DEFENDING
AMERICA

The F-16 Fighting Falcon has been selected to shoulder responsibility for the strategic air defense of the continental United States. F-16A models will be outfitted for this air-to-air intercept mission and will replace older aircraft — such as the F-4 and F-106 — at key strategic locations throughout the country. F-16s recently replaced F-106s at Jacksonville, Florida, where General Dynamics-built aircraft have been performing the air defense mission for more than 25 years. (See related article, page 26)
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B-24 flyby highlights Carswell AFB ceremony.
Signal one minute,” the Thunderbird Commander/Leader tells his crew chief. Everything is set. Thousands of people are watching, waiting, straining to see the beginning of one of the most famous aerial demonstrations on earth.

From his position on the ladder, the crew chief turns, straightens his hand. It’s the signal. In sixty seconds the shriek of six afterburning turbofan engines will subdue all other sound, command attention, dominate thought.

The crew chief’s hand signal has begun a sequence. Number two’s crew chief sees it, turns, straightens his hand. Then three, four, five, and six. The signals ripple down the row of perfectly aligned airplanes. Precision is everything — the crisply starched uniforms, the snap in each movement — as if all six airplanes, the pilots, the crew chiefs, and their assistants are merely extensions of a single mind, a unified whole.

Out in front of the aircraft, the line chief comes to attention. The crew chiefs climb down off the ladders — together, sharp. Six ladders are lifted from six aircraft and stowed. Six crew chiefs step in unison to a position next to the six assistant crew chiefs, then the twelve step to the front of the aircraft. Timing. Precision.

The line chief, straight as a light pole, salutes. Quickly. As he drops his arm, the engines come to life, spooling up from a deep, metallic whine to a roar of rolling thunder. It’s not just noise. It has substance. The crowd feels it on their skin, like an armchair vibrator.

Six canopies ripple down in staggered, symmetrical unison, sighing into place. The show begins! The Thunderbirds — all 120 of them — have done it again.

“The purpose of the team,” said Maj. Bill Pritchett, Jr., “is to perform aerial demonstrations for the public — for the taxpayers. Everything that this organization does is toward that goal, whether it’s in public affairs, admin support, the ops clerks, all the maintenance personnel, whatever. All are working to get six airplanes in the air at showtime.”

Maj. Pritchett, who stepped down as the Thunderbirds’ Logistics Officer at the conclusion of their 1986 show season, said the entire Thunderbird organization “is just phenomenal. So many things are behind the scenes. The public doesn’t see them, and you don’t want them to. It’s not really necessary that they’re aware of it. What we do is a stage production. As soon as it’s over we’re preparing for the next performance. It’s a never-ending cycle.”

And for the team members, that cycle means long hours, hard work, and unending sacrifice with few tangible
rewards. So why do they do it? Capt. Terry Williamson, the Thunderbirds' Maintenance Officer through the 1986 season, said desire is the key.

"When we were kids growing up," Capt. Williamson said, "we saw the magnificent teamwork and beauty of these six red, white, and blue jets. And just to have a small part of that will make my Air Force career. It's a feeling that's hard to describe. Every time I see the airplanes take off, I feel it. I feel that accomplishment. I've seen 'em take off for two-and-a-half years now and I still get the same tingle.

"The Thunderbirds have the desire to achieve as a team. They understand that it does not take just a maintenance crew chief, but it also takes a pilot. And the pilot understands that it's not just him flying the airplane — that the admin clerk takes care of all his records so he doesn't have to worry about it. The admin clerk understands that the supply troop must supply all the parts for the maintenance guys to perform their job. And the supply troop understands that it takes the people over in public affairs to send out all the pictures and answer all the fan mail. Everybody knows exactly how they fit into the recipe. If every ingredient is not there, the cake will fall right in the middle," Capt. Williamson said.

"Attitude is number one," Maj. Pritchett said. "We don't select a person unless he has the ability to do the job. And
every individual's job is important. Here you don't have to beg people to help, or worry if the work is being done. The people put in the time they have to put in to get it accomplished. There's a pride in this organization, and no one is going to let themselves be the shortfall. It's great to work in an organization that's like that. You don't have to run and look for that broken link in the chain, because it's not there.

The purpose of the team is to perform aerial demonstrations for the public — for the taxpayers. Everything that this organization does is toward that goal, whether it's in public affairs, admin support, the ops clerks, all the maintenance personnel — whatever. All are working to get six airplanes in the air at showtime.

You go from one end of it to the other and everyone pulls their weight.”

That sentiment was echoed by Senior Master Sergeant (Chief Selectee) Mike Myers, the Thunderbirds' Line Chief.

“Everybody that's here wants to be here,” Myers said. “Everybody knows what they're getting into and they want to be here. They want to do the job they're doing. It makes it so much easier for everybody. It's nice to work with a lot of people that are strictly top notch. They know what needs to be done. You don't have to babysit 'em.

“We have a crew chief and an assistant crew chief on each aircraft, but everybody else pitches in. There's a lot of teamwork in the squadron. People just walk out on the ramp when they have nothing to do and they'll grab a cloth and start wiping down a wheel well, or jump up on top of the wing and start polishing — because it's a job we've got to do. It's our livelihood — our showpiece. Guys are out there today, as a matter of fact ... and this is supposed to be their day off.”

“Today is supposed to be a day off,” said Sgt. Clayton Osborn, the dedicated crew chief on the number six aircraft, “and I'm in here cleaning and polishing and doing paint touch-up. Nobody makes me do that. It just makes me feel good that I'm in here. You know, if I'm not in here and I know the aircraft is dirty and it's a nice day that I can be out there cleaning on it ... well, it just makes me feel good. The motivation is being able to show off what I'm doing, the competition between the other crew chiefs, striving to get a job on the team for next year. We average working 12 hours a day. And in training season last year my average day was 14 to 16 hours.”

Master Sergeant Don Gall, the Thunderbirds' Specialist Flight Chief (he supervises all specialists, technicians, and assistant crew chiefs) joined the Thunderbirds for the challenge.

“I've been at it almost three years and I've loved it,” Gall said. “It's different every single day — constantly changing environments, all the travel involved. It's the most challenging job I've had and I love it from that respect. Plus the pride that goes with it and the chance to work with the best technicians in the Air Force. The highlight of my time on the team, without a doubt, was my flight in that F-16B. February 19, 1986. Maj. Pritchett took me up for my incentive ride. We went up on the range north of Indian Springs. We pulled nine g's. I got my 9-g pin and everything. That was unbelievable.”

Other than the pride of having been a member of the team, the incentive ride is one of the only benefits a Thunderbird enlisted person can expect. There's no extra pay. There is, however, a wagonload of hard work and a seemingly endless number of hours to do it in. Add to this an apparent misconception that you have to be a Superman to be selected for the Thunderbirds and it's easy to understand why the team almost always has job openings.

“We're always looking for new people,” said SMSgt Myers. “I don't know why it is, but we get very few packages from the field. We tell people (about) our vacancies, our openings. We request application packages. But a lot of the guys will come back with the response, 'well, you've probably got thousands of packages. You probably wouldn't want to take me.' And that's not the case. People think that the Thunderbirds are too good to take them on the team, but we're always looking for people. We're shorthanded in a lot of areas.

“Most of us just come right smack off the flight line, just like everybody else. We're just normal folks. One week you're crewing an F-4 at George Air Force Base, and the next week you're working on F-16s here at Nellis. But we have a problem getting the packages we need so we can keep our work force up. Administrative clerks, photographers, public affairs, B-shoppers, hydraulics, electricians — whatever.”

“We aren't necessarily the best people in the Air Force,” said Tech Sergeant Sue Moore who works in plans and scheduling, “but we're probably the best people that have applied for the team. A lot of people don't apply for various reasons. They don't want to be TDY, they don't want to commit themselves to be away from their family ... or maybe they don't think they can be hired, but it's not as hard as people think.”

Maj. Pritchett described what happens to the applications they receive.

“The application is screened, starting at the lowest level — whoever will be the immediate supervisor. It then will go right up the chain to include the First Sergeant, the maintenance officer, maintenance superintendent, and then myself. Then it goes over to our commander/leader. The things we look at are experience level, proficiency report ratings ... and we don't necessarily just look at the work performance. We also look at personal appearance, and the statement of desire. Another important aspect is the concurrence and understanding letter that we have the spouse put in — that they understand the amount of time that will be consumed by being on this team, plus the travel that's involved.”

Sometimes, Maj. Pritchett said, an applicant is acceptable but no position exists immediately in his specialty field.

“In those cases we'll send them a letter saying, 'There's nothing wrong with your package or experience. You're exactly what the team needs. However, we are fully manned at this time. An opening will come in such-and-such month. Please reapply.'”

When an applicant is accepted, "they come on the team and immediately go to work," Pritchett said. "The first 21 days is kind of a checkout period for both of us. They look at
us. We look at them. It gives them an opportunity to say, 'Yeah, I thought I knew what it was, but this is not really what I thought it would entail.' The first 21 days are very difficult. We work them long hours, we let them see every aspect of the operation. We do that for several reasons. One, so they can get to know everyone, get to know each of the shops and what each duty entails. And if they can take the pressure of the 21 days, then they can stand the pressure of any of the TDY commitments that we have or the work schedules that we have under normal operations. We do lose some here and there, but very few people just quit. And if someone gets demotivated, or really gets down, then an active team member will say, 'Look, this is not the way it really is. Just hang in there and it will come around.' We don’t really have a big problem with attrition."

New people undergo this 21-day check-out period during what the Thunderbirds refer to as their "training season" — from late November to mid-March. From pilots to administrative people, the newcomers have this time to become adjusted to the Thunderbird organization. But it’s equally as difficult for the "old hands" according to Staff Sergeant Rob Guevara, an environmental systems specialist and the assistant crew chief on the number five aircraft.

"Our roughest time, I’d say, is training season because you’re flying six-turn-six a day, and then maybe two (aircraft) go here and two more go there. All you’re doing is working real hard. Tension gets high. You’re out there marching every day, learning how to do the show launch perfectly, and sometimes things don’t go the way you want ’em to. You look for any word of encouragement because the days are long, it’s cold, or it’s hot, or it’s raining. It’s no fun, but you know that when March 15 rolls around you’re going to be doing an airshow and you’re going to get to go out there and show everybody your stuff. It really makes you proud. It’s all worth it," Guevara said.

"Those three-and-a-half months are the most time consuming of the whole year," Maj. Pritchett said. "A lot of people don’t understand that. They think we get a break. We do close down two weeks at Christmas so the pilots can have a break. Pilots can’t take any time off except for that two weeks. No free holidays. Yesterday was a federal holiday. We flew."

Since the Thunderbirds began flying the F-16 three years ago, they’ve at least had more time for cleaning and polishing. Staff Sergeant John Bienick, the dedicated crew chief on the number three aircraft, said the F-16’s ease of maintenance was a real surprise to him.

"I went straight into phase maintenance my first year on the team," Bienick said. "I was used to depotting F-111s and doing phases on F-111s. They (the Thunderbirds) said, ‘O.K., let’s depanel for a phase.’ And I was, like, all geared up to go and then they said, ‘O.K., we’re done.’ And I thought, ‘Whadda ya mean, done?’ The F-16 is a very easy airplane to maintain."

"I think the F-16 is an outstanding jet," Maj. Pritchett agreed. "We’re leading TAC in all our maintenance mea-

urement data. We’re running 98.5 percent mission capable. The maintenance on the F-16 is easier than for the T-38. That (the mission capable rate) is both a reflection on the superb maintenance that the guys and gals do and on the airplane itself. That’s why I say the F-16 — for our mission and for what we are doing — as far as I know there’s no other aircraft that would be better suited. It can keep the airshow close to the people, it has nice lines, it’s pretty, it’s highly maneuverable, great fuel efficiency . . . it just can’t be beat."

"Last week I was at the Worldwide Maintenance Managers Review Conference," said Capt. Williamson, "and I was kinda surprised at some of the small things we were discussing that we call big problems. I think we’ve come to a point where the F-16 is such a good airplane that we’re getting bogged down with real small problems. It’s just a super airplane."

When they’re not doing a show, or fixing something, or cleaning, or polishing, the Thunderbirds spend their spare time visiting hospitals, attending dinners, or involved in other public relations work — or they spend it practicing the show routine.

"There’s a lot of marching involved," said Staff Sergeant (Tech Sergeant Selectee) Marty McGuire, the dedicated crew chief on the number seven aircraft during the 1985
show season. "You have to look a lot sharper when you're launching or recovering the aircraft. There's nothing else like it in the Air Force as far as the professionalism and general appearance. You are representing the Air Force as a whole. For a lot of people, the only time they've seen an Air Force airplane is when they've seen one of our airplanes. We're always being looked at, no matter where we are. We'll go to an airshow, and hours after the show's over with there's always people just standing there at the fence, looking at our airplanes and wanting to come over and talk to us. You never know who's gonna be watching you. They're just happy to watch the airplanes sitting on the parking ramp."

All this time and dedication, however, can take its toll. That's probably why a Thunderbird tour is restricted to two years, with an option for a third year. Family life can be rough.

"My wife understands the long hours I have to keep," Capt. Williamson said. "She's the housekeeper, babysitter, bookkeeper, cook, she does my laundry — she does it all. I do nothing around the house. For two-and-a-half years I've done nothing around the house and she's had to take all that. If something's wrong with the car, she has to take it in because I'm on the road. The wives have got to be as committed as their husbands are to the ideals of the Thunderbirds."

"My average day," said SSgt. Guevara, "is 13 hours. So when I put in eight hours ... a guy in a regular squadron would go home, but eight hours to me? That's like lunch time."

"I'm married and have four children," said TSgt Bost, an avionics/communications specialist. "When I get home (from a road show) the first thing I want to do is go home and see the wife and kids, you know, and eat a good meal and sit down and relax and watch some television. Well, when you come back in here and it's about 2:30 or 3 o'clock in the afternoon, you step out of the jet and the first thing they guy hands you is a fistfull of 349s and says, 'OK, here's what's broken.' And I call the wife up and say, 'Hey, babe, I'm home.' She says, 'Well, when you gonna get here,' and I say, 'I have no idea. They just handed me a bunch of work.' So, about three or four the next mornin' I get home ... and jump up and be back to work at 7 o'clock."

They do it because of pride, "To be part of the best," said SSgt Guevara.

"There's a lot of competitive people in the Air Force," said Maj. Pritchett, "and something about this job appeals to that competitiveness. If you're not a competitive type, you probably wouldn't even put your application in. So now you've got a group of competitors all lumped together, and they all want to be the best. When you get a group like that it's a dynamite team."

Maybe that's why the Thunderbirds have not had a show cancellation due to maintenance problems. Never. Not once in their 33-year history.

"That's the key right there," Maj. Pritchett said, "the personal drive or initiative that each individual has before he even applies for the team. Even after you're gone you still have a love for the team, for the people you knew, and even for the people that are still on the team because you know what they're going through. You never leave the team."

It's something you'll hear from any Thunderbird, if you take the time to ask — "Once a Thunderbird, always a Thunderbird."
LOOKING FOR TROUBLE

By BUDDY LOTT
F-16 Marketing

EDITOR'S NOTE: In the last issue of Code One, an article titled “Eyes of the Strike Force” outlined the tactical reconnaissance (tac recce) mission, and related the efforts being made to upgrade and improve tac recce capabilities. The article provided a background of current capabilities, and offered a glimpse at the future for those who fly “alone, unarmed, and unafraid.” The article centered on the recently completed F-16 reconnaissance simulation evaluation. This article details the concurrent F-16 recce demonstration flights that took place at Edwards AFB from June through September 1986 to determine the feasibility of a “near real time” (NRT) concept of rapidly providing recce information to commanders in the field.

The current tac recce capability, designed around the RF-4C, is slow, cumbersome, and unresponsive to the immediate needs of a commander who might have the Red Army standing on his front porch. The aging, unarmed RF-4C must overfly heavily defended targets, film them, then survive the egress, land back at home base, and have the film processed before any usable information can be extracted, evaluated, and delivered to field units. . . and by then the target has probably moved.

The USAF, General Dynamics, and several subcontractors set out in September 1984 to put NRT tac recce to the test. The idea was to validate a basic concept, which could then be incorporated into either existing RF-4Cs or a follow-on aircraft. By the time testing was completed, it was demonstrated that a fully armed F-16, with a recce pod mounted on the centerline station, could do the job — using advanced recording equipment (electro-optical sensors) capable of
Sometimes it's just plain "dumber than dirt" to fly over a target protected by a division of SAMs, just so you can take some pictures. Why not fly offset from the target and "look in" from a distance?

instantaneous transmission (real-time data link) of target imagery to either an orbiting relay plane or a ground station. The only limiting factor is that line-of-sight is necessary between the recce pod and the receiving facility. Additionally, a recce crewmember can record, scan, and edit this imagery in the cockpit (if necessary) prior to transmission. And even when the recorded imagery must be flown back to the home station, the time saved by eliminating the requirement for film processing is significant.

Because this was a concept validation and not a pre-production flight test, efforts were made to insure the demonstration closely paralleled actual operational conditions. An extensive target list, developed by Air Force intelligence personnel, included all 17 recce target categories and kept the imagery interpreters and flight test crewmembers busy during the actual missions.

In September of 1984, the USAF was interested in demonstrating both film and electro-optical sensors. But NRT requirements soon eliminated film from consideration, leaving EO sensors as the only game in town. EO sensors had been around for some time, but their use in the tactical environment had yet to be demonstrated. As a result, the demonstration team found itself defining and designing both the NRT recce concept and the equipment that would make that concept a reality. Under the leadership of Paul Henkel, a former recce wing commander with 30 years of recce experience, the task of demonstrating both concept and equipment was begun. The first step, completed in January 1986, involved six flights of a pod containing the film version of the EO sensors. The contractor-funded flight series validated the F-16 as a viable recce platform and also validated the pod as the container of the sensor suite. The next step was the NRT recce demonstration at Edwards AFB in July.

Mission profiles were flown using tactical scenarios to emphasize low-altitude (200-500 ft.) and high-speed (480-600 kts) flight. During these flights, sensor/recorder capabilities were observed, and aircrew members had an opportunity to instantaneously view imagery on the cockpit displays, with varying degrees of magnification.

This flight demonstration was conducted to verify the feasibility of NRT recce. Specific recce system hardware (the pod and its sensors) and platforms (the F-16) were secondary considerations for the USAF. However, the tests did confirm that the F-16, with a centerline mounted recce pod, is a leading candidate to replace the RF-4C.

There were concerns that "poddled" reconnaissance, especially pods using EO sensors, would not be suitable because of the vibration resulting from low-level, high-speed flight. Also, the pod might seriously reduce the F-16's range to the point where it was inferior to the very jet it was trying to replace. Finally, there were concerns that the F-16's maneuverability and performance — two things that make it such an outstanding multi-role fighter — would be adversely affected by adding a recce pod on the centerline station.
These were legitimate concerns, and what better way to address them than to put both systems — the F-16 and the pod — to the test at Edwards?

The demonstration consisted of two phases. The first phase was conducted at low-altitude, using two low-altitude sensors — an EO sensor and an infrared line scanner (IRLS). Additionally, both in-flight review and data link of recorded imagery was demonstrated during this phase. The second phase was conducted at medium-altitude, using a medium-altitude sensor and a self-contained environmental control system (ECS) within the pod. Over two-thirds of the demonstration flights were dedicated to low-level/high-speed profiles (phase one). But, to validate as many aspects of the NRT concept as possible, the need for a standoff tac recce capability was the thrust of the last 15 sorties (phase two).

Let’s talk first about phase one. Tac recce currently relies on low-altitude and high-speed ingress to (and egress from) the target. The idea is to get “down in the dirt at the speed of heat” in order to cover the target successfully and survive. The threat is out there. It is a target-rich environment, and if you’re going to beat the threat, the general consensus among aircrews is that you have to be low and fast. The demonstration flights during phase one were flown with low-altitude/high-speed doctrine in mind. It should be noted, however, that the test was not to demonstrate tac recce doctrine but to validate the NRT concept of target acquisition using real-time cockpit viewing, in-cockpit review of target imagery, and data link of selected imagery to a waiting ground station.

The typical demonstration flight consisted of three to five pre-planned targets and at least one additional target of opportunity. Each acquired target could be recalled for review, magnification, and editing prior to data link. When ready, the aircraft would climb (if necessary to insure line-of-sight with the ground station) and transmit the files. The aircraft would then continue with the mission, or return to base where the tape, with all recorded imagery, could be removed for more detailed interpretation.

A team of Air Force photo interpreters (PIs) evaluated the acquired imagery. They were extremely impressed, both with the imagery and with the NRT concept. All had recently been assigned to operational tac recce units, and all expressed tremendous appreciation for the potential demonstrated in the tests. Prior to phase one there was a concern that the loss of resolution inherent in switching from film to EO (video taped EO and IRLS) imagery would not be satisfactory to the PIs. To the contrary, however, they were very supportive of the switch, and felt the resolution loss would not seriously affect tactical exploitation.

Responsiveness — NRT recce’s big advantage — was graphically demonstrated on one particular sortie. The PI on duty rode out to the approach end of the runway to observe the takeoff. By the time he arrived back at the ground station, tactical targets for his interpretation were being linked down from the jet he had just watched depart. The time lapse was between ten and fifteen minutes... definitely a look to the future of tac recce.

Overall, the phase one demonstration goals (collection of EO and IR imagery, plus in-flight editing and data link) were met. The feasibility of NRT recce in a low-altitude, target-overflight mode was easily demonstrated, and comments from PIs, ground support personnel, Flight Test Center personnel, and aircrews were outstanding.

Then came phase two — and an entirely different approach to the tac recce mission. Sometimes it’s just plain "dumber than dirt" to fly over a target that’s protected by a division of SAMs. Why not fly offset from the target and "look in" from a distance? Such a "target standoff" capability was the goal in phase two — to be able to record imagery at an oblique angle, on a flight path some distance from the target, while retaining the capability of relatively low-level, high-speed flight. Phase two provided a very basic look at this concept in action, using a long focal length sensor in a side oblique position. The results were extremely valuable.

The long focal length sensor demonstrated during phase two could be positioned in flight (left oblique, right oblique, or vertical) from the cockpit. Overcoming the problems of vibration and high temperature on a pod-mounted sensor severely tested both the F-16 (as a viable, stable platform) and the pod (with its internal ECS). To some extent, both problems were addressed in the pod. The ECS maintained pod temperatures within acceptable ranges, and a degree of stabilization from vibration/turbulence was designed into the sensor. The imagery provided during medium-altitude (15,000-25,000 ft.) missions was outstanding, and afforded the PIs another excellent opportunity to evaluate EO as the sensor of the future for tac recce.

Missions were flown at low altitude with the EO sensors in the side oblique position. Only a small amount of sensor stabilization was used, and the resulting imagery was distorted due to turbulence. Although less evident, distortion was also a factor in the higher-altitude sorties. The demonstrations proved, however, that quality EO imagery CAN be recorded in any tactical flight regime, with proper stabilization. Anyone who has tried to use a large telephoto lens is aware of stabilization problems, yet technology is now available that provides the required stabilization for the recce pod’s long focal length sensor at up to a 50-degree oblique angle, despite the turbulence inherent in a low-altitude, high-speed flight regime. Incorporating this stabilization into the pod will be an easy process.

From a concept validation standpoint the demonstration results were excellent, considering the fact that the majority of the pod’s systems were quickly put together for this demonstration. This was the first tangible step toward the recce capability of the future.

Lessons learned have already been applied by the USAF in their efforts to demonstrate NRT capability on existing RF-4Cs. These lessons also aid the USAF’s posturing efforts for a tac recce follow-on, and additionally hold tremendous promise for all allies equipped with F-16s.

Improvements to the pod and its systems continue. The pod used in the Edwards demonstration has been downsized by one-third, and will soon be ready to accept other sensors and support systems for further demonstration and a chance at full-scale development.

As a possible tac recce platform, the F-16 proved equal to the challenge. And as the Fighting Falcon replaces “double ugly” as the USAF’s all-purpose fighter, it will have to accept these roles and do them well. The results at Edwards AFB support the feeling that the Fighting Falcon is more than capable of undertaking the role of “Eyes of the Strike Force.”

ABOUT THE AUTHOR: Buddy Lott is the marketing lead for the F-16 recce program at General Dynamics. He is a 1976 graduate of the USAF Academy and has over 1800 hours of flight time, with 600 hours in the RF-4C. He is currently assigned to the 301st Tactical Fighter Wing, an AFRES unit at Carswell AFB, Texas.

CODE ONE/9
In the last installment in this series, I mentioned how we should get serious about using the head-up display (HUD) in the most efficient manner. I'm certainly aware of current directives concerning use of the HUD, and it is not my intention to incite a mutiny or even a minor riot. As I write this, however, the F-16 has been flying 12 years, the F-15 is fourteen years old, and the A-7 is on the wrong side of 20! Three very fine aircraft, all equipped with very fine HUDs. Now, it's simply a fact that there's a lot of misinformation being passed around out there about just what the HUD is and is not, and how it can or can't be used. The time has come for someone to stand up and say "the emperor has no clothes." So let's us discuss some of the most oft-mentioned HUDisms and dispel the myths, where appropriate.

Rumor #1: The HUD Is Disorienting

False. What is disorienting is being "stuck out in the breeze" with today's modern bubble canopies — much more so than in earlier airplanes. As a result, the pilot is more exposed to erroneous stimuli than in the past. But the HUD has very little to do with it. This tendency toward increased disorientation is going to occur in the F-16, F-15, OV-10, and the A-10. And you'll see a small increase in disorientation incidents if and when the F-4 is retrofitted with its new "clear vision windscreen." The real truth is that you've not been properly trained to handle weather. All of us are unique in our response to the stimuli around us. For instance, I know of only two times that I've felt disoriented in weather while flying single ship... yet every time I'm flying wing at night I start to wonder, within seconds after entering weather, why lead is using 90 degrees of bank, or why we're climbing at 70 degrees... inverted! I know it's always going to happen, so I'm prepared for it. And it's far easier to keep myself oriented by glancing through the HUD than by having to look down between my toes to find the ADI (like I had to do back in the days of flying the Rhino). Learn your own response to various weather/night situations. Be prepared to cope with them when they occur.

Rumor #2: HUD Symbology Moves Around Too Much

False. Except for severe turbulence, the HUD doesn't twitch — unless you move the stick. Pay attention to the effect various control inputs have on the HUD. They never vary. Once again, it's easy when you know what to expect.

Rumor #3: HUD Symbology Moves Off the Side of the Combining Glass

Partially true. If you know what the airplane drift is doing it's no big deal. (More on that to follow.) At any rate, the drift cutout switch is on the face of every F-16 HUD I know of — so learn what the switch does, and when best to use it.

Rumor #4: HUD Symbology Needs Improvement

True. The Human Factors department (under the guidance of Manuel Tapia) is conducting research to define symbology changes that will improve HUD attitude awareness. After exposure to these candidates, I'm certain you'll agree that several of them promise a great deal of improvement. But the fact is that even the earliest versions of the F-16A/B HUD gave you a superior instrument that is easier to use than any head-down arrangement.

Rumor #5: The HUD Is Not a Control Instrument

This is the most false of all! Not only is it a great control instrument, it is a control and performance instrument at the same time! (Much more on that later).
S

o what really is this HUD we're talking about? What it is, is everything you had head down — except now it's all in one place. And better yet, you can still look at the real world while you're looking at instruments. The only thing missing is the TACAN information, so why not make the most of it? All TACAN latitudes and longitudes are listed in the IFR supplement. If you take the time to properly plan the flight (you always do, don't you?) then there's no reason not to have all the information you need all the time. If the HSI is too dim to see the DME accurately at night with your dim cockpit light settings, you can always back it up with the distance information off the INS in the lower right corner of the HUD. (With the relative bearing addition to the C/D HUD you can also determine what radial you're on.) The HUD's only real drawback is its field-of-view size. It is necessary to move your head slightly in order to see all the displayed information. But with a little practice it becomes second nature, and you get the information you need at the time. Seldom, if ever, do you need to see the whole field of view at any given time anyway. As long as you can see the velocity vector and any portion of the pitch ladder, you can control the airplane precisely. A larger field of view is nice, however, and you folks who'll be flying the C/D as they get into the field will be better off in this regard. The larger field of view is much nicer, and you can see all you need without any effort (other than moving your eyes). It's obvious that this HUD capability exists.

There are a few "different" pieces of information on the HUD that you're not accustomed to having available. Most obvious is the flight path marker and its interaction with the pitch ladder. First of all, just what the hell is a flight path marker? It's really very simple — the little symbol that looks like the backside of a fat little airplane with stubby wings and tail. It's there to tell you just where the F-16 is going (in other words, the "vector" of the aircraft's CG). It's calculated in the INS system, but is simply the pitch attitude of the airplane to which we've added AOA (algebraically) and drift left or right from the current wind (there is also some beta — yaw angle if you prefer — but that's usually minimal). With the drift cutout switch, you can remove wind effect, but you cannot remove AOA effect. The drift cutout switch will center the display in the HUD and keep it there... but just be careful. Remember which way it moved so you'll know on which side of the airplane the runway will appear if you're flying a "no kidding" approach to (or below) minimums.

A big word of caution here: If you have drift cutout selected and the FCC has failed (one or the other, by itself, has no effect) then the flight path marker will present bogus pitch information if you have any bank established (the greater the bank, the greater the error). So be careful! I've never seen it, but the possibility is definitely there. The C/D will give you a caution/avionics light and "FCC failed" on the PFL. The A/B will not! Both will no longer display the lower data blocks on the HUD, the AOA bracket with the gear, or TGT info with a radar lock-on. These are all good clues, so go back to drift normal or use the head down if the FCC fails!

And speaking of an approach to minimums — here is another area where the HUD really shines. Since you're already looking through the HUD to fly the approach, you're the first to know when you've broken out... as opposed to the ridiculous requirement to crosscheck head down, look outside, refocus, look back inside, refocus again, look back outside, etc., etc., ad nauseam. The flight path marker is really useful information. If it's superimposed on the horizon line, then you're flying at a constant altitude, regardless of airspeed. It has always bugged me to be on an approach and constantly having to reset the ADI as the airspeed continuously decreased from initiation until final. With the flight path marker I can put the symbol on the horizon line and know I'm maintaining a constant altitude — whether I'm going 600 knots or 130 knots. I've heard complaints that it's hard to control the airplane with the use of the flight path marker. I disagree. It's really very easy! Follow me through this. (You guys who've been flying an airplane with a LCOS gunsight have a leg up on the dirt beaters or the FAIPS in this category, but everybody should be able to understand the following explanation.)
Let's assume you're straight and level (i.e., you've managed to get the flight path marker superimposed on the horizon line) and you want to climb or dive a fixed amount. The control input is almost the same as if you were making an aiming change with a LCONS sight. If the piper is behind your intended victim, you've learned not to pull the sight directly to the target. Instead, you normally make a correction of about two-thirds the distance and allow the system to settle down. And if you've been practicing correctly, you're rewarded with the sight drifting up to the target. The reason you have to do this is because the increased g necessary to pull the sight to the target is interpreted by the sighting system as an increased target turn rate. As a result, the sight is depressed still further. Then, as you get the sight to the target and partially relax the g to continue tracking, the sight thinks the target has backed off. This means less lead. Thus, when the sight takes out some of the depression, the piper moves out in front. Damn! Hopefully your friendly squadron weapons officer explained what I just did, or you discovered this fact for yourself. The result is, we learn how the airplane reacts to the way we like to fly; then we establish our own set of rules to move the piper fore and aft on the target.

Controlling the flight path marker requires almost exactly the same technique. If I'm straight and level and I want to pull up to a ten-degree climb, I don't pull the nose up until the flight path marker is on the ten-degree line. Why? Easy. As I pull, I increase the AOA. Right? As a result, the flight path marker will be depressed from where I just started. When I get to the ten-degree line, I have to decrease the AOA to stop there, so the flight path marker continues to rise slightly. So I overshoot. Damn! Instead, I use my own fudge factor, based on how I fly the airplane. If I'm making a rapid correction, I'll pull to about six or seven degrees nose high and stop there. If I'm making a slow correction I might pull to eight or nine degrees and stop there. In either case, I end up with the flight path marker on the ten-degree-up line. Viola! This technique works in both directions. All you have to do is establish your own gains, and you can fly the devil out of the F-16 using the HUD. Once you do so, flying any instrument approach is incredibly easy. If you're using one of the rapidly disappearing GCs, all you have to know beforehand is what angle glide slope the controller will be using, and when he says "begin descent" you fly the F-16 to that descent angle (regardless of airspeed) and all you should hear is "on glide path." The same is true of any ILS. Look at the approach plate beforehand and it'll tell you what the glide slope angle is going to be. Fly the F-16 to that descent angle and the glide slope indicator shouldn't move. It's also a further crosscheck that the ILS director bug is working properly. Furthermore, if the flight path marker is 500 feet down the runway, then that is almost exactly where you're going to touch down (providing you don't make any gross control inputs, and allowing for a little float during the flare — if that's how you land the airplane).

With only a little practice you can also use the flight path marker as a bank indicator. The stubby little wings of the flight path marker always remain fixed in the same relationship to the stubby little wings of the F-16. Therefore, the angle between wings and pitch ladder is the bank angle of the airplane. Make sure you know — without thinking about it — whether you're looking at a positive line (climbing) or a negative line (descending) and the HUD makes for the world's best attitude indicator.

For you dichards who insist you can't possibly fly an airplane on instruments without a pitch reference, all is not lost. Simply turn on the standby reticule. You can now increase or decrease the mil setting so that your favorite part of the reticule is superimposed on the horizon line. How about that? Instant electronic attitude indicator! It might even be a good idea for everybody to start this way until you're comfortable with using the flight path marker.

One other very subtle difference in the HUD exists for those of you who've never had occasion to use one. Although a degree is always a degree, it appears that the angles displayed on the HUD are much larger than you're accustomed to on the normal ADI. If you think about the geometry involved (much longer sight radius with the HUD focused at infinity) it should be clear why this impression exists. The result is that your impression of necessary correction sizes (to fly the F-16 on instruments, using the HUD) are larger than the ones you're accustomed to using head-down. The first inclination is that you're making much larger corrections on the HUD. Just install this in core and, once more, the fact that it's easy to fly instruments on the HUD should be apparent. In other words, what appears to be a small correction on the ADI gives the impression of a much larger correction on the HUD. Just recognize this fact and there should be no reason for confusion.

I told you the HUD is focused at infinity. I lied. At least the engineers lied to me. The HUD is focused close to infinity but not quite. So during the flare make a conscious effort to look at the ground. The HUD symbology will still be clear enough to read but you will be better able to judge just when you are going to arrive on terra firma. Nicer landings should result.

I mentioned earlier that the HUD is both a control and a performance instrument. I meant exactly that! All I have to do is place the velocity vector on the horizon line with no bank angle and I know the aircraft is in level flight. I don't have to look at the vertical velocity because I already know it's zero. I'm so sure it's zero that I never bother to display it on the HUD. Since the vertical velocity is zero I know the altitude has not changed. If I have not made a power change since the last time I was stable I know the airspeed has not changed. The wings are level so the heading is not changing. Notice, please, that I've not yet had to look anywhere but the center of the HUD — hence my comment about field-of-view size having little direct bearing on the A/B HUD. You can never say the same about flying with a head-down pitch reference system — like you still have between your legs in the F-16 or any other airplane. This is not to say that I don't crosscheck other HUD information. I do exactly that if I want total situational awareness. But the important fact is that aircraft control with the HUD is infinitely easier and more precise than you can get head down. And you can get all this information with only one glance at one part of the HUD.

The main thing about the HUD is that it's different than what you've been using — unless you just came from the A-7 or the F-15. But it makes little difference whether you've been using the HUD or not. Sit down, stop what you're doing, and think about what the HUD will provide. Read the books, engage in some self-study, and the end result has to be better aircraft control. It works. It works well. And it's time to get rid of all these old wives' tales that aren't worth the paper they're printed on or the booze they're discussed over at the bar. The HUD is an excellent device for aircraft control and weapon delivery. There's absolutely no reason for guys to kill themselves simply because they haven't taken the time to get really familiar with a new system and what it can do for them!
FURTHERMORE...

By JOE SWEENEY
Experimental Test Pilot

Joe Sweeney has been a General Dynamics test pilot for two years. A Naval Academy graduate and former Navy pilot, Joe flew A-7Es operationally, and was a project pilot during the F/A-18’s full-scale development, and all phases of that aircraft’s operational test and evaluation. At General Dynamics, Joe is a project pilot for several programs. He is currently an F-14 pilot with Naval Reserve Squadron VF-201 at Naval Air Station Dallas.

The concept of using the HUD as a primary reference for instrument flight has been steadily gaining support during the last five to ten years. As yet, however, the idea is not what one might call “widely accepted.” My own operational experience has convinced me that, when compared to a capable HUD, the traditional, dedicated control and performance indicators actually require more work and talent to achieve equal performance. Additionally, in this age of information-intensive cockpits, we simply cannot afford to devote such a large quantity of forward-quarter instrument panel space to non-versatile equipment. But don’t get the idea that I’m about to advocate the HUD as a tradeoff to gain panel space for advanced sensors and controls. Not at all. I’m about to advocate the HUD as the primary instrument reference, based on its own merits in that role. Cockpit panel space just happens to be a welcome side benefit.

I’d like to offer the following opinions for you to consider.

Not All Huds Are Created Equal

We talk of using the HUD to perform certain tasks, provide information, and to make life simpler. Joe Bill and I refer primarily to the F-16 HUD. However, I will comment on Huds in general because it’s important to note that specifications and standards have not been rigorously applied, so what you have are HUD capabilities and characteristics that vary greatly between aircraft types. Originally, the HUD was not envisioned to fulfill a requirement for instrument flight indication. The classic control, performance, and navigation instruments essentially satisfied those needs. The HUD was designed as an air-to-air and/or air-to-ground weapon delivery reference. As such, symbology, layout, fields of view, and information sources varied greatly. But it soon became apparent that the flight path marker or velocity vector information, if accurately displayed, provided both control and performance indication without a requirement to interpret and integrate separate indications. As a result, pilots flying airplanes with more capable Huds (the A-7D or A-7E for instance) soon included the flight path maker in their instrument scan. Many pilots progressed further to making the flight path marker/pitch ladder combination the hub of their scan (instead of the ADI) and now included the ADI as just another instrument in the scan. This transition was crucial, since it effected the pilot’s control strategy. No longer did he have to control one or two indications and then interpret five or six others in estimating the airplane’s performance state. Now he could use the same indication to control the main performance parameter—the flight path.

Since Huds have not been integrated into the aircraft to provide an instrument flight reference, each HUD has to be independently assessed to determine whether (or to what extent) it can be used for instrument flying. The F-16, particularly the C/D model, has the necessary HUD capabilities for safe and precise instrument flight. The HUD is reliable, provides failure indications, contains accurate and usable symbology, and (in the C/D) has a good field of view. And the so-called “primary flight instruments,” provide both an adequate cross check (should you feel the need) and system redundancy in case a failure occurs in the HUD, in its display generator, or in an information source (i.e., the CADC).

So when anyone addresses the topic of “the HUD” or “using Huds,” they must qualify the specific capability to which they are referring. Some level of standardization is required in Huds, but in the meantime, individual Huds can be independently assessed as to their instrument flight reference capability.

A HUD Can Be Extremely Reliable and Can Indicate Failures

This appears to be a comment encompassing two separate issues, but in fact they are intertwined. Both capabilities have been criticized as lacking in Huds. Here you have two of the primary arguments against using existing Huds or designing future Huds as the primary instrument flight reference. Well, sure, given the premise that not all Huds have been designed to perform instrument flying tasks, I’ll certainly agree that reliability, redundancy, and adequate failure indications are not always inherent in specific HUD designs. However, a few points need emphasizing.

Let’s talk in generalities first. Neither reliability level nor lack of failure indications should ever be used to dismiss designing a HUD as the primary instrument flight reference. Reliability and failure indications, given today’s technology, can be specified and designed into the equipment. Furthermore, independent instruments solely for cross-checking HUD accuracy would no longer be required. That level of redundancy belongs in the HUD and in its information sources. Cockpit design is leaning more and more toward multifunction displays (MFDs), capable of providing the same HUD display in an alternate, head-down manner when necessary or desired. As with today’s and tomorrow’s flight control system requirements, all HUD information required for instrument flight can be provided by redundant sensors and data paths. These integrated inertial sensor assemblies and redundant air data systems would make the HUD as reliable as the flight control system.

How does the capability for failure indication relate to HUD reliability and accuracy? Contemporary airplanes are being designed with continuous system failure monitoring during all phases of ground and flight operations. We simply need to decide what failure indications are necessary, allow system
redundancy to automatically compensate for failures, and reconfigure the system accordingly. Indications to the pilot need not be manifested in the HUD but simply in a fault list or status display. If redundancy is present and the system is capable of a full-up display during failure states, why should the display change? I don’t know about you, but I never cared for partial panel instrument flying. If the failure is in the HUD, rather than in the information source, then an MFD capable of displaying the HUD format provides the pilot with a simple, consistent transition. Now the only time you’re without your HUD display somewhere in the cockpit is if you’ve been degraded to battery only — and that requirement will probably be a separate design issue based on statistical probabilities. So the idea is to make system reliability requirements drive failure indication requirements. Let’s specify and design reliable, accurate HUD information displays based on redundancies in the information sources (which is already available to some extent in electric flight control systems). And let’s provide an ability to alternately display the desired information on a separate MFD.

Those were the generalities. Now, what about the specific airplane we’re flying? Well, we’ve got a different kind of redundancy — the HUD and the head-down instruments. We also have plenty of failure indications through the continuous fault monitoring system and PFL/MFL displays. When the information sources fail, that information is deleted from the HUD. In the case of flight path errors, I have no trouble deciphering the absence of the flight path marker as an adequate failure indication since it’s the focal point of my scan. And I much prefer this deletion to an erroneous information display. Nothing used to disorient me more than when an instructor would fail my ADI under the bag or in the simulator and the instrument would sit there frozen. It’s extremely difficult to drop it from your scan. If the CADC fails, you simply have no airspeed or altitude. It’s impossible not to notice it — and I realize that impossible is a dangerous word to use. Any subtle degradation in HUD attitude information is also going to affect your ADI — the information comes from the same source. Summing up — the F-16 provides you with sufficient reliability, redundancy, and failure monitoring to use the HUD in any weather with the confidence that you know and understand the state of your airplane and the status of its equipment.

**Meaningful HUD Training Is Necessary To Gain Your Acceptance of the HUD’s Strengths**

In the F-16, when I talk of using the HUD as an instrument flight reference, I don’t mean to say that it's already optimized for that role. That will come as HUDs further evolve from studies, research, and (most importantly) increased operational use. Is it going to happen? Sure it is, because advanced cockpits and increased pilot awareness of HUD capabilities will demand it. I’m simply trying to convince you — regardless of whether you’re flying your first operational airplane or have logged 5000 hours — that meaningful HUD training in the F-16 (especially the C/D) will make instrument flying easier, will make you a more consistent and precise instrument pilot, and will ease future transitions into different aircraft. But you won’t notice the immediate effects by sampling the HUD on only a few sorties, nor will it impress you if 400/1 in rain is your initiation. Training is the key! I think Joe Bill and I may differ a little here in that I didn’t immediately get comfortable with the HUD. But the logic was inescapable — it had to be easier. So, over an 18-month period, I very methodically weaned myself off the ADI, altimeter, airspeed indicator, and VVI in the A-7E. Now I find myself in an interesting situation: in the F-16, I’ve never used any of the head-down instruments (besides the HSI for TACAN) except in a backup situation. Flying F-4s in the Navy Reserve, I have no HUD, so it’s back to head-down attitude instrument flying. From that dual perspective I’m in complete agreement with Joe Bill on the subject of disorientation and weather-induced accidents. I’m convinced that the reason for accidents in IMC conditions is IMC, and the lack of pilot proficiency in IMC. It’s not easy to fly in bad weather. Furthermore, it’s downright difficult to continually scan six to eight different instruments, located who-knows-where in relation to one another, fight the false physical sensations, and still have to interpret and integrate the information to get an estimate of what you really want to know... which is where you and your airplane are going.

Now let’s take the HUD. Defining it as a “primary flight instrument” can be stated as “sole use of the HUD for any control, performance, or navigation information required for instrument flight.” That may be a handful at first, but in the F-16 there’s no reason to approach it like that. The fundamental transition that must be made is in relocating the focal point of the instrument scan — from the old, head-down ADI to the HUD’s flight path.
marker and pitch ladder. Your instrument scan during workup periods can then encompass whatever you need, either on the HUD or head down, until you’re comfortable with the basics of the flight path marker. You must use it every chance you get in IMC conditions, but make it a continual buildup process. Practice self-controlled approaches in actual IMC during medium altitude penetrations. The two-seater can be used for IMC and night unusual attitude recoveries with the rear seater backing you up. Training in controllable situations at every opportunity will soon have you referencing the flight path marker as the focal point for control and performance data. From there, it’s a simple matter of getting comfortable with the HUD as the source for altitude, airspeed, and heading information. Additionally, you’re provided with raw ILS needles and a flight director that makes the whole approach simple. You don’t need a VVI, and I guess bank angle is a debatable topic. I’m perfectly comfortable with the flight path marker for that. I may not be able to nail 45 degrees angle of bank, but I can give you 45 plus or minus five every time — and I don’t have to open up my scan to do it. It also takes some pre-IMC penetration thinking to remind yourself that even though you’re looking up (and hence out) there’s still no reason to be less than a hundred percent on instruments (i.e., the HUD symbology) except for quick looks for VMC. You really can concentrate fully on HUD symbology in IMC.

In the F-16C we do not have the capability to put the HUD head down on an MFD. That’s regrettable, since it’s sometimes a quick cure for when you’re fighting vertigo and just want to bury your head somewhere. Sure, you can use the attitude instruments, but that flight path marker is too valuable. Additionally, as you get comfortable with the entire HUD display, a headdown replica makes for no difference in control strategy.

Not everything will be intuitive at first, but think back to your initial training with head-down instruments. They’re intuitive now because they’re familiar. I’ll agree that the F-16 HUD could certainly benefit from some symbology optimization. I’ve seen better ideas for certain aspects of HUD symbology in different HUDs. But with training and repetition, a rapid interpretation of your airplane’s state will soon become much more complete and meaningful — and that will make you a safer instrument pilot.

**The HUD Is Being Successfully Used As the Primary Instrument Reference in Contemporary Fighters**

The contention that the HUD is not a suitable instrument flight reference loses credibility when you learn that it is, in fact, being so used. The Navy chose to design its F/A-18 cockpit such that the HUD fulfilled the instrument flight reference requirement. The airplane is still equipped with a very small, pneumatically driven set of performance instruments (altimeter, airspeed, and vertical velocity) and a small, self-contained standby ADI, but these instruments are poorly located for primary use, and are included solely as a backup system. The HUD is it. Additionally, the HUD display can be selected on an MFD if desired. The transitioning pilots are a cross section of the Navy’s entire aviation experience base — from low-hour, first-tour aviators to seasoned fliers with over 5000 hours and 1000 carrier landings. Except for those with prior A-7E experience, all are new to using the HUD for instrument flight. There is no situation more disorienting than over open water on a very black night. Yet, the initial two carrier air wing deployments of the F/A-18 (six squadrons of airplanes) proved that not only could the HUD be successfully used, but that performance could improve as well. Day and night carrier boarding rates (the ratio of successful arrests to total approaches) actually exceeded overall fleet averages, including those of airplanes (F-4, A-7) that were replaced by the F/A-18. Admittedly, that result is attributable to various aspects of the airplane’s design, but the HUD is certainly a contributor. There is very little difference between the HUD in the F/A-18 and that in the F-16C/D. The F/A-18 includes a bank angle pointer, some TACAN CDI information, a slightly different attitude indication, and proportionally canted pitch bars for unusual attitude determination. I believe that most of those pilots, after training to use the HUD and acquiring the operational experience to go with it, would choose it over traditional attitude instrument flying.

**There’s An Analogy With the Sidestick Controller Here Somewhere**

It’s not an exact analogy by any means, but acceptance of the HUD for instrument flight can be compared to acceptance of a relatively fixed sidestick for control of the airplane. Both are departures from traditional, warm-feeling systems that worked. Both require some time, thought, and training to use proficiently. Both still have many detractors who are simply unwilling to change. Yet the majority of pilots who have flown both types of instruments and both types of controllers prefer the HUD and the sidestick to the more traditional equipment. Finally, both the HUD and sidestick give cockpit designers the flexibility and freedom required for advanced cockpit and systems integration. Proven, simple designs should not be changed simply because a seductive new technology has appeared. But the HUD and sidestick are technological advances that truly provide more capability for the pilot.

**The F-16C/D Is A Great Training Vehicle for HUD Instrument Flying**

Now I know this article is not going to make anyone immediately change their philosophy about using the HUD. I saw the same mindset in the Navy at the beginning of the F/A-18 program that I read about in HUD surveys among Air Force pilots. Primary support for using the HUD came from HUD users — former A-7 drivers. Most others were either misled due to lack of HUD exposure, or were not convinced that there’s any reason to give up using a technique that works. Keep in mind, though, that all of us were initially instrument trained the same way. I’m not advocating that you abandon your present technique. I’m simply expressing an opinion: if you take advantage of the F-16’s very capable HUD and its complete set of traditional instruments, methodically and patiently transition the focal point of your scan to the flight path marker/pitch ladder, and let nature take its course . . . then you won’t be able to stop yourself from converting. Now, I’m not going to be surprised if I get hate mail within a few months stating, “I tried all this HUD stuff and it doesn’t do anything for me.” I can’t help recalling, however, that I started studying the German language in the ninth grade, yet it didn’t make pictures in my mind until the tenth grade. Training is the key. It should start in UPT with a HUD-equipped trainer. If not there, then with your first flight in the F-16.
EDITOR'S NOTE: David Lee "Tex" Hill was a U.S. Navy pilot in 1941 when he was recruited to serve in the American Volunteer Group. Formed with President Roosevelt's blessing prior to America's entry into the Second World War, Claire Chennault's AVG supported Chinese leader Chiang Kai Shek's efforts against the Japanese. Hill was credited with 12 and-a-quarter victories while flying with the AVG—or "Flying Tigers" as they were popularly known.

This article by Bob Cunningham, the fourth in our series of interviews with some of the world's top aces, was conducted in 1980 at Tex Hill's home in San Antonio, Texas.

the Interview...

HILL: If you're interested in a little background on the AVG [American Volunteer Group], its formation and so forth, we were all, as I say, contrary to popular belief, we were not barnstormers or cotton dusters. We were military pilots who were recruited out of the Army, Navy, and Marine Corps for a purpose, and that was to act as an air force for the Chinese. They needed experience fast, so they set up a company called Chinese Aircraft Manufacturing Company (CAMCO), with W.D. Pauley as the sole owner. He was the guy that recruited and hired us. General Chennault was also paid by Pauley. The money CAMCO got to do this came from the Chinese government. Of course, that money was loaned to the Chinese government by us, but that's the way the mechanics of the thing worked. We were able to buy a hundred airplanes and pay the salaries and the bonuses for the airplanes shot down. And we did this for 13 million dollars. The airplanes, Curtiss P-40s, were the big item. They cost us $75,000 apiece. Well, that was seven and a half million dollars there, and the rest of the money was for
administration and salaries and so forth. That was pretty good bang for the buck in those days.

CUNNINGHAM: The Chinese and the Japanese had been fighting some time when you got there. In other words, you were meeting experienced Japanese pilots.

HILL: They got fat down there on the Chinese, you know, starting in 1937. And they just about wiped the Chinese air force out. It was just an air force in name only when we came over there. In the early days we saw quite a few Bettys, which were kinda like the old Martin B-26 twin-engine bombers. And then they had these dive bombers that would come in too, that were twin-seaters. But they never would break formation. These guys, I’m telling ya, they’d come in a big V and they’d stay there till the last one was gone. They’d never break a formation and we were able to eat ’em up. There again, that’s where firepower paid off, because the rear gun on these bombers was just a single 30 caliber.
CUNNINGHAM: This tenacity to holding formation really worked to your advantage, didn't it?

HILL: Oh, yeah. I tell ya, our first ace down there was a guy by the name of Duke Hedman, and in his first encounter he became an ace. He drove up behind the bomber formation and he shot down five of 'em. When he got back, the canopy, windscreen — everything was gone. The airplane was totaled. The War Department had sent some people over there to find out what kind of tactics we were using, and Duke said, "Well, what you do is just drive up behind them about 50 feet and hold it on one till he drops, then move over to the next one." And that's just about exactly the way it happened.

We had a squadron that came out of Singapore when Singapore fell. They moved a squadron of Brewster "Buffalos" in there. These guys were veterans. A lot of 'em had been through the Battle of Britain.

CUNNINGHAM: British pilots?

HILL: Yes, yes — but most of 'em were Aussies. They had been over in the Battle of Britain, and they... it was sad for 'em, I'll tell ya. They shot down every one of 'em... the Japanese shot down every Buffalo. There were only three pilots who survived out of that squadron, and the only reason they did was because they didn't have anything to fly. But there's where you have a situation where you've got an airplane that has nothin' going for it. It couldn't turn inside of 'em, it couldn't get away, and they [the Japanese] had the firepower, that's all. But with the other two elements gone, they had no chance. The British wanted to give us Hawker "Hurricanes" as replacements for the P-40. We flew 'em, but there again is an airplane that just wouldn't work in that environment. It had nothing going for it except the firepower.

CUNNINGHAM: You mean you would actually prefer the P-40 over the Hurricane?

HILL: Oh, definitely. I mean, we wouldn't even fly 'em. The guys, the squadron that they brought in there, only one of 'em that I know of survived. They shot 'em all down. With those two elements gone, maneuverability and speed, you'd had it.

CUNNINGHAM: The P-40 you flew in China. You mentioned a while ago the man that came home with it all shot up and the windscreen gone. Was it a fairly survivable aircraft?

HILL: Oh, that was one of the characteristics. It was very, very rugged and it would just take a lot of punishment. The engine, because of the coolant deal, was one area that was very vulnerable, but actually this was more to ground fire. These guys [the Japanese] learned very early in the war not to make a head-on pass. Matter of fact, the first mission that I went on, the first one I shot down was from — I shot him down from behind; but the second one in that mission was a head-on deal.

But you're all tensed up like any other thing you're apprehensive about — the first blood. We were goin' over to strafe a field in Thailand, a little place called Tac, and we went over at about 10,000 feet. We hadn't expected to find any people alerted over there, so we were busy lookin' at the airfield. And the first thing I noticed, when we started down to strafe, was that there were more than three of us in the pattern. This guy was on Jim Howard's tail, just really eatin' him up. And so I pulled right in behind him. I didn't even look. We had a ring and head gunsight on the airplane, not like the others where we eventually had an optical sight. We had this ring and head sight, but I didn't even look through that. I was just looking through the windscreen there at the tracers and just kinda hosing him down, just kept pullin' the nose right around on him till he just blew up. And in the meantime, this other guy came in. He made an overhead pass — like this — and he came right on down and shot 33 holes in my plane. Fortunately, none of 'em got in the cockpit or the engine.

CUNNINGHAM: Was that the worst you ever got shot up?

HILL: Yep. That was the worst. I got smart after that one and paid a little more attention to what was around me.

CUNNINGHAM: You had one combat where I believe you shot down an aircraft right over your own airfield didn't you?

HILL: Yeah. That was a big day. Many things happened that day. But, ah, actually the Japanese came in and bombad that night, and real heavy. That was the tactics they'd use; they'd come in and bomb at night and then they would send a big, strong fighter sweep the next morning, hoping they'd catch us on the ground.

I sent two pilots up — Johnny Alison and Ajax Baumler [Baumler was an ace from the Spanish Civil War] — and I was
They said, "There's another wave of bombers comin' in." I was just in a little sarong that I slept in, and I ran and jumped in this P-40 and got off. I went roaring up north, thinking they came out of Hangkow, but they apparently had come out of another field, so I turned around and headed back, gettin' ready to land. They'd put three lanterns out on the field and had a jeep parked at the end. And so I was comin' in on final when a stick of bombs went right across the runway. I doggone near spun in. This formation had come out of the south, and we didn't have any warning on it. The runway was so damaged I couldn't get in, so I throttled back to conserve fuel and wait till daylight to see if I could find someplace to put it down. Just at daylight, I was able to maneuver between the craters and get it down. Well, no sooner had we refueled there, then here comes a strong fighter sweep. That was the combat that a lotta guys saw. It was kinda spectacular because we had this head-on pass. I had this guy make a head-on pass with me — right over the field. It was pretty low altitude, and I thought he was gonna ram me. I went down and fired just a split second, and he burst into flames and went in. He put it right down on the end of the runway.

CUNNINGHAM: That was a well-confirmed victory, wasn't it?

HILL: Yeah, that was well-confirmed. But it was kinda hairy, because I didn't know where the guy was gonna maneuver up and I just instinctively... I was flarin' all the way comin' in with those six 50s on that P-40. I'll tell you, if those guys made a head-on pass at you, and they've had it.

CUNNINGHAM: You were serving under Claire Chennault there. Could you tell something about Chennault and his personality?

HILL: Well, Chennault was one of the greatest people I've ever known in my life. He was a man! If you read anything he's written, you'll find that he doesn't waste any words. But even with his tough exterior, he was a very gentle man, very considerate, very loyal to the people he worked for. He couldn't stand incompetence. A lot of these people who were above him, they didn't like him because he was smarter than they were. Matter of fact, one of the anecdotes I always think of about Chennault... He told me one day, he said, "Tex, you know if you want to teach a dog tricks, first you gotta be smarter than the dog." I always thought that was pretty basic philosophy.

Another thing that happened, we were visiting Quay Lin and we were gettin' ready to move a squadron in there, and I flew down there with him. They had an alert, and these Japs came in and we were back on this hillside where they had some anti-aircraft batteries. The Chinese had these... I believe they were Czechoslovakian guns. Anyway, they were beautiful guns, but they didn't fire a round at the Japanese planes. These guys were doin' acrobatics around the field, you know, and having a field day, and so when they left, the old man asked these guys, he asked the battery commander, "Why didn't you shoot at those guys?" And he said, "Oh, if we'd done that they'd come back and really beat this place up." So he said, "Don't you know if you'd shot that guy down, he couldn't come back?" That's the kind of thinkin' he had. He was also a tactical genius. He was the first one to start the two-ship element.

He trained us. He had these tactical lectures when we first arrived there, and he told us how to use this airplane, and not to engage in a dogfight with them. When they got on your tail, we'd push it over and roll straight down, because there was no airplane in the world that could stay up with a P-40. The P-40 had something like 13 g's you could pull on the wings, you know, and there's no airplane could stay with it.

We only lost four pilots in aerial combat, and we shot down 297 airplanes that we got paid for. We got another 250, some that were unconfirmed that we claimed, but were not...

CUNNINGHAM: Quite a record!

HILL: Yep. Well, I know that around Rangoon we found somethin' like 50 somethin' airplanes on the ground, you know, that nobody's claimed. But those comats... maybe we'd have six or seven combat in one mission, and if you didn't see the guys just blow up in front of you, then you didn't know whether you got him or not — because you make a pass, and then you're on to another airplane.

EDITOR'S NOTE: The AVG was disbanded on 4 July 1942, and on that same day Hill joined the U.S. Army Air Force. He served with distinction with the 14th Air Force and added another six combat victories to his score by war's end. Upon returning to the states in 1944, he commanded the 412th Fighter Group — the first American unit to be equipped with jets. He separated from the service in 1945 and joined the Air National Guard, serving as Commanding General of the 58th Fighter Wing. He retired in 1968.
Down and Locked... Maybe

By NEAL E. SOCHA
Design Safety Engineer

Since the invention of retractable landing gear, a lot of pilots have landed “gear up” — and many more will undoubtedly crown themselves with this dubious distinction in the years to come. For some time now, retractable-gear aircraft have had warning systems that remind the pilot to lower his gear, yet pilot-induced gear up landings still occur. In the F-16, unfortunately, pilot-induced gear up mishap rates are poor when compared to other fighters.

The F-16’s gear warning system works pretty much like any other fighter’s — it functions when (1) indicated airspeed is less than 170 knots, plus or minus 11, (2) the pressure altitude is below 10,000 feet, plus or minus 276, and (3) the descent rate is greater than 250 feet per minute, plus or minus 150. The landing gear warning horn will sound and the takeoff/landing configuration warning light will illuminate if the wheels aren’t down and locked when all three conditions exist simultaneously. The 170-knot speed was chosen because it is low enough to reduce the incidence of “nuisance” warnings. The central air data computer (CADC) may direct the horn to sound when airspeed gets as low as 159 or as high as 181 knots (the system’s speed tolerances).

Aside from the warning horn and caution light, another cockpit indication of gear condition is available. If everything (including the pilot) is functioning normally, the HUD angle-of-attack (AOA) bracket will light up whenever the pilot selects gear down and the nose landing gear unlock switch disengages. The gear may be hung up, or down but not locked. It doesn’t matter. As long as the nose gear unlock switch disengages, the AOA bracket should appear in the HUD. The system was intentionally designed this way so that the pilot may continue an approach — armed with vital AOA information — despite gear malfunctions. Even if the gear is stuck, the plane’s gotta land sooner or later anyway, so the approach might as well be a safe one from an AOA standpoint.

So, as long as the AOA bracket is displayed in the HUD, you at least know that you’ve selected gear down and the nose gear unlock switch has released. Right?

Welllllll, maybe not. The AOA bracket will also light up whenever ILS is selected — regardless of gear unlock switches or anything else. Please note this. It means that, with the F-16’s current software configuration, an AOA bracket appearing in the HUD is not a reliable indication of gear condition. A change is in work that will eliminate the ILS-driven bracket display. When this change is applied to
your aircraft, you may be sure that a displayed AOA bracket means the nose gear uplock switch has disengaged and your F-16 is not likely to be confused with a bobsled. (Another pending change will alter the dash one to include airspeed, pressure altitude, and descent rate tolerances of the landing gear warning system.)

As always, however, the most reliable indication of gear condition is airspeed. For a given weight and AOA, the aircraft will fly as much as 30 knots faster with the gear up than with the gear down. For instance, when you fly a 28,000-pound aircraft at an AOA of 11 degrees — and your gear is up — then your approach airspeed is going to be greater than the 181 knot maximum gear-warning speed. ... and you can fly all the way to the concrete without a horn. If you cross-reference your indicated airspeed with desired airspeed, you can quickly tell if something is wrong. The habit of airspeed cross check should have started in undergraduate pilot training (UPT). It's a good habit to have. The cross check works at all speeds and configurations (the drag from external stores has little effect on the landing speeds given in the dash one).

Remember — the habit of cross checking speed on approach is important in the F-16. It becomes critical as the aircraft's flying weight increases. And the habit of always cross checking airspeed can save more than just embarrassment — it can also save a valuable combat aircraft, possibly a career, and maybe even a life.
Faking It

By DOROTHY M. BALDWIN
Senior Engineering Specialist

THE SETTING: A two-ship in West Germany’s Fulda Gap region. Present day.

OK, time to get serious about this. We’re now vulnerable to get hit at any time. No contacts on the tube. RHAW (radar homing and warning) is clean. Two’s in good position.

Looking . . . nothing . . . nothing.
Wing flash to let two know we’re going 90 right.
Still nothing . . . wait! Subtle reaction on the RHAW but nothing steady. Think it was about seven o’clock.

“Two, let’s slice back left.”

Careful. Stay on the preplanned g and keep the energy up. OK, two’s six is clear and I don’t see anything on the inside of the turn where they might . . .

“Lead, someone’s locked onto me — left, nine o’clock!”

There be is! My left, 10:30 low, about two miles — looks like a Flogger.

“Two, keep the turn coming. You got a Flogger at your left, nine o’clock low, closing.”

Missile override. Slewable ACM nearly full left. Come on now . . . come onnnnnmm . . . there! Locked! Angle almost right . . . pickle! Take that, you DRPCB. Sierra Hotel! The missile is tracking.

“Your six is clear, lead.”

Nice work two . . . impact! Good on ya, Ford Aerospace. A direct hit, just forward of the intake on the right side. Only thing exiting the fireball is big pieces.

“You’re still clear, lead.”

Where’s the other one? He should be close. there! Two o’clock low. Trying to run. Come on airplane, accelerate! Unload just the right amount . . . there . . . through the Mach. Still no closure, but those Floggers are fast. Boresight . . . aba! Locked . . . great! The stupid *%\&* the rhaw reaction. Good angle now and closing. Inside the turn . . . now! Second missile away. Looks good . . . looks good . . . ham! Prox fuse works and he’s hit. Trail a lot of fuel vapor from the fuselage, but still flying. Watch the overtake now; he’s slowing fast. Switch to guns . . . careful . . . careful . . . shoot! A flurry of hits on the canopy and fuselage. He’s burning and exits, stage right.

“Lead, two is joker.”

“OK, two, let’s bug out.”

“I’m your right five o’clock, a mile.”

Good. A slight check-turn right so two can close. He’s back in, and . . .

“OK, console, freeze it.”

The lights come up as the pilot steps out onto the platform and starts toward the briefing room to talk it over with “two” and the console operator.
The latest developments in simulation technology allow fighter aircraft system designs to be evaluated in the arena where it counts most — AERIAL COMBAT!

The mission almost seemed real, but it was just another evaluation in General Dynamics Fort Worth Division's new dual-dome air combat simulator — a remarkable achievement in simulation technology that allows pilots to "fly" unrestricted air combat profiles, complete with realistic threats.

Although simulation has long been a vital part of the aircraft design process, the technology required for realistic, "pilot in the loop" evaluations — involving actual tactical missions — is still evolving. A two-part series on engineering flight simulators and how they are used was presented in the first two issues of Code One. This article describes the Flight Simulation Laboratory's recently completed dual-dome air combat simulator (ACS) and how it is used to evaluate new airframe or equipment designs in the toughest environment they'll ever have to face — aerial combat. The advantage, of course, is in obtaining "flight" evaluations prior to the start of detailed design or production commitments. These simulations are complete with fully operable avionic controls, displays, and very realistic mission scenarios.

The dual dome ACS features two independent pilot stations, capable of simulating single-ship profiles, two-ship formations, or an adversary air combat mode. The principal ACS components are two 40-foot diameter domes with associated optics, image generation and graphics equipment, pilot stations (one located in the center of each dome), two operator control stations, a computer complex, an equipment monitor station, and facility support equipment (such as power distribution and air conditioning).

Simulation of any realistic, out-of-cockpit visual scene has always been one of the more difficult problems for simulation technology. Simulating the full air combat maneuvering range, however, provides an even more difficult challenge. It requires an unrestricted field of view on an out-of-cockpit visual display, containing target images with a resolution matching that of the human eye. Covering an entire hemisphere with such high-resolution background imagery is not practicable from a cost standpoint, not to mention the engineering problems involved. The solution was to restrict the high-resolution display to an "area of interest" (the aerial target) which is then dynamically projected onto the
inside of the spherical dome. Resolution is such that the targets can be identified at the same range as the pilot would expect in actual flight. The lower-resolution sky/earth (background) scene expands, contracts, spins, tilts, pivots, and "translates" (rushes by) to provide a realistic, three-dimensional simulation of every conceivable aircraft motion and attitude.

Each dome's projection capability covers a full, 360-degree background scene, plus the ability to project two very high-resolution targets anywhere within that scene. The targets are controlled either by (1) the pilot in the other dome, (2) a pilot utilizing the controls at the operator control station, or (3) adaptive, maneuvering-logic software programs in the host computer. The background scene projectors are mounted outside the dome and project through openings in the dome surface, unseen by the pilot. The target projectors are located inside the dome, below the pilot's line of sight. After the pilot enters the cockpit the platform safety rails fold into a position below his line of sight to eliminate visibility restrictions. The target projectors are driven by a computer image generator. Multiple targets can be selected for display. And — by providing two high-resolution targets — the system can simulate one-on-one, two-on-one, or one-on-two air combat scenarios. Additional "cues" in the visual scene include indications of opposing aircraft firing guns and launching missiles; indications of missile trajectory (smoke trail); explosions caused when the pilot's bullets/missiles hit the target; opposing aircraft going to or coming out of afterburner, or changing speed brake position; and SAM launch and trajectory indications.

Two Operator Control Stations (OCSs) constitute the heart of the ACS. Each OCS operates a single dome. A stick and throttle enables the OCS operator to maneuver a target aircraft, which is projected in the dome. Capability is provided for displaying and recording a wide range of information, such as aircraft armament, weapon status, scoring, environmental effects, etc. To operate in an integrated mode, the two OCS/dome pairs are linked together. The system is driven by a complex of six super-mini digital computers, supplemented by two high-speed array processors.

The ACS-generated tactical environment consists of detailed simulations of reactive air targets (with weapon capabilities), communication/radio-navigation stations, surface-to-air missile sites, and other surface targets and threats. The software system can generate multiple air-to-air or air-to-ground targets, complete with accurate radar and IR cross-sections. Air targets can be accurately represented on cockpit radar displays, with characteristics unique to the particular radar being simulated. Target detectablility ranges are based on computer-directed environmental conditions, and can be preprogrammed, manually controlled, or both. All aircraft targets can launch missiles and fire guns. Armament includes multiple missile, gun, bomb, and rocket types — complete with scoring. The particular aerodynamic and lethality characteristics of each gun or missile are faithfully simulated. The aircraft and weapons are physically referenced to each other to provide visual simulation of targets and weapon deployment. SAM sites launch missiles with characteristic flight parameters. G-cuing effects include g-suit control and dimming of the visual scene.

Simulators with this kind of capability are proving to be invaluable to designers of new aircraft/systems/subsystems. Many conflicts between trends in modern fighter airplane development and sensor development can be resolved without having to modify a flying prototype. Critical pilot/vehicle interface information is provided to designers prior to full-blown development. As systems and subsystems are perfected, the "real thing" can be plugged into the simulation until a workable cockpit is ready for flight test.

The real payoff is in knowing — long before a new airplane begins its first takeoff roll — that the new system will work. And that means tremendous savings in the high-dollar aerospace industry.

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ACKNOWLEDGEMENT: The author expresses thanks to Joe Bill Dryden for creating the graphic, "pilot's view" introduction, and to Jack Drewett, Simulation Laboratory Manager, for reviewing this article.

EDITOR'S NOTE: This report was compiled from official USAF news releases, along with information provided by the General Dynamics office in Dayton, Ohio.

Photo By J. W. Barr
The Strategic Air Command has taken delivery of the first FB-111 aircraft, signifying initial completion of a major modification to its bomb-navigation system. General Dynamics’ role is that of integrating contractor. By 1993, General Dynamics and other aerospace contractors will have modified all of the F-111 aircraft in the USAF inventory through the Avionics Modernization Program (AMP), a major system upgrade that will provide a 12-fold increase in reliability, a 29 percent improvement in weapons delivery effectiveness, and a 96 percent probability that the aircraft will arrive at the target with an operating bomb-navigation system.

The first AMP-equipped F-111 is an FB-111A, which was delivered by Sacramento ALC to General Earl T. O’Loughlin, commander of the Air Force Logistics Command. Gen. O’Loughlin then flew the aircraft to Pease AFB, New Hampshire where it is permanently stationed.

The first production AMP upgrade was completed during regular programmed depot maintenance at the Sacramento ALC. Most of the F-111 fleet will receive the AMP modification there, but F-111D and F-111F models will be upgraded at the base level.

AMP improvements increase the reliability of components used in the various aircraft models, thereby helping drive down support costs.

“The Air Force has taken on responsibility to essentially be the prime contractor,” said Lt. Col. Michael LeBeau, F/FB/EF-111 AMP Manager at Sacramento, “and while we are contracting integration efforts from General Dynamics, we are buying the components that fit into the AMP program directly from individual manufacturers.

“We are proud to say it appears to be working well, and we also believe this is an omen of the way modifications will be handled in the future — trying to combine them in a very cost-efficient and effective manner.

“The existing planned life expectancy of the F-111 fleet is now being forecast for about the year 2010,” Colonel LeBeau continued, “We believe that the avionics modernization program is in fact going to be a very essential key as far as keeping the F-111 weapon system viable and credible for the service life of the airplane.

Considering the significance of the improvements, as well as the payback period in regard to usable service life, we believe the AMP is a very cost-effective approach.”

Gen Earl T. O’Loughlin
The Fighting Falcon is assuming a new role — that of strategic air defense of the United States. F-16s are currently in service with the 125th Fighter Interceptor Group at Jacksonville, Florida (See Code One, Fall 1986) and are scheduled to replace F-106s at other Air National Guard units in 1987 and 1988. Air Force Secretary Edward Aldridge, Jr., announced last October that a version of the F-16A — "missionized" for the air defense role — had been chosen over offers of an F-16C version and the F-20 in the Air Defense Fighter competition. In all, 270 Air Defense (AD) F-16s will replace F-4s and F-106s at eleven ANG interceptor units and one training unit — and will significantly increase the ANG's continental air defense capability.

The baseline used for the AD F-16A proposal was the Block 15 aircraft, modified with the Operational Capabilities Upgrade (OCU) package (see Code One, Summer 1986). AIM-7 integration is facilitated by wiring and space provisions included on all Block 15 F-16A/B aircraft. The AD modification will incorporate all remaining equipment to carry, launch, and guide AIM-7s.
Modification kits for air defense requirements will be provided to the Ogden Air Logistics Center, which will install this equipment while the OCU modification is being performed. The first kits will be delivered in September 1988, the first aircraft completed in January 1989, and all aircraft will be completed by 1991. Early in 1989, the 114th Tactical Fighter Training Squadron at Klamath Falls, Oregon, will become the first unit to transition to the AD F-16. And the first operational unit — the 142nd FIG at Portland, Oregon — will be fully equipped with AD F-16s by July 1989.

The Air Force considered alternate proposals for contractor and organic logistics support. However, the standard, three-level organic support arrangement was selected in order to take advantage of the existing F-16A/B logistics establishment. Complete intermediate maintenance will be provided at each site.

Each operational base will have an F-16 cockpit procedures trainer (CPT), a new device that provides a dynamic environment for learning routine, emergency, and weapon employment procedures. The CPT bridges the gap between static, part-task trainers and the trainer flight simulator.

The ADF program contains several unique training support features. General Dynamics will provide computer-based instruction courseware for continuation training of both aircrew and maintenance personnel. Under a separate contract, General Dynamics will provide "arms-around" logistics support of all aircrew training equipment at the twelve sites, with a 95 percent availability warranty.

The air defense modifications do not affect the F-16's superb performance capabilities — large useable speed/altitude envelope, rapid acceleration, and unmatched agility. In range and persistence, the F-16 is superior to all aircraft currently employed in the U.S. strategic air defense role.

In addition to the M61 20mm gun, the AD F-16 will carry up to six of the world's most lethal air-to-air missiles — AIM-7F/M Sparrow, AIM-120 AMRAAM, and AIM-9L/M/P Sidewinder. Addition of Sparrow and AMRAAM radar missiles provides the F-16A with a beyond-visual-range, all-aspect, all-weather intercept capability. The AD F-16 will be able to launch AMRAAMs in three modes: boresight, "launch-and-leave", and midcourse update. The F-16's advanced fire control system provides highly accurate aiming and in-range cues for both air-to-air and air-to-ground weapon delivery.

The APG-66A multimode radar provides long-range, all-weather detection and attack, even when looking down against small targets. Useful radar features include the latest in ECCM, AMRAAM midcourse update, "bull's eye" search reference, intercept steering, situation awareness mode (track one and display 63 others), and search target altitude determination.

Target identification is aided by an advanced IFF interrogator, extensive information on target radiators; auto correlation of radar and IFF targets; a night identification light; and HUD cues to help the pilot visually acquire a target.

The HF radio (in addition to the F-16's UHF and VHF radios) furnishes long-range, over-the-horizon communication. Incorporation of the Global Positioning System (when it becomes available) will provide a navigation supplement to the F-16's accurate INS plus precision update and rapid, inflight INS alignment.

Compared to the aircraft it is replacing, the F-16 exhibits three times the reliability, requires one-third as many maintenance manhours, and has 40 percent lower operation and support costs. Finally, since the AD F-16 has a large growth potential and can share in planned upgrades with the rest of the F-16 fleet, it is assured of remaining a highly effective fighter-interceptor throughout its long service life.

The Air National Guard accounts for over 70 percent of the strategic interceptor force guarding the United States. Dating back to the 1950s, General Dynamics (Convair) fighters — the F-102 and F-106 — have served continuously and with distinction in this vital role. Selection of a missionized F-16 ensures a strong national air defense force for the 1990s and carries on this proud General Dynamics tradition.

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**Air Defense F-16A Modifications**

- **F-16 A/B Block 15**
  - OCU Baseline
  - APG-66A
    - Small Target Detect
    - AMRAAM Capability
    - Memory Expansion
    - ECCM Enhancements

- AIM-120 AMRAAM
- AIM-7
- "Have Quick" Radio
- IFF Interrogator
- HF Radio
- Crash Survivable Flight Data Recorder
- ID Light
- "Grp A"
- Enhanced Cooling
- AIM-9

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*In some regions of the world, F-16s have long been performing in an air defense role, as depicted in this photo of a Norwegian aircraft intercepting a Russian Backfire bomber.*
The U.S. Air Force recorded its one millionth F-16 flight hour on Dec. 19th when Maj. Gen. Mark Anderson, Deputy Chief of Staff for Operations at TAC Headquarters, landed at Homestead AFB, Florida, completing a familiarization flight. Gen. Anderson was the front-cockpit pilot in F-16B No. 114, with Lt. Col. Randy Scott, instructor pilot and Assistant Operations Officer for the 309th Tactical Fighter Squadron, 31st Tactical Fighter Wing, in the rear cockpit. The aircraft was part of a flight of two F-16s and two F-4s from the 31st TFW, on an intercept training mission.

General Anderson praised the F-16's record as a dependable, reliable, safe, and cost-effective fighter in remarks at a ceremony immediately after the flight. He said the F-16 would be a mainstay in the USAF inventory for many years to come.

Col. Hale Burr, 31st TFW Commander, was master of ceremonies at a flightline gathering to commemorate this major milestone in the Fighting Falcon's history. General Dynamics was represented at the event by Timothy J. Roels, the Fort Worth Division's Director of Product Support. Distinguished guests included Sen. Christopher Dodd of Connecticut, and several local civic leaders.

F-16B No. 114 is assigned with Homestead AFB's 309th TFS — the base's second F-16 unit and then the most recently activated Fighting Falcon squadron in the USAF.
A Ride for Royalty

A ride for Royalty — Prince Claus of The Netherlands was recently treated to a ride in an F-16B, piloted by Captain Frank van Vught of 311 Squadron, Volkel Air Base. During the ride, the Prince witnessed air-to-ground gunnery training at the Dutch Vleeland range.

Prince Claus in the cockpit of an F-16B.

Fighter Weapons Instructor Training Course Established in Europe

A fighter weapons instructor training course — patterned after the Fighter Weapons School at Nellis AFB, Nevada — has been established in Europe to train F-16 pilots in the fine art of weapons delivery. The European school makes it possible for F-16 pilots from Belgium, Denmark, The Netherlands, and Norway to receive such advanced training.

Captain Neinhuis, a Royal Netherlands Air Force pilot assigned to 323 Squadron at Leeuwarden Air Base, was named the top student — both academically and as a result of demonstrated flying skills — in the school’s first graduation ceremony, attended by Major General David W. Forgan, USAFE’s Director of Operations. Skrydstrup Air Base in Denmark was the site of the inaugural class. The school will be conducted annually, with sites to be rotated among the participating air forces.

The two-month course teaches tactics and weapon-delivery skills in both air-to-air and air-to-ground profiles. The school is a joint effort by all European Participating Governments, and instructors from all four nations participate. A U.S. Air Force representative monitored the first class, and aggressor aircraft support was provided by USAFE.

Instruction included live ordnance delivery in the air-to-ground mode and live AIM-9 firing in air-to-air.

Lt. Col. Jef DeHeyn of Belgium chaired the first school, and Dutch Lt. Col. Jan van Fersel has been selected to chair the next one, with Maj. Dick Berlyn of The Netherlands as Project Coordinator.
Egypt received its first F-16C aircraft on 11 October when the newest model F-16 arrived at the refurbished Beni Suef Air Base. Known as Peace Vector II, this follow-on buy of advanced F-16 aircraft by the Egyptian government involves 34 F-16Cs and six of the two-place F-16Ds.

The Beni Suef activation ceremony was highlighted by an F-16C flight demonstration from General Dynamics test pilot Dave Palmer, and by speeches from Field Marshal Mohamed Abdul Halim Abu Ghazala, Egyptian Minister of Defense; Air Marshal Mohamed Abdul Hamid Helmi, Commander of the Egyptian Air Force; U.S. Ambassador to Egypt, the Honorable Frank G. Wisner; General Dynamics Chairman Stanley C. Pace; and F-16 Wing Commander Colonel Abdel Hady. Also attending the ceremony was former General Dynamics Fort Worth Division General Manager Herb Rogers, who has since been promoted to General Dynamics Executive Vice President for Aerospace.

A second aerial demonstration flight was provided by Egyptian Air Force pilots flying four F-16As out of An Shas Air Base. Attendees at the ceremony were offered a close-up view of an F-16C and three F-16D aircraft on static display.

As of 1 January, six D models and five C models had been delivered to Beni Suef, and 27 more F-16Cs are scheduled for delivery by the end of June. Two F-16Cs will be delivered at a later date, following enhancements in the U.S. that will benefit all Peace Vector II aircraft.

The aircraft was having some problems with JFS start one,” Captain Loewenhagen said. “It was starting fine in start two, but I told the pilot to ground abort the next time start one failed so we could fix the problem before it got any worse.” Failure of the JFS start one, Loewenhagen explained, is not uncommon and normally would not be cause for an abort.

The airplane is flown by the 4th TFS, 388th TFW, Hill AFB, Utah. Maintenance is the responsibility of the 4th AMU, 388th Aircraft Generation Squadron.

Sgt. Mark D. Newey is the aircraft’s crew chief, and his assistant is Sgt. Barry J. Koons. Loewenhagen said both men are “exceptional. We have many exceptional people.”

Of those 226 sorties, more than 150 terminated “Code 1,” meaning that the aircraft was ready to fly again with no maintenance actions required.

Loewenhagen called the F-16 “the most reliable fighter platform designed to date.” USAF records indicate that the Fighting Falcon is the most reliable fighter aircraft in its inventory.

The record-breaking aircraft was the 470th F-16A delivered to the USAF when it arrived at Hill on March 10, 1983. More than 1,000 F-16s are now in the USAF inventory, and that number could easily exceed 3,000 before the program ends.
It was like something out of the twilight zone. On the ramp, scores of mechanics, pilots, refuelers, armament people, and others craned their necks skyward to look at the strange craft entering the pattern at Arizona's Luke Air Force Base. If only briefly, work stopped on the modern F-16 Fighting Falcons and F-15 Eagles as a gleaming, 45-year-old Curtiss P-40 Warhawk dropped out of the morning sun and taxied — prop spinning — to a point adjacent to an F-16. The vintage fighter's Allison engine coughed into silence, leaving just a hint of blue smoke from the horizontal row of exhaust stacks. From the cockpit emerged a pilot decked out in period leather flying jacket, leather helmet, and goggles.

It was as if man and machine had been transported to this point in time and space by some sci-fi time warp. Actually, the airplane was brought in to add nostalgia to a strikingly unique squadron activation ceremony.

There to meet the WWII fighter were members of the original 314th Tactical Fighter Squadron, deactivated in 1945 and being reactivated on this date, October 3, 1986. It had been a long time.

Lt. Col. Arthur C. “Ace” Carlson, III, was responsible for this unusual event. The 314th's new commander had contacted every living member of the original squadron and arranged for them to be on hand for the reactivation ceremony.

While it may seem like a lot of trouble to go to for a simple squadron activation, Col. Carlson was happy to do it. And if the F-16 pilot seemed a bit choked up when he accepted the squadron colors, maybe it was because the old soldier who passed those colors to him had flown P-40 Warhawks and P-47 Thunderbolts during the war. More likely, though, it was because many of that old soldier's missions involved providing fighter escort for the new commander's father, Arthur C. Carlson, II, who flew B-25s out of North Africa to strike targets in France, Italy, and Germany. It was a fitting moment.

Later, at a celebration at the “O” club, young fighter pilots mingled with old ones to swap tales of current technology and former glory.

Now equipped with F-16Cs and redesignated the 314th Tactical Fighter Training Squadron, the newest arm of the 58th Tactical Fighter Wing has a proud history to uphold. The old 314th pursued Rommel across North Africa, supported the invasion of Sicily, and augmented the assault on the infamous monastery at Cassino in northern Italy. Distinguished Unit Citations and the French Croix de Guerre with Palm decorate the unit colors.

The new 314th will train today's fighter pilots to fly the F-16C Fighting Falcon. ■
She's the lady known as Lil — "Diamond" Lil to be exact. Lil is getting old and has seen better days, but she's still beautiful in an exotic sort of way. "Diamond Lil" is one of only two B-24s still in flyable condition. She now belongs to the Confederate Air Force, but was originally produced during World War II as an LB-30 for Britain's Royal Air Force. Lil was later converted by the CAF to the more familiar B-24 configuration. She was number 18 off the B-24 assembly line at San Diego, damaged in transit to England, No. 18 was never accepted by the British, and ingloriously finished the war as a Consolidated Aircraft Co. shuttle bus, making frequent flights between San Diego and Fort Worth.

Lil was recently ferried from her home base at Rebel Field in Harlingen, Texas, to Fort Worth for a solemn purpose — to participate in the reburying ceremony of Major Horace S. Carswell at the Air Force base named in his honor. Major Carswell was a B-24 pilot with the 374th Squadron, 308th Bombardment Group stationed in China during World War II. On October 16, 1944, he led an attack against a fleet of Japanese ships in which a cruiser and a destroyer were sunk. For this action he was awarded the Distinguished Flying Cross. Nine days later Carswell made two attacks on a 12-ship Japanese convoy. His first pass, made at 600 feet, took the ships by surprise and damaged a destroyer.

Intense enemy fire was encountered on the second pass, however, and Carswell's B-24 was heavily damaged. His copilot was badly wounded, as was a crewmember whose parachute was shredded by the gunfire which knocked out two engines and damaged a third. Carswell wheeled the dying bomber back toward China in hopes of finding a place to land and get aid for his wounded. When the third engine failed, he ordered those who could to bail out. But Carswell remained, trying desperately to keep the bomber in the air on only one engine. Despite his valiant efforts, Major Carswell and the two wounded men were killed when the B-24 crashed into a mountain and burned. For his heroic action and devotion to his men, Carswell was posthumously awarded the Medal of Honor, Distinguished Service Cross, Distinguished Flying Cross, Air Medal, and Purple Heart.

Maj. Carswell's son, Robert, was 13 months old when his father died. Although he never really knew him, Robert learned of his father's love of flying and his dedication to aviation. For Robert Carswell, the burial of his father on the base named in his honor was a lifelong dream come true. "I've always wanted my father in this place. He belongs here," he said.

The October 17 ceremony made the Fort Worth Air Force base the first ever to have it's namesake buried on the grounds. As part of the dedication ceremony for the Carswell Memorial Park, a B-24 was wanted by the Air Force for a flyby. At the time, only one B-24 was known to be in flying condition. Responding to an appeal from General Dynamics, the CAF's "Diamond Lil" passed majestically over the burial site precisely at the appointed time — just as the final notes of the National Anthem were fading in the warm morning air. The venerable bomber was closely followed by a flight of F-4s of the 301st Tactical Fighter Wing in the "missing man" formation.

Flown by a crew of three CAF Colonels (pilot Dave Hughes, co-pilot Ray Krottinger, and flight engineer Jim Jaque) "Diamond Lil" performed her first — and probably her last — "military" mission.
QUESTION: WHAT'S TH' MOST VORACIOUS ANIMAL ON EARTH? IS IT TH' SHARK? HOW 'BOUT TH' PIRANHA? OK, WOULD YOU BELIEVE IT'S AN AFTERBURNIN' TURBOFAN ENGINE...

DON'T BE TAKEN IN BY THE INTAKE!

... SUCH THAT HABITATES TH' INNARDS OF TH' FIGHTIN' FALCON?

AT FLIGHT IDLE THIS PREDATOR CAN SNATCH UP UNWARY HUMANS FROM AS FAR AWAY AS 15 FEET.

AN' AT HIGHER THRUST SETTINGS, TH' CREATURE'S GRASP EXTENDS TO 25 FEET!

EVEN IN CAPTIVITY (DURING ANY MAINTENANCE GROUND RUN) TH' BEAST MUST BE MUZZLED WITH AN ANTI-PERSONNEL SCREEN IAW T.O. 1F-16C-2-70 JG-00-7.

DON'T YOU BE CAUGHT SHORT. GIVE THIS BIRD PLENTY OF BREATHIN' ROOM!
Spanning The Years

The B-24 "Liberator" was the first aircraft ever produced at Fort Worth's "bomber plant." The one in this photo performed a flyby to commemorate the reburial of Medal-of-Honor winner Maj. Horace Carswell at the U.S. Air Force base named in his honor.

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