres were kept in a wheel change trolley, an ancient but functional wooden contraption that could be towed behind a Land Rover. The trolley was parked outside the main hangar, about 400 meters as the Flight Line Maniac flies. The kit consisted of two main wheels, two nose wheels, a jack and various tools and weighed…well, it was sufficient to give one a nasty case of the ruptures.

I stood in the darkness for an instant deciding on options. Wake up the snecko (SNCO) (not wise), get one of my associates (again not wise) or do it all on my own. Fed in part I suspect by embarrassment at my stupidity, I elected for the third option.

I ran full tilt to the hangar (easy going with the gale and snow behind me) and pulled the full trolley by hand to the Q shed with the storm full in my now-seared and wind-blasted face. I opened the shuttered doors, wincing at every squeak and squeal, jacked the aircraft (probably way over the max mass allowed on the tiny bottle jack), changed the wheel assembly and had everything squared away within 20 minutes.

I could no longer stand, my hands were like a grease-covered hamburger, my legs were shaking, I felt nauseous, I was bathed in a cold sweat and had taken the skin off both sets of knuckles—not from dragging them along the ground as some thought we were inclined to do (or was that the armorers?) but from the speed and desperate energy with which I had applied myself to the task. And all the time dreading the sudden banshee wail of the scramble hooter. (I grew to hate the sound and even now, almost 27 years later, my heart still skips when I hear anything sounding remotely like that hooter.)

I learned about stress from this.

I learned that people are vital resources and should, in times of great stress, be given the chance to sleep and to follow as near to proper shift patterns as operations will allow. Not just snatched hours but quality sleep away from disturbance. A lesson here for manpower and shift control during heavy periods of work: It is dangerous to assume that people can cope, and as managers it is incumbent on us to ensure that we actually check our people, talk to them and ask them how they are feeling. It's great to talk.

I learned that I was as prey to stress as the next man and that I could not "keep going" on the adrenaline rush from the excitement of the occasion, even as young a pup as I was then.

I learned that stores and equipment that might be required to support the Q sheds and aircraft should have been parked close to them for ease of access, or if they were shared inventory then more should be purchased to avoid this issue.

I learned that when tired it is important to step away from tasks that are beginning to tax and stretch the temper. Take a slow count of ten, take a powder or get someone else to take the mantle for you or at least help. Once again, it's great to talk, and a problem shared is a problem halved.

I learned that the tools of the trade should be kept in an effective and viable condition and in this case that the wheel charging kit accumulator should have been charged at all times and not left empty as usual. The standard of most tools at the time could be best described as "well worn."

I learned that to lose one's temper is counterproductive and will achieve nothing positive.

I learned that taking out my temper on equipment by physical abuse achieved nothing, and in fact could only be negative in its end result.

I learned that faulty equipment should be reported as soon as it becomes faulty and should never be left for others to find; likewise they should do the same. This of course involves changing cultures. Sometimes we must accept the cost in fiscal terms.

The following day, after I had related the tale to my SNCO and the "guys," and after they had stopped their hysterical laughter, it was found that the thread on the charging valve was worn out and extensively damaged, hence the continual troubles with getting it on and off. It came as no surprise that others of my honorable trade then began to relate similar tales of woe with the valves on other items of ageing equipment. We then carried out a check of equipment available to us, changed torch batteries, replaced worn or damaged earth leads, replaced worn and damaged covers and locks, replaced worn and damaged tools, replaced or fixed broken head sets and long leads and re-applied paint to various and sundry items. It came as a shock to realize the number of rounded nuts and fasteners on pipe and hose ends, and how badly damaged other vital items of ground support equipment were. These would take longer to replace.

We had drifted into a comfortable but negative frame of modus operandi, we had omitted to question the viability of the tools of our trade, we had taken for granted the vagaries of equipment, had operated with a substandard set of procedures and tools, and had "got by." We had been totally task-oriented and had forgotten the team and the individual. We had not considered the expert opinions of our own most important resource, our people, and had been content to work with tools that were, by any standard, substandard.

How many of the readers today can, hand on heart, say that all tools they work with daily on our very expensive frontline aircraft are fit for their purpose? How many shift managers can say who out of their charges are suffering the onset of stress-related illness or are displaying the symptoms of stress? Stress is insidious and its effects can be devastating to both the sufferer and those with whom he or she has to communicate daily.

I could not "keep going" on the adrenaline rush from the excitement of the occasion.

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

THE LITTLE THINGS!

How often do we forget the little things in our daily routines? Unfortunately, in our business the little things can become large and expensive very quickly. Look out for each other, and remember the little things!

Is The Hatch Secure?

A C-141C departed on an AMC-directed channel mission. As the aircraft passed FL250 to its assigned altitude of FL310, the aircraft experienced a rapid decompression, and there was a loud noise, followed by a vibration. The quick-reacting crew followed the checklist and returned the aircraft to a safe altitude. At this time, the crew found the #2 emergency escape hatch (located overhead and just aft of the crew entry door) was open, and the escape ladder and survival kit were outside the aircraft, flailing against the aircraft skin. The crew retrieved the wayward items and secured the hatch to the cargo floor. The aircraft then safely landed back at home station.

Did this crew cover all the little things? Was the inspection the crew conducted of the hatch enough to ensure the hatch was secured? You decide. The little thing of ensuring a latch is in the correct position, and doing the preflight inspection by the book, will ensure you don't have to wonder if the hatch is secure.

Was The Intake Inspection Clear?

An MH-53M had flown an FCF in the morning and was returned and released for flight. It was then scheduled to fly a night tactical low-level sortie. However, the FCF crew had written up the #1 engine air particle separator (EAPS) caution light for intermittent illumination. The FCF crew and the mishap crew had a face-to-face debriefing. The mishap flight engineer completed his preflight, and the mishap pilot also completed the required walkaround inspection.

Now the fun starts. During engine start the number two engine started normally, but the gas generator speed (NG) on number one started to roll back. With all other indications normal, the crew aborted the engine start. The mishap crew then attempted two more engine starts on the number one engine, all with the same results. Dedicated aircrew here, don't you think?

After giving up on starting the number one engine, they retuned the aircraft to maintenance. Maintenance then inspected the number one engine and found severe damage to the first three stages on the inlet guide vanes. Upon teardown of the engine, the propulsion backshop found three pieces of FOD that appeared gold/brass/bronze in color and appeared to be from the same object. What was the object? We aren't sure, but could the crew have prevented the FOD or the extent of the damage? How many times do you try before you stop and let maintenance check things out? We need to press on with the mission, but when it comes to our engines maybe we need to look before we try too many times. Another little thing we can do to prevent or limit damage to very expensive Air Force assets.

Who Is Providing Wingtip Clearance?

We all travel to exotic locations, but for a C-5B it turned into a little bit longer trip than anticipated. The aircraft arrived at the foreign airfield and had to make two 90-degree turns into its final parking space. All guidance showed that the taxiways and airfield were suited for the large C-5B. The aircraft was cleared to taxi to the USAF-approved parking ramp. Four foreign nationals, who were untrained in C-5B operations, provided guidance to the parking spot. The aircrew noticed that the two 90-degree turns they had to make would bring them close to an aircraft hangar and a large semi-rigid tent.

The first turn was uneventful, and as the aircraft made the second turn the right wingtip impacted the semi-rigid tent. Do you think the tent was on the airport diagram? The crew shut down the aircraft and surveyed the damage to the aircraft. Another "little thing" that caused a damaged aircraft and a delayed mission. We must ensure that our operations around the world are done safely and smartly. When in doubt, STOP! The few extra minutes you take may save days and thousands of dollars.

How Far Can You Taxi An Aircraft?

Once again at a deployed location, a B-1B taxied to the runway for takeoff, a distance of 3500 feet. Then, due to winds and the maximum weight takeoff, the crew elected to taxi to the other end of the runway to take off, another 12,500 feet. All this movement of a heavyweight aircraft took place within about 15 minutes. The aircrew then *tried* to take off without delay. Unfortunately for them, during the takeoff roll the number four tire experienced tread separation, and pieces of the tire entered the number four engine. The aircraft was past the decision point and the aircrew took off. The airfield folks cleared the runway of debris while the aircrew shut down the engine and lightened the aircraft for a return to base.

Luckily for the Air Force, the crew was sharp and the aircraft landed without further incident. What went wrong? How much taxi time can you have on an aircraft before you overheat the brakes and subsequently the tires? Every aircraft is different, and the tires you use are designed for a maximum taxi distance. In the case of this B-1B, the tire was only designed for a 10,560-foot taxi distance without first allowing a cooling time based upon ambient temperature, taxi speed and tire pressure. If you aren't sure of the taxi distances at the deployed location, stop and ask the experts. Things change rapidly at our deployed locations, but the few minutes you wait could save your mission.

Didn't I Tell You Not To Touch Anything?

The flight was to be a two-ship incentive ride for a deserving airman. One of them got the ride of his life. The aircrew briefed the personnel involved on what they were going to experience and the safety requirements IAW all MAJCOM and Wing operating instructions. This included cockpit orientation, location of canopy jettison handles, ejections handles and the appropriate switches, as discussed in the step brief. The crew stepped to the aircraft and the deserving airman was assisted in strapping in by the crew chief. Takeoff was normal and everything was uneventful until they were performing the second G-awareness exercise, at which time the canopy departed the aircraft. The canopy handle was in the down instead of the locked position.

The aircrew safely recovered the aircraft back to home station and the investigation started. How could an experienced pilot and an inexperienced but deserving airman lose the roof? On the F-15D the canopy is a full manual lock canopy. In order to lock the canopy, the handle must be moved to the locked detent, and this is the only way the canopy-unlocked light will extinguish. The rear seat has an identical handle to that in the front seat, located approximately three inches below the rear seat canopy sill armrest. We need to make sure all personnel in the cockpit know what they can and cannot touch! Everyone must understand what the emergency procedures are, and it is up to the experienced parties involved to ensure they cover all parts of the safety briefings thoroughly. The little things can and will come back to haunt you at the worst times.

Maintenance *Matters*

Editor's Note: The following accounts are from actual mishaps. They have been screened to prevent the release of privileged information.

LET'S TALK POWER, OR LACK THEREOF…

Without the engine, an aircraft doesn't go very far. It seems we maintainers have a knack for finding ways to FOD our motors, or just not quite do things the right way to ensure the operators can keep the motors running. In fact, we do it to ourselves time and time again.

Do You Have All The Pieces?

Aircraft maintenance personnel were tasked with troubleshooting a C-5 #3 engine generator discrepancy. Worker 1 performed the outside walkaround and the required intake/exhaust inspection of all four engines. During the #4 engine inspection he found a nut and washer missing from the fan stopper. The fan stopper is a wooden handle with a heavy rubber tip attached to sheet metal and secured by three screws. He finished the inspection of the #4 engine, then re-inspected the #3 engine to ensure it was clear of FOD. Finding none, he documented the inspections in the aircraft forms. Good work ethic, right?

Worker 1, along with two co-workers, started and warmed up the engines and performed their assigned task. After the run, Worker 1 performed the required post-flight intake inspection, and guess what he found? FOD damage to the #4 engine fan blades and surrounding areas! Where could it have come from?

During the initial investigation a screw was found lodged in the #4 engine fan blade's second stage outer shroud. This screw matched the two other screws that were installed in the fan stopper handle. IAW T.O. 1C-5A-2-1, the fan stoppers are to be inspected prior to use. However, there is no criteria for inspecting the fan stopper.

How could we have prevented the $350,000+ repair cost and lost mission-capable time of a critical airlift asset? How about closer attention to detail or more defined directions? Or if you don't have all the hardware, *stop* and find out where it went *before* you start the engines.

Did You Put The Cap On?

One of our F-16CG aircraft came home with an engine exhaust nozzle problem. A Jet Troop and a Crew Chief proceeded to change the engine-driven hydraulic pump servo filter to correct the slow-to-close nozzle IAW 1F-16CG-2-78-00-1. The task was completed, and an operational check was performed with no leaks noted, so the aircraft was returned to service.

The aircraft then proceeded to fly the next sortie of the day. Unfortunately for the pilot, he got to come home early as the exhaust nozzle was stuck at 75 percent and the oil pressure was fluctuating out of limits. The pilot landed uneventfully and the aircraft was turned over to maintenance, *again*!

"What happened?" you may ask. Post-flight inspection revealed the engine hydraulic pump servo filter cap hanging by the safety wire, with oil leaking out of the filter. There was no damage to the threads on the cap, the threaded portion of the hydraulic pump servo, or to the safety wire. In addition, the pump checked out good during a backshop bench check. So, why did this happen?

No one knows for sure how the cap came loose. It was discovered that the F-16 Career Field Education and Training Plan (CFETP) does not directly cover the filter in question. The CFETP just lists "remove and replace filters." It's up to the individual and their supervisor to ensure *they* know all the tasks required by the aircraft. We train our people on many tasks during upgrade, and some tasks have many different parts. If you need to narrow the field in the training record, take the few extra minutes to make an AF Form 797 entry to cover the additional task. Even better, contact your career field manager and see if you can add the task to the CFETP. The few extra minutes you spend on paper will be gained back by ensuring the Air Force has fully-qualified airmen.

Was The Seal There Or Wasn't It?

Another one of our F-16s was rejoining on a tanker and had a little in-flight oil problem. He safely returned the aircraft to the nearest landing field and called for maintenance, as there was oil on the underside of the aircraft. When the maintenance recovery team arrived they found all four chip detectors properly seated, but the number four detector was missing one O-ring and the second O-ring was cut. The MRT then serviced the engine with 21 half-pints of oil, out of the 47 half-pints total capacity...

What caused this engine event? Simply put, there are two scenarios that could have happened. Either the O-ring was not installed during the post-flight inspection chip detector check, or the seal blew out during flight. No one knows for certain which event happened. Bottom line…when you do the routine pre/post-flight task, ensure you check everything!

How Much Oil Can We Use Per Flight Hour?

In preparation for an over-the-pond deployment, the mishap unit performed several phase inspections which require the engine AC generator to be removed, as was done on the mishap aircraft. After the phase inspection, the required leak checks were performed to include a hot servicing of the engine. The aircraft forms showed 45 half-pints of oil were serviced into the engine. The aircraft then flew one .6-hour sortie. In addition to this sortie, there were two maintenance runs completed due to a fuel malfunction during the sortie.

The sortie and the two engine runs were accomplished all in the same day. After the sortie and the maintenance runs, the engine oil was checked and four half-pints of oil were added and documented. Now, tech data, in this case T.O. 1F-16C-70FI-00-1, states that maintenance should have compared the flight time to the oil consumed, .6-hour sortie/four half-pints. Now T.O. 1F-16C-70FI-00-1 also states that if oil serviced exceeds 1.5 half-pints per hour, of engine operating time, then download the engine data and get the exact engine operating time. This would then include ground operating time as well as flight time. If the oil consumption rate still exceeds 1.5 half-pints per hour, troubleshoot for oil consumption. In this case, the exact operating time was only 1.8 hours. What oil consumption rate do you calculate?

The cost of this maintenance event? The aircraft flew off into the wild blue yonder for a planned 11-hour across the pond sortie. While enroute the pilot received an oil system malfunction message and had to divert to the nearest airfield, only 247 NM away, over water, in a single-engine aircraft with an engine oil system problem. The entire four-ship and their accompanying KC-10 followed to provide support in case the worst happened over the water. Luckily for the Air Force, the aircraft landed safely at the divert field, and the other aircraft then continued on their merry way to the original destination.

"What was wrong with the aircraft?" you might ask. Well, the maintenance recovery team arrived a day and a half later and they serviced the engine with 14 half-pints of oil. During the maintenance engine run, they found oil leaking from the AC generator O-ring, which had been pinched during installation. What could have stopped this event? We all know the rules on proper documentation of oil servicing, but have we fully trained our people on oil consumption? As professional maintainers we must ensure even the youngest crew chief and engine troop, or other specialty if they perform oil servicing, know what and where to check to ensure an aircraft won't run out of oil in the wrong place at the worst time.

USAF

Class A Flight Mishaps

FY02 Flight Mishaps (Oct 01-Apr 02)	**FY01 Flight Mishaps (Oct 00-Apr 01)**
17 Class A Mishaps	**11 Class A Mishaps**
6 Fatalities	**4 Fatalities**
11 Aircraft Destroyed	**11 Aircraft Destroyed**

14 Oct	♣	An HH-60 crashed into a river while flying a low-level training mission.
17 Oct		An F-16CG was severely damaged following an aborted takeoff.
25 Oct		An F-16C departed the runway after landing.
02 Nov	♣	An MH-53 crashed while performing a mission.
05 Nov	✶	An F101 engine undergoing Test Cell maintenance sustained severe fire damage.
12 Dec	♣	A B-1B crashed into the ocean shortly after takeoff.
21 Dec	♣✶	A C-141B sustained a collapsed wing during ground refueling operations.
30 Dec	♣✶	An RQ-4A Global Hawk unmanned aerial vehicle crashed while returning to base.
08 Jan		A C-17 was damaged during landing.
10 Jan	♣	An F-16C crashed during a surface attack training mission.
10 Jan		An MH-53J crashed during a search and rescue mission.
17 Jan	♣♣	Two A-10As were involved in a mid-air collision. Only one pilot ejected safely.
24 Jan		An MH-53 crashed while performing a mission.
25 Jan	♣✶	An RQ-1 Predator crashed on landing.
31 Jan	♣	A T-37 crashed during a training mission. The two crewmembers suffered fatal injuries.
02 Feb	♣	A C-21 crashed while landing. The two crewmembers suffered fatal injuries.
12 Feb		An F-15 was severely damaged due to an engine fire.
13 Feb	♣	An MC-130P crashed during a mission.
18 Mar		An MH-53 crashed during landing.
20 Mar	♣	An F-16 crashed during a training mission and the pilot did not survive.
15 Apr	♣	An F-16 crashed into the sea during a training mission.

- A Class A mishap is defined as one where there is loss of life, injury resulting in permanent total disability, destruction of an AF aircraft, and/or property damage/loss exceeding $1 million.
- These Class A mishap descriptions have been sanitized to protect privilege.
- Unless otherwise stated, all crewmembers successfully ejected/egressed from their aircraft.
- Reflects only USAF military fatalities.
- "♣" Denotes a destroyed aircraft.
- "✶" Denotes a Class A mishap that is of the "non-rate producer" variety. Per AFI 91-204 criteria, only those mishaps categorized as "Flight Mishaps" are used in determining overall Flight Mishap Rates. Non-rate producers include the Class A "Flight-Related," "Flight-Unmanned Vehicle," and "Ground" mishaps that are shown here for information purposes.
- Flight and ground safety statistics are updated frequently and may be viewed at the following web address: http://safety.kirtland.af.mil/AFSC/RDBMS/Flight/stats/statspage.html
- **Current as of 29 Apr 02.** ✈

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The Aviation Well Done Award is presented for outstanding airmanship and professional performance during a hazardous situation and for a significant contribution to the United States Air Force Mishap Prevention Program.

Airman First Class Ryan L. Moore
325th Bomb Squadron
Whiteman AFB MO

A1C Ryan Moore demonstrated keen situational awareness and safety practices when the B-2 his ground crew was recovering experienced a #2 brake fire in the quick-turn area. Upon taxiing back, the ground crew noticed flames originating near the brakes, on the lower end of the left main landing gear. As the event quickly developed, the ground crew made crucial decisions and took immediate action to mitigate the risks present to both the flight crew and aircraft. As the ground crew expeditiously contacted the flight crew to notify them of the pending danger and assisted them with egress procedures to a safe distance from the potential danger, A1C Moore unselfishly approached the aircraft and extinguished the fire. Once it was out, he remained on scene and monitored the brake until the fire department arrived. His safety-focused decisions resulted in only minor damage to the brake assembly, no loss of life, and no damage to the aircraft or adjacent components. In the subsequent investigation, A1C Moore provided critical technical inputs and findings to assist in determining the cause. The investigation revealed a flaw in brake change technical data, resulting in a maintenance procedural change.

We did it again... with your help!

HQ AFSC Photo by TSgt Michael Featherston