GREETINGS,

I would like to take this opportunity to introduce to you a new quarterly publication that the Fort Worth Division of General Dynamics has created for you, our customer. It is called "Code One" and includes items of interest, safety and maintenance tips, and current events from the field.

The fleet of General Dynamics aircraft in the field today has risen to over 1800. The F-16 Fighting Falcon is being flown by nine air forces at some 28 locations throughout the free world, while the F/FB-111s are flown from seven locations, including Australia.

In this and coming issues, we will detail some of the many aspects of both the F-111 and F-16 that we feel sure will be of interest to you, the user-both maintenance and aircrew personnel. We will keep you abreast of key events in the General Dynamics aircraft world.

The title "Code One" was selected because of its importance to aircraft readiness. The phrase stands for dependability, for being able to do the job when the job needs to be done, for being able to fight and return and fight again. Because of your efforts, we are able to prove that our design does, in fact, produce Code One sorties.

We hope you will enjoy this issue of "Code One" and the ones to follow. We solicit your comments and hope all your missions return Code One.

H. F. Rogers
Vice President and General Manager
General Dynamics Fort Worth Division
IN THIS ISSUE . . .

FEATURES

GUNSMOKE '85
This USAF gunnery competition leaves no doubt that the F-16 is dominant in the air-to-ground role.

SEMPER VIPER
What's different about the F-16, from a test pilot's perspective (part one of a five-part series).

PROGRAM NEWS

ADVERSARY!
The U.S. Navy selects the Fighting Falcon for an air combat training role.

ENGINEERING FLIGHT SIMULATORS
Building a better mousetrap via simulation technology.

F-111 AVIONICS MODERNIZATION PROGRAM
A battle-proven warbird gets an electronic facelift.

SAFETY

THE BOTTOM LINE
A low-altitude warning system is being considered for the F-16.

WATCH THAT STICK!
A reminder about unintentional side-stick controller interference.

MAINTENANCE

AVIONICS INTERMEDIATE SHOPS
Maintaining the "Code One" standard.

EVENTS

A MILESTONE IN OGDEN
ACL given program management responsibility for F-16A/B weapon system.

PAVE TACK
Australians roll out first enhanced F-111C.

THE INDEFATIGABLE FIGHTING FALCON
Hahn squadron sets new USAFE surge record.

HOMESTEAD ACTIVATION
The Fighting Falcon now nests in southern Florida.

BARRENTINE TROPHY
F-111 bomb wing personnel win weapons loading competition.

LOADEO
F-111/F-16 units make fine showing in USAFE weapons loading competition.

SAFETY AWARDS
Idaho F-111 wing honored for safety record.

LOGISTICS MANAGEMENT AWARD
F-111 maintenance officer receives recognition.

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Dub Ballow .......................................... Cartoonist

ABOUT THE COVER

Painted by General Dynamics artist Bob Cunningham, the cover of our inaugural issue depicts the F-16 flown by Capt. Mark Fredenburg of the 50th Tactical Fighter Wing, Hahn AB, Germany, Air Force Chief of Staff Gen. Charles A. Gabriel, in a message to the winners of Gunsmoke '85, said Capt. Fredenburg could rightfully claim the title "world's best fighter pilot" after the Captain won the "Top Gun" title in the USAF's biennial, worldwide, air-to-ground gunnery competition, held in October at Nellis, AFB, Nevada. The canopy frame bears the name of Capt. Fredenburg's crew chief, SSgt. Emmanuel Rojo.

The F-111 in the painting is flown by Col. Dale Thompson, Commander, 20th TFW, RAF Upper Heyford, UK. Maintenance crews from this wing won the air-to-ground weapons loading category while finishing second overall in a very close competition for USAFE's 1985 Loado title.
The F-16 Fighting Falcon has once again demonstrated its superiority in visual ground attack. Out of 17 teams participating in Gunsmoke '85 (the U.S. Air Force's biennial worldwide fighter gunnery competition) the six teams flying the F-16 finished first, second, fourth, fifth, sixth, and seventh. Gunsmoke '85 was held October 6-19, 1985, at Nellis AFB, Nevada, and involved select teams from TAC, PACAF, AAC, USAFE, ANG, and AFRES. In addition to the six F-16 teams, there were five A-10 teams, four F-4 teams, and two A-7 teams.

The overall winner was the 419th TFW from Hill AFB, Utah. The 419th began flying the F-16 in January 1984, and it was the first time this AFRES unit had participated in Gunsmoke since transitioning from the F-105. Pilots from the 419th reportedly averaged 350 hours in the F-16 when the competition occurred. The 419th scored a record 9431.5 points (out of a possible 10,000) and captured two first places and a second place in the team standings for the three weapon delivery profile categories.

Just two points back in overall standings was the 1983 defending champion 50th TFW from Hahn AB, Germany. The 50th TFW earned one first place and two second places in the three profile categories, as well as the "Top Gun" award for the competition's best individual performance. This coveted award went to Captain Mark Fredenburgh, who finished the competition with 2415 points out of a possible 2500. Finishing in second place was Colonel Bane Lyle from the 419th TFW with 2394.5 points, and in third place was Captain Mitch Dodd from the 50th TFW with 2373.5.

In commenting on his winning individual effort, Capt. Fredenburgh said the credit must be shared by his crew chief, SSgt. Manny Rojo, and assistant crew chief, Sgt. Tim Colvin. Fredenburgh praised their efforts for giving him "the confidence that the jet would start, that all systems would work. I had no worries. And this confidence reflected in my performance on the range. They (Rojo and Colvin) left nothing to chance. They made the luck window real small."

Fredenburgh also had high praise for the airplane.

"The F-16 is always going to win. It's an amazing airplane - amazing in how it performs and in how accurate it is," he said.

Colonel Bane Lyle, Assistant DCO for the 419th and winner of two of the six competitive events, called the F-16 "a fantastic machine. To compete in a world-class competition like Gunsmoke, you need to work with the airplane a lot," he said, adding that such tough competition requires near-perfection, "and the F-16 is super consistent."

But Col. Lyle also credited his crew chief, SSgt. Bob Mather, for a super effort. "He (Mather) wouldn't let any minor detail get bad. He'd get right on it and correct the problem."

As for the narrow, 2.5-point margin of victory in the team standings, Col. Lyle said that "the F-16 is getting so accurate that the ability to score (the competition) accurately is becoming a problem," and said that winning this type of competition "is directly related to how much work you do — both pilots and maintenance people. More people are responsible for those 'good' bombs than just the pilots."

F-16 pilots made a very impressive showing in the individual standings, capturing the first 11 positions and 17 of the top 20.

Each of the 17 teams had four aircrews, so there were 68 aircrews participating in the meet. The competition gets keener at every meet, as evidenced by the top two 1985 teams surpassing the 50th TFW's 1983 record score of 9378.5 points.

In individual events, F-16 pilots again dominated, finishing first in five of the six categories and taking a large portion of the top three places.
MISSIONS

Each aircrew flew two sorties in three mission profiles: conventional “box pattern” bombing, tactical bombing, and a navigation/attack mission. The highest sortie score was used in determining overall team and individual standings; but both scores were used to determine individual standings in the various events.

The conventional “box pattern” missions, flown in four-ship formations, required each aircraft to drop two bombs in each of three deliveries: (1) 30-degree dive, (2) 20-degree low-angle/low-drag, and (3) 10-degree low-angle/high-drag. Each aircraft then made three strafing passes, firing a total of 100 rounds of ammunition. The 50th TFW team finished first with 3106.5 points (out of a possible 3400), followed by the 419th TFW with 3047.5, and the 23rd TFW with 3041.5.

The tactical missions, also flown in four-ship formations, required both level deliveries and “pop up” patterns from 200 feet AGL. Two deliveries were required in the “pop up” patterns: (1) 20-degree low-angle/low-drag bombs and (2) 10-degree low-angle/high-drag bombs. Two passes were made in each of the three delivery categories.

The 419th TFW finished first with 2850 points (out of a possible 3000), followed by the 50th TFW with 2838, and the 8th TFW with 2785.

The navigation/attack missions, flown in two-ship formations, required low-level navigation for 150 to 200 miles, flying over several checkpoints en route, acquiring a specific tactical target, and making a level-delivery pass from 200 feet. To achieve a maximum score, the checkpoint gates had to be crossed within five seconds of the specified times, the pilot had to accomplish a direct hit, and the bomb had to impact precisely at the specified “time on target” — to the second.

In Gunsmoke ’83, the only perfect score was achieved by an F-16 pilot. In Gunsmoke ’85, this seemingly impossible feat was accomplished by four F-16 pilots: Col. Bane Lyle and Maj. Waldo King of the 419th TFW, Maj. Chuck Devlaming of the 169th TFG, and Capt. Burt Field of the 474th TFW. The 419th team finished first in this event with 3534 points (out of a possible 3600), followed by the 50th TFW with 3485, and the 474th TFW with 3439.
<table>
<thead>
<tr>
<th>EVENT</th>
<th>WINNER</th>
<th>UNIT</th>
<th>AIRCRAFT</th>
<th>SCORE</th>
<th>F-16 PILOT PLACES IN TOP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-deg Dive Bomb</td>
<td>Capt. Smiley</td>
<td>8 TFW</td>
<td>F-16</td>
<td>3.5m CEA*</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>20-deg Low-Angle/</td>
<td>Maj. Hamilton</td>
<td>419 TFW</td>
<td>F-16</td>
<td>4.5m CEA</td>
<td>1, 2, 3</td>
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<tr>
<td>Low-Drag Bomb</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10-deg Low-Angle/</td>
<td>Col. Lyle</td>
<td>419 TFW</td>
<td>F-16</td>
<td>3.0m CEA</td>
<td>1, 2, 3</td>
</tr>
<tr>
<td>High-Drag Bomb</td>
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<tr>
<td>200-Foot Level Bomb</td>
<td>Col. Lyle</td>
<td>419 TFW</td>
<td>F-16</td>
<td>0.25m CEA</td>
<td>1, 2</td>
</tr>
<tr>
<td>Strafe</td>
<td>Maj. Dardis</td>
<td>185 TFG</td>
<td>A-7</td>
<td>97%</td>
<td>3 (95%)</td>
</tr>
<tr>
<td>Navigation/Attack</td>
<td>Maj. Devlaming</td>
<td>169 TFG</td>
<td>F-16</td>
<td>898 (900 Max)</td>
<td>1, 2, 3</td>
</tr>
</tbody>
</table>

NOTE: The above scores represent the average of two performances in each event. The 20-degree and 10-degree event scores were obtained in two types of mission profiles as described in the following section.

*Circular Error Average

<table>
<thead>
<tr>
<th>UNIT</th>
<th>LOCATION</th>
<th>ORGANIZATION</th>
<th>AIRCRAFT</th>
<th>TEAM SCORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>419 TFW</td>
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<td>AFRES</td>
<td>F-16</td>
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<td>50 TFW</td>
<td>Hahn AB, Ger</td>
<td>USAFE</td>
<td>F-16</td>
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<tr>
<td>23 TFW</td>
<td>England AFB, LA</td>
<td>TAC</td>
<td>A-10</td>
<td>9106.5</td>
</tr>
<tr>
<td>8 TFW</td>
<td>Kunsan AB, Kor</td>
<td>PACAF</td>
<td>F-16</td>
<td>9096.5</td>
</tr>
<tr>
<td>169 TFG</td>
<td>McEntire ANGB, SC</td>
<td>ANG</td>
<td>F-16</td>
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</tr>
<tr>
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<tr>
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<tr>
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<td>ANG</td>
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</tr>
<tr>
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<td>ANG</td>
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<tr>
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<td>ANG</td>
<td>A-10</td>
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<tr>
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<tr>
<td>4 TFW</td>
<td>Seymour Johnson AFB, NC</td>
<td>TAC</td>
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<tr>
<td>343 TFW</td>
<td>Eielson AFB, AK</td>
<td>AAC</td>
<td>A-10</td>
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</tr>
<tr>
<td>37 TFW</td>
<td>George AFB, CA</td>
<td>TAC</td>
<td>F-4</td>
<td>7208.5</td>
</tr>
<tr>
<td>507 TFG</td>
<td>Tinker AFB, OK</td>
<td>AFRES</td>
<td>F-4</td>
<td>6472.5</td>
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<tr>
<td>188 TFG</td>
<td>Ft. Smith, AR</td>
<td>ANG</td>
<td>F-4</td>
<td>6234.5</td>
</tr>
</tbody>
</table>

The average team score for each type aircraft participating was

F-16 (9124), A-7 (8446), A-10 (8273) and F-4 (6981).
MAINTENANCE & LOADING

Throughout the competition, maintenance crews were judged on how well their aircraft were maintained, how fast they could regenerate aircraft, and how quickly the crews could repair an airplane when it experienced problems. Crews were also judged on AFR 35-10 (uniform and appearance), on safety practices, and on following technical order procedures. The winning maintenance team was the 442nd TFW with 5944 points (out of a possible 6000), followed by the 419th TFW with 5921, and the 185th TFG with 5908. The next-best F-16 unit, the 169th TFG, was tied with the 81st TFW for fifth place at 5903 points.

Each participating team competed in a munitions “Loadeo.” In this event, the three-man load teams were given two chances to load six MK 82 bombs on their aircraft. Teams were judged on speed, safety, observance of technical order procedures, tools and equipment, and military appearance. The 442nd TFW won this event with 3108.3 points, followed by the 23rd TFW with 3083.7, and the 419th TFW with 3048.4. Four of the F-16 teams finished in the top 10 places in the Loadeo.
F-16: THE STANDARD OF EXCELLENCE

Gunsmoke '85 is the third major bombing competition in which the F-16 has participated, and each time the results have been spectacular. In the F-16's debut, just six months after reaching Initial Operational Capability status, a team from the United States far surpassed all opponents in the RAF Strike Command 1981 Tactical Bombing Competition. All records were smashed as the F-16 team scored 98 percent of the maximum possible points, achieved 100 percent bombing effectiveness, and was credited with 88 “air victories” against aggressor fighter/interceptors (while suffering only one “loss”) while en route to the targets.

In Gunsmoke '83, the three participating F-16 teams finished first, second, and fourth out of a 16-team field and F-16 pilots took the top three individual spots, with half of them finishing in the top 15 percent.

The USAF brought its best to Gunsmoke '85, and the statistics make it clear that the F-16 is the “best of the best.” F-16 teams won six of the top seven team positions — including first place. Moreover, individual F-16 pilots held the top 11 slots and 17 of the top 20, took first place in five of six events, captured 15 of the top 18 places, and unbelievably achieved four “perfect” scores in the navigation-attack missions. These accomplishments are to the credit of the F-16 pilots and maintenance teams involved, and leave little doubt that, in visual ground attack, the Fighting Falcon is the finest aircraft in the world.

TOTAL FORCE

In Gunsmoke '85, the Air Reserve Forces (ANG and AFRES) clearly demonstrated their capabilities as full members of the Total Air Force. The eight ANG/AFRES teams achieved the following distinctions:

- First- and fifth-place teams
- Six of top 11 pilots in Top Gun standings
- Five of six first-place pilots in individual gunnery events
- Top three places in maintenance competition
- Two of top three places in Loado competition

Although it was their first major competition with the F-16, the two AFRES/ANG F-16 teams did very well in all categories. Particularly noteworthy was their performance in weapon delivery where, like active duty F-16 pilots, they finished far ahead of AFRES and ANG pilots flying other type aircraft.
Let's get serious about the Electric Jet (or)

SEMPER VIPER!

by Joe Bill Dryden
Experimental Test Pilot
(but still your basic Fighter Pilot!)
General Dynamics / Fort Worth Division

EDITOR'S NOTE: Those who have been associated with the F-16's development will know that "Viper" was one name being proposed for the world's first nine-g fighter. Although it is now officially called the Fighting Falcon, this high-performance airplane will always ("semper") be affectionately known as the Viper to some. Viper is the call sign for F-16s of the 422nd Test and Evaluation Squadron, 57th Fighter Weapon Wing, at Nellis AFB.

The F-16 is now in the field in real numbers and it is high time that we set to rest some of the rumors concerning just what the F-16 can and cannot do. To fully understand the F-16, the "Dash One" is the first place to start; but after you've thoroughly digested its contents, reading this document will help fill in some of the blank spaces. It is my intent to try to help clear up some grey areas and point out some things you might not have noticed in the time you've been flying the Fighting Falcon.

If you were to try to sum up the F-16 in a single word, you would find it nearly impossible to do so. I keep coming up with four words, all beginning
Joe Bill Dryden is a graduate of the U.S. Air Force Academy, Class of '62. Retired from the Air Force, Joe Bill is now an experimental test pilot for General Dynamics. His experience with the F-16 began when he was selected to represent IAC as one of the original members of the YF-16/YF-17 Lightweight Fighter Joint Test Team. Since then he has flown and helped develop every combination of F-16 airframe, engine, wing, flight control system, and avionic system (except for the AFTI/F-16).

He is a graduate of the USAF Fighter Weapons School, the Interceptor Weapons School, and the USAF Test Pilot School short course. He has been an ACM instructor both in the air and on the "platform."

In addition to his normal involvement with production F-16 improvements, Joe Bill is currently involved as project pilot for the F-16F, the Advanced Tactical Fighter (ATF), and the F-16C/F110.

Joe Bill Dryden —

with "D," that the F-16 is or is not. The F-16 is not difficult, it is not devious, and it is certainly not dangerous. The F-16 is simply DIFFERENT! If you are a student of aviation history (or perhaps a really crusty old Lt. Col.) you will recall that there was a lot of nervous hand wringing going on in the late 1940s and early 1950s as jet-propelled aircraft began replacing the props. The feeling was that the tremendous differences between jet and reciprocating engines would be difficult for the pilots to overcome. Well, these "differences" proved to be minor. Once you've digested what's gone into the F-16, you'll see that there's a larger delta between it and the aircraft that immediately preceded it (the F-15, F-14, F-4, F-8, MiG-21, Mirage III, etc.) than ever existed between the F-80, F-84, F9F, and the P-51, P-47, F4U. Once you can insert this difference in your brain's core memory you'll begin to see why the F-16 does the things it does so well, and why it does NOT do some of the things you may have been asking it to do. In this article, the F-16 flight control system will be discussed. Future articles will feature aerodynamics, the cockpit, and engine characteristics. When we're through, you should have a better understanding of and appreciation for this "mysterious" electric airplane.

The flight control system is from whence came the moniker "electric jet." The flight control system in the F-16 is different (that word again) from anything you've ever flown in an operational fighter.

That is worth repeating...

"The flight control system in the F-16 is different from anything you've ever flown in an operational fighter."

How different? In the past, any time you moved the stick (or, God forbid, the yoke) you got a corresponding movement of the flight control surface (as long as you didn't exceed the hinge-moment limits of the system). Then, depending on airspeed, cg, and/or configuration, you got a varying response. This is NOT the case with the F-16. You only THINK it's you moving the control surface. In fact, the computer positions the control surface to give you the roll rate or g it knows you want, depending on how hard you leaned on the stick. For example, two pounds of pull or push force might move the stabilator two-tenths of an inch at 600 KCAS. That exact same two pounds of force might move the surface six inches at 180 KCAS. And in some cases, two pounds of force will drive the surface all the way to the stop! At either airspeed, the two pounds of force gave you an incremental .6 g.

The only times you have direct control of the surface are (1) when the weight-on-wheels (WOW) switch is closed (i.e., you are sitting on the ground), (2) when you have the manual pitch override (MPO) switch on and push in the nose-down direction, or (3) when the MPO switch is off, the angle of attack is above 29 degrees, and you pull in the nose-up direction. As a result of the computer determining both magnitude AND direction of surface movement, the F-16 gives you a nearly constant response from a constant input across the entire flight envelope. This is only one of the results you'll see with the electronic rate (g) command system.

Since the "black box" is really flying the F-16, we can instruct it not to exceed a given g, a given angle of attack, or a given roll rate. And it will do this with very few exceptions. These exceptions are why you may have heard some of the horror stories about the F-16. But I'm getting ahead of myself.

I've heard the usual reactions: "I don't want any g limiter on my airplane! If I want to pull 10 or even 12 g I don't want to be limited to ONLY 9 g!"

Now, stop and think a minute. While there may be some instances where this is true, they're very rare.
Tell me one other jet in which you’re even ALLOWED to routinely attempt 9 g. I’ll wait while you think.

And while you’re thinking, consider this scenario: We’re both going straight down at 400 knots TAS. You pull out using 10 g, but I pull only nine. You’ll be recovered to level flight about 160 feet sooner than I will. Since there are few (if any) of us humans who are blessed with senses keen enough to allow them to delay that additional 160 feet before they start to pull out (about .2 of a second) the difference between 9 and 10 g quickly becomes academic.

There’s also energy bleed rate to consider. As you continue to increase the angle of attack in search of more g, the increased drag sometimes results in an increased airspeed bleed rate, such that the average g for any given amount of time turns out to be less than if you started with (and maintained) slightly less g at the beginning. If you get deeply into the engineering involved, you’ll find that the present g limit is as close to optimum as you’re going to get with today’s flight control system technology and F-16 aerodynamics. What this “limiter” ensures, then, is max command in, max performance out.

With the F-16’s g limiter, you can snatch symmetrically on the controls without fear of ever overstressing the aircraft. As a result, some of the initial moves you’ve seen the aircraft perform are astounding. In an amazingly short time, you can have more g than the other guy is even allowed. And then you can add another g or two over the next few seconds. If you try to match the resultant pitch rate in any other aircraft, you’ll only succeed in destroying the airplane you’re flying. In addition, the angle-of-attack limiter portion of the electronic flight control system will not allow you to pull the aircraft to an angle of attack where you can get in trouble (more on that later). External stores, however, are no different than you’re used to. You must still pay as much attention to the dash-one and dash-thirty-four as you have in the past.

Since fighters have historically done some funny things at elevated angles of attack and elevated roll rates, we can also instruct the computer to limit the available roll rate in certain portions of the envelope. The result is an F-16 that achieves 324 deg/sec maximum roll-rate command within the first 90 degrees — and this is then cut back as the angle of attack goes up or the configuration changes (e.g., the CAT III switch). There’s a series of flight parameters that the flight control system looks at in determining just what roll rate it’s going to allow, but I don’t have time to mention all of them here. (Take my word for it — trying to go completely through the flight control circuit diagrams in their entirety is enough to give anyone religion.)

Now, before someone comes up with what I’ve heard before (i.e., “My T-38 will roll 720 deg/sec.’”) let’s set a few things straight. First of all, that is a bogus number. The T-38’s actual maximum roll rate is barely half that value — and even then it only occurs during the third consecutive, full-deflection roll under optimum conditions, and is entirely too fast to be of any operational use. Instead, consider this: the F-16 is as fast to 90 degrees of bank as just about anything you’ll run across; and although there are areas of the envelope where the computer limits the F-16 to less than 100 deg/sec, you still have nearly twice the roll rate available, under similar conditions, as any adversary you’ll meet. From the obvious amazement of every adversary who views the F-16 across the circle for the first time, it’s obvious that this g and AOA “limit” is not a player in any engagement you’ll come across in the foreseeable future. But before we go on to other considerations, there are some other points about this “different” flight control system I should make. Recall that it’s a rate command system and not a displacement system, like you’ve been accustomed to flying. With a displacement system, we’ve all become accustomed to the different response rates we get as the airspeed changes. Therefore, we’ve become a nation of “samplers” — constantly reassuring ourselves that we still have control over the aircraft we’re flying. We do this on almost a subliminal level, and are not aware of this habit unless someone points it out. As the airspeed decreases on final, we tend to “sample” to ensure that we’ll have enough control left to complete the landing. As we try to fly really close formation, we
tend to sample to ensure in our minds that we've got enough control not to hit lead. And, because all displacement systems have a small "dead band" that we must go through, we again tend to sample to continuously reacquaint ourselves with just where the dead band ends and control begins. With some airplanes, we tend to keep the stick moving in an attempt to reduce the breakout friction to a manageable level. You may not be aware of this sampling phenomenon, but we all do it to some degree.

Now, enter the F-16—with a rate command system that supplies good, constant pitch and roll response so long as the aircraft is physically capable of flying. Further, there is little or no dead band associated with the F-16. Also, since we are not actually "moving" anything mechanical, there is no friction to consider. So the moral of the story is this: If you don't want the F-16 to move, don't move the stick! This is NOT to say that the F-16 is "too sensitive." Quite the contrary, it is simply a tremendously RESPONSIVE airplane. Resist the temptation to sample or you'll get response in spades. Although this seems like a simple request, old habits die hard, so pay attention to how you're flying the F-16. Become aware of just how you're manipulating the stick and your impression of how hard or easy the F-16 is to fly will improve. Remember—if a correction is necessary don't be afraid to move the stick, but if you don't want the F-16 to move, don't move the controls (i.e., don't sample).

It is also very important to realize that this rate command system works both ways. That is, if you move the stick, you get response. But conversely, if the airplane moves and you haven't asked it to, the flight control system will try to damp that motion without any help from you. This system is not too different from some of the stability augmentation systems you've seen in previous airplanes, with the exception that this one has more authority...much more authority than you've ever seen before. THIS black box is occupied by an 800-pound gorilla, not by some of the squirrels you've had in earlier airplanes. You guys who really look into control systems will be able to see bits and pieces of this "rate" command system in other airplanes. The F-111 (GD's 'other' airplane) had some aspects of a rate system creeping into the picture. The F-15 and certainly the F-18 share a lot of this design philosophy. However, none go to the lengths the F-16 does in controlling the basic airplane.

One result is the F-16's very good ride at high airspeed and low altitude. As soon as the F-16 is disturbed by any type of turbulence, the flight control system has a correction in, almost before you can think about it. This self-correcting feature is why you see the horizontal stabilizer moving around so much during taxi. The flight control system is not getting any input from you, but it IS feeling the aircraft move as you taxi across all the bumps on the taxi route. So, what you see is the flight control system trying to smooth out the taxiway. This is also why you don't have to put in any check command to stop the roll rate as you try to do any number of precision point rolls.

One minor drawback of this self-checking feature shows up in what has been described as "roll ratcheting." You will recall earlier we talked about how different the flight control system is, compared to what you've been using. The ability to do smooth rolls requires some concentration on your part until you become completely familiar with this different airplane. What's happening is that you're putting in some amount of roll command. Since the roll acceleration of the F-16 is so good, you make the subconscious decision that if you're rolling this fast, this quick, then in a couple of seconds you're going to be going nine million RPM. The natural tendency is to want to slow the roll rate. With a conventional flight control system we simply decrease the amount of stick deflection. In order to accomplish this we relax pressure on the stick and allow the self-centering forces to move the stick closer to center (i.e., less aileron deflection), thus slowing the roll rate to what we want; then apply sufficient pressure to keep the stick at the new position. This relaxing of pressure will normally go to zero momentarily, and with the F-16 this is sufficient for the self-checking feature to stop the roll rate completely. (Remember—you don't have direct control over the amount or direction of control surface deflection.) The roll rate deceleration is ALSO rapid, so your body and hand tend to couple with the aircraft motion and probably make stick inputs that weren't intended.

The end result is some pretty sloppy rolls until we get used to the system. What you need to do is (1) learn to adjust the roll rate with subtle pressure changes on the stick, and (2) get away from the stick position cues you've been used to using. Once you can get yourself "tuned" to using finite pressure changes to control the roll rate, you'll be able to make smooth roll inputs. This is so despite a force-per-roll-rate slope that isn't constant. There are two distinct changes in the slope of the curve. This is to make sure that the airplane isn't too sensitive for small inputs, and that the force required for max inputs is not too high. Those devilish engineers also used two different roll time constants for small and large roll inputs. All this is nice to know, but if you simply pay attention to the amount of force you're using on the stick, you'll be able to do very nice rolls with the F-16.

By now I'm sure all of you are asking why it's necessary to use such a markedly different flight control system. Well, this self-checking feature is really one of the main reasons this flight control system is in the F-16. It allows an aircraft design that uses new and different aerodynamic principles. In the next issue of 'Code One' we'll discuss these principles.
Aircraft and weapon system designers in unfriendly corners of the globe are not exactly hibernating, and while there is nothing to indicate that their technology is on a par with ours, there is every indication that it is not very far behind.

Let’s assume two things: (1) that men in one corner of the globe are about equal in native intelligence and ability to their counterparts elsewhere, and (2) that “friendly” and “threat” fighter aircraft performance capabilities are not so different as to give one a significant advantage over the other in the air combat arena.

Now let’s add lessons from history to demonstrate the fallacy of trusting the victory either to superior numbers (them) or to superior arms (us), skill, cunning, and plain old luck have often turned the tide on the battlefield.

So who has “the edge?” Who is likely to come out on top when we’re playing for keeps?

The answer has to lie in training. The modern air battle will be won by the man/machine combination that is best prepared for the ordeal. And this specific type of training is what the U.S. Navy’s Topgun program is all about.

Topgun is the nickname for the Navy Fighter Weapons School at Miramar Naval Air Station, San Diego, California. Run by the Deputy Chief of Naval Operations/ Air Warfare, the school accomplishes two major goals: (1) it trains experienced Navy fighter pilots to think, act, andfly like the pilots from threat nations, based on the best information that the Allied intelligence community can provide on threat pilot training, tactics, and aircraft performance capabilities; and (2) it allows Navy, Marine Corps, and Air Force fighter pilots to pit their aerial combat skills against these “threat” aircrews in actual sorties. Later, a videotape of the sortie is analyzed in a classroom environment, problems are noted and discussed, solutions are offered, and another sortie is flown.

In all, 35 sorties per class are flown by the students against “adversary” aircraft piloted by Topgun instructors. Additionally, the students receive 75 lecture hours on threat-related subjects.

The result is “the edge”—the ability to win the modern air battle, and to survive in the process. Even the most sophisticated fighter airplane in the world needs a skilled pilot. And to win, this pilot must have a fighting edge over his foe—a foe who is also flying a high-tech aircraft, has also received excellent training, and is also determined to win. Be assured there is no warrior’s field of honor at twenty thousand feet. No Red Barons. Only the stark reality of “kill or be killed.”

Aircrews trained through Topgun return to their home units where they serve as training officers to disseminate their knowledge to all military fighter and adversary squadrons.

The value of dissimilar air combat training has been documented. Navy fighter aircraft effectiveness in Southeast Asia increased dramatically after Topgun training was initiated. Since that time, pilots have honed their skills against “adversary” A-4s (slied up in several ways to increase performance), T-38s, and F-5Es.

But advancing threat aircraft technology has in many ways exceeded the ability of our adversary trainers to emulate threat capabilities. Without a worthy opponent to train
F-16N SAA Configuration

**ADVERSARY FEATURES**
- **Current Production F-16C Airframe with Common Engine Bay**
- F110-GE-100 Engine
- 6000-Hour Service Life
  - Cold Work Lower Wing Skin Holes
  - Titanium Lower Wing Attach Fittings
- 9g Capability with 2 Missiles and Full Internal Fuel
- APG-66 Multimode Radar
- Latest Cockpit Design
  - Multifunction Displays
  - Video Tape Recorder
  - Head-Up Display

**DELETIONS FROM F-16C**
- Gun
- ASPJ

Relative to current, real-world threat aircraft, the F-16N is slightly larger than the MiG-21, about equal to the MiG-23 and MiG-29, but smaller than the Su-27. The addition of radar is a new item for the adversary role, but it increases the training value by allowing instructors to "set up" their initial encounters more easily and to compensate for student errors. An excellent air-to-ground and air-to-air radar, the APG-66 will provide a more realistic electromagnetic environment for students to operate against.

Modifications unique to the F-16N include removing the gun, and removing the wing pylons and racks from the four under-wing stations. The resulting decrease in takeoff gross weight yields a thrust-to-weight ratio in the "plus one" range with full internal fuel.

The F-16's cockpit design will be appreciated by instructor pilots because of the outstanding visibility. The pilot sits rather high in the bubble canopy, and the absence of a forward frame gives the impression of sitting on top of the aircraft rather than in it. The standard F-16 seat is tilted back 30 degrees, and the pilot's heels are supported six inches above normal. This is an exceptionally comfortable attitude to sit in, and it also raises the pilot's g tolerance by 1.5-to-2 g. The F-16 has a design load factor of 9 g, the highest of any U.S. military aircraft, and the seat position enhances the pilot's ability to use it all.

The aerodynamic concept of reduced static stability, coupled with
a fly-by-wire control system, makes the aircraft very agile. From the instructor’s standpoint, the real beauty is the g and angle-of-attack limiters built into the system. The pilot is simply not allowed to “depart” the aircraft or to overstress the airframe. Of course, things like zero airspeed can defeat the flight control system, but they require unusual effort. The instructor can therefore fly to the very edges of the envelope while concentrating on his student, rather than having to worry about his own aircraft. And if the pilot lets go of the flight controls, the system commands one g and zero roll rate, so that the aircraft continues straight ahead. Once the F-16N is trimmed for level flight, no other trimming is required, regardless of airspeed, because of an on-board computer that maintains constant trim. Furthermore, the avionics systems will provide some caution warnings (low-altitude/terrain-clearance warnings, bingo fuel warning, predicted arrival fuel at primary and alternate destinations, and optimum profile guidance) should the pilot get too engrossed in his ACM training.

Contractor support, which has worked well in other Navy programs, will be provided by General Dynamics for day-to-day operations. The aircraft long ago completed USAF qualification testing and will have gained much operational experience prior to the first Navy delivery, scheduled for April 1987. A two-aircraft-per-month delivery rate will ensure that the first operational F-16N aggressor squadron is filled quickly.

The F-16N represents a forward step in the Navy’s threat simulation capability, and F-16N performance will ensure that Topgun training remains top-notch for years to come.

Size comparisons: F-16 vs. current threats
ENGINEERING FLIGHT SIMULATORS

The Technological “Edge” In Advanced Aircraft Design  
by J.D. (Jack) Drewett
Manager, Flight Simulation Laboratory

Back in the days of World War II, when aircraft production was a fledgling industry, fighter aircraft design was a relatively uncomplicated process (at least when compared to current standards). The time span from contract go-ahead to production was measured in months. The first production P-47 Thunderbolt, for example, was delivered 19 months after contract award.

Seems unbelievable, doesn't it? Remember, though, that the P-47 was a single-engine fighter whose only armament consisted of eight .50 cal., wing-mounted machine guns, aimed by a fixed, manual sight. The pilot depended largely on his skill and on the maneuverability of his aircraft to accomplish his air superiority mission.

About the only similarities between the P-47 and its modern counterpart, the F-16 Fighting Falcon, is that pilot skill and aircraft maneuverability are still two prime factors in maintaining air superiority. Beyond that, any comparison becomes a contrast. Today's fighter airplanes are faster, more maneuverable, fly higher, and carry more armament. And they perform multi-role missions, both day and night, in all kinds of weather. In addition, they carry a broad range of sensors (radar, infrared, TV), more sophisticated navigation equipment, aids for penetrating enemy defenses, and on-board computers with tens of thousands of software “words” to assist in managing this equipment... all crammed into an airplane similar in size to the P-47. The Thunderbolt seems a hollow shell by comparison.

The simple design task that forty some odd years ago was accomplished by a few people in a matter of months now requires many hundreds of highly trained engineers several years to accomplish. Consider that with each new airplane capability there exists a corresponding requirement for controls and displays to allow the pilot to exploit that capability. In other words, the cockpit has become the focal point for the integration of virtually all air-
plane systems. To accomplish this task, sophisticated new tools had to be developed.

The modern engineering flight simulator is such a tool.

Flight simulators are not new. The Link Trainer, for example, was first introduced in 1929, and has been used almost exclusively as a tool for pilot training. Recent advances in simulator technology, however, have given rise to a new generation of flight simulators that provide a degree of realism never before attainable. These new-generation simulators still provide pilot training, but are now used extensively to support the engineering design process, especially that part of the design process that has to do with pilot/vehicle interface (PVI). In fact, this part of the design process has become so complex and so important that the Fort Worth Division has established a new engineering directorate to deal exclusively with PVI.

Recognizing the need for a high-quality engineering flight simulator, the Fort Worth Division began developing the Flight Simulation Laboratory in 1980. By the end of this decade, General Dynamics will have invested nearly $100 million in this facility.

Why? What would cause one of the most successful airframe manufacturers in the world to invest that much money in a single tool - a flight simulation facility?

Actually, there are several reasons. One might think that the ever-escalating cost of conducting a flight test program would be reason enough to make such an investment — and in fact that is one very good reason. Flight simulators will not eliminate the need for inflight testing, but good simulation capability can certainly increase the efficiency of flight test programs by allowing first-order problems to be discovered in the laboratory rather than in flight.

Another reason is that the Air Force has recognized the wisdom of having an engineering flight simulator, and any airframe manufacturer without this capability could be at a disadvantage when competing for new programs. Perhaps the most important reason, however, is money. The money saved by discovering design errors prior to production can more than offset the cost of simulator development during the life of any modern, high-performance aircraft program. At the same time, we can produce a superior product through design validation and pre-production testing of new ideas or equipment.

To fully understand how a simulator can reveal design errors, it is helpful to consider the evolution of design requirements for a modern fighter like the F-16. First of all, the F-16 was designed as a single-seat, lightweight tactical fighter. This mission demands that the cockpit be as small as possible. Second, the airplane is required to have both an air-to-air and an air-to-ground capability. Third, the pilot must be able to attack a target without having to look down at his instruments. That means he must have enough “hands on” controls and enough “head up” displays to allow weapons delivery without removing his eyes from the target or his hands from the stick and throttle. Finally, the airplane must be capable of delivering a variety of weapons in an increasingly sophisticated threat environment.

What this boils down to, then, is a space problem. Weapons, navigation equipment, mission equipment, air traffic control equipment, penetration aids, firepower control equipment, airplane controls, and instruments are all competing for control and display space in the cockpit. The problem is further compounded by the need for flexibility. During the life of the program, new systems will
continue to be added to the airplane. The complexity of integrating the F-16 cockpit with the control and display requirements for all these systems provides the designers with enormous latitude for making errors — the kind of errors that heretofore were discovered only after the airplane was subjected to an extensive flight test program.

Today, this situation has changed drastically. With the introduction of the modern flight simulator, PVI problems are being discovered in a laboratory environment long before cockpit hardware and software designs are committed to production.

Let's look at how the flight simulator is used throughout the life of a typical high-performance aircraft program. To do this, we'll divide the program into four phases — conceptual, design, validation, and flight test — and we'll examine each phase to see how the flight simulator aids in its execution.

1. THE MISSION/SYSTEM ANALYSIS (CONCEPTUAL) PHASE: Long before an RFP is issued, mission requirements are studied and discussed with the customer, operational analyses of proposed designs are conducted, and candidate cockpits incorporating the latest in control and display technology are postulated. Full-scale models of these cockpits are then brought into the flight simulator where test pilots "fly" them in an artificial environment that closely matches real-world scenarios.

A PVI team (consisting of pilots, design engineers, human factors people, and many other engineering disciplines) joins with simulation engineers to run exhaustive tests on each candidate cockpit. It is during this phase that major issues are resolved; for example, will the cockpit be single- or two-place? How many displays will it have? What size displays will be used? To evaluate pilot workload, time lines are established for each pilot task. Then firm requirements are established for each control, display, and instrument to be installed in the new cockpit.

Finally, a new high-fidelity cockpit will be constructed, incorporating the best features of each candidate cockpit. Concurrently, a flexible software set will be developed to represent the rest of the airplane. This cockpit/software combination will then be used to support . . .

2. THE DESIGN PHASE: After the cockpit design has been conceptualized, the effort turns towards a point design. During the design phase, we use the flight simulator to examine, in detail, the mechanization of different weapon delivery modes, navigation modes, target symbology, target hand-off sequencing, etc. It is during this phase that mechanization requirements are established for incorporation into the operational flight programs (OFPs). OFPs are the software programs used in the on-board computers. Many simulator sorties are flown, by both company and government pilots, before the final requirements are released.

Another very significant output from the design phase is the restructuring of simulation software. Up to this point, little attention has been paid to software "partitioning." Instead, we've been interested only in making the cockpit behave as it should, when observed by the pilot. Now, before entering the validation phase, we restructure the software so that it begins to look more like the real airplane. To do that, we must partition the software such that all radar functions are in the radar model, all fire control computer functions are in the FCC model, all stores management set functions are in the SMS model, and so forth. It then becomes much more difficult to make changes, but by this time fewer changes should be necessary.

3. THE VALIDATION PHASE: One primary activity in the validation phase is to verify that OFPs are ready to support real flight. To accomplish this, we replace the software models (created in the design phase) with real airborne hardware. Recall, for example, that we created a software model of the fire control computer. During validation testing, we will disable that software model and replace it with the actual airborne.
computer manufactured from the simulation specifications. (This little trick is possible because the software model was designed to communicate over a multiplex bus in the same manner as the actual airborne hardware.) The real computer will then be loaded with the same software (OFP) intended for the production airplane. This is sometimes referred to as "hardware-in-the-loop" testing. Each airborne computer is connected into the simulator in the same manner.

With the airborne computers connected into the simulator (as described above) and loaded with their respective OFP's, various mission profiles are flown until all mechanism requirements defined in the design phase have been verified and validated. To accomplish validation, each mode and sub-mode of every airplane system must be tested, and every OFP algorithm must be exercised.

Once the OFPs are validated, the simulator can then be used to perform tasks related to the next phase; e.g., test pilot familiarization, flight manual validation, and validation of aerospace engineering instructions (AEIs). AEIs are instruction manuals used to support the airplane during the interim before technical orders (T.O.s) are published.

At completion of this phase, the airplane is ready to support the flight test program.

4. THE FLIGHT TEST PHASE: Finally, the simulator is used to duplicate "squawks" and anomalies encountered during flight testing of the actual airplane. A test airplane is put through its paces at the USAF's test and evaluation facility at Edwards AFB. When a problem occurs, the sim-
ulator is used to identify the source, develop solutions, and validate those solutions — without further risk to the airplane or its pilot. Normally, finding the problem and designing a "fix" is not difficult, but difficulties can arise due to OFP complexities. Frequently, because of the interdependency of software routines, fixing a problem in one mode may actually generate additional problems in other modes. Therefore, before a single fix can be sent back to flight test, much of the testing done in the validation phase must be repeated.

Of course, ultimate fix confirmation can only be achieved through further flight testing, no matter how thorough the fix is tested in the simulator.

PHASE 4
FLIGHT TEST AND OT&E SUPPORT

But having this simulation capability significantly reduces the risks inherent in any flight test program. Couple this with the enormous complexities of modern aircraft development, and with rapid technological advancements, and few would argue the wisdom of developing a flight simulation laboratory capability.

In the next issue of "Code One", we'll discuss the engineering flight simulator — what it is, the different types, the elements that make up a simulator — and we'll describe the flight simulator facility at the Fort Worth Division.
When the F-111 was introduced in the mid-60s, it was a technological masterpiece—the first swing-wing aircraft ever put into production and the first aircraft with terrain-following radar, a feature that allows supersonic flight at altitudes as low as 200 feet above the ground.

Twenty years after its introduction into service, the F-111 is still a mainstay in the USAF inventory and, when compared to threat counterparts, is still technologically intimidating. But technology has not stood still since the first F-111 rolled off the assembly line at the General Dynamics/Fort Worth Division facility on Oct. 15, 1964, and the venerable F-111, while still an awesome aircraft, is beginning to show its age—especially in the field of aviation electronics, or "avionics." Signs of age, however, can be eliminated with a facelift, and for the F-111, such a facelift is called the Avionics Modernization Program (AMP).

For the F-111A, the AMP program is designed to replace aging bombing/navigation avionics with a modern, digital system. Even though the F-111 airframe has a service life predicted to extend well into the 21st century, the low reliability and frequent maintenance demands of the original bombing/navigation system adversely affect the F-111's readiness and mission effectiveness.

AMP is an integrated approach to on-going Air Force avionic upgrades, involving standardization of equipment, and incorporating current-technology hardware to achieve significant improvements in system reliability and maintainability at affordable logistic support costs. With AMP, the F-111A fleet will achieve a major advance in system readiness and mission effectiveness.

The F-111A AMP encompasses tasks to be performed by General
Dynamics, by its subcontractors and associate contractors, and by the USAF in the development and production phases of the integrated modification effort. Sacramento Air Logistics Center is the program integrator and General Dynamics is the technical integrator.

In the development phase, General Dynamics has subcontracted with (1) Rockwell Collins for the integrated communications-navigation identification set, (2) Sperry Flight Systems for the multifunction display set, (3) Teledyne Ryan Electronics for the Doppler radar set, and (4) Novatronics for the auxiliary communications panel. General Dynamics has developed, in house, the SRAM/ inertial buffer unit and the airborne video tape recorder control panel, and is developing software for the weapons navigation computer and the MFDS system functions.

Group "A" kits for installation of contractor-furnished equipment and government-furnished equipment have also been developed. In the production phase, General Dynamics will furnish only the in-house-built items; the remainder will be contracted between applicable suppliers and the USAF.

In addition to the FB-111A AMP, General Dynamics is under contract to assist USAF in upgrading the F-111D and F-111F aircraft. The F-111Ds will each receive an updated terrain following radar, and the F-111Fs will additionally receive an attack radar set. General Dynamics tasks for these AMP aircraft include studies and analyses, terrain following simulations, development and production of minor Group "A" modification kits, and support to Sacramento ALC for kit trial installations and kitproofing.

Associate contractors in the development phase include General Electric for the attack radar set, Texas Instruments for the TFR, Singer/Kearfott for the WNC and the advanced microelectronic converter, Litton Systems for the Air Force standard inertial navigation unit, Gould for the combined altitude radar altimeter, and Fairchild Weston Systems for the flight data acquisition and processing system (FDAPS). The FDAPS element is applicable only to the FB-111A AMP development flight test airplane instrumentation. Westinghouse is in the process of reaching General Dynamics associated contractor status in relation to their avionics intermediate shop-replacement program.

In the development phase, General Dynamics has modified one FB-111A aircraft to form an FB-111A AMP trial installation test aircraft. System tests following the rollout ceremony (held on schedule on 2 August 1985) are currently under way in preparation for flight testing. Initial functional flight testing of the trial aircraft will be accomplished at Fort Worth, DT&E and OT&E flight testing will be conducted at McClellan Air Force Base by Sacramento ALC and the Strategic Air Command.

General Dynamics will also furnish a kit for kitproofing in another FB-111A by Sacramento ALC at McClellan Air Force Base. The kit is currently approaching full capability for delivery to Sacramento ALC and is on schedule. In the production phase, General Dynamics will furnish the modification kits and all FB-111A, F-111D and F-111F aircraft modifications will be accomplished by USAF.

Due to the increased reliability provided by state-of-the-art avionic capabilities, this modernization program is tantamount to creating an entirely new aircraft—but for a mere fraction of the cost. Even at twenty years of age, the solid, proven F-111 airframe is still superior in its assigned mission. The addition of updated avionic systems will ensure that this important weapon system remains in the forefront of America's deterrent force for a long, long time.
LOOKING FOR A

LINE IN THE SKY?

by L. F. (Larry) Smith
Aerospace Safety

It's coming with the Block 15S software update for F-16A/B aircraft. Conceived as one means of reducing "controlled flight into terrain" (CFIT) mishaps, the "line in the sky" is a fire control computer (FCC) software function that will activate visual warnings on the head-up display (HUD), radar electro-optical display (REO), and fire control/navigation panel (FCNP) whenever preset altitude limitations are violated.

The -34 describes it as a "low-altitude warning system." The pilot sets his desired line in the sky by entering an MSL altitude value into the FCNP (DATA knob in ALT CAL; depress DATA OPT twice to get ALO in the alpha display; enter the altitude in the LMD). This value will be retained from flight to flight unless zeroed or reentered.

The feature is activated when the landing gear is retracted. Visual warnings will be displayed if the FCC determines that system altitude is decreasing below the pilot-entered ALO (Altitude Low) altitude. Whenever this determination is made (1) a flashing "break X" and the words ALT ALO (ALO flashes also) will appear in the HUD, (2) a matrix of Xs will appear on the lower portion of the REO, and (3) the words ALO and ALT will appear, respectively, in the FCNP's LMD and alpha displays. The visual warnings will persist until the climb rate exceeds 3000 FPM, altitude increases above the ALO value, or the FCNP CLR button is depressed. (Depressing CLR while the visual warnings are present resets the ALO value to zero.)

Whether or not line in the sky has a chance to reduce the number of CFIT mishaps depends entirely upon pilot acceptance and use of the feature. Please try it. If you like it, talk it up. If not, then tell us how to improve it.
Beware of Unintentional Side-Stick Controller Interference

by D. G. (Donald) Gwynne, Jr.
Aerospace Safety

If your F-16 suddenly enters an "uncommanded" right roll, the problem is not necessarily a flight control malfunction. Instead, you may be experiencing unintentional interference with your side-stick controller ("stick")—especially if you’re flying a B or D model aircraft and have a non-rated passenger in the back seat. Several recent F-16 incidents have pointed out a need to reemphasize the potential for such interference.

The probability of knee/leg interference increases when the passenger has his feet on the floor, as opposed to riding with them on the rudder pedals. When the feet are on the floor, the elevated knees can more easily contact the stick, causing an unintentional right roll.

Other possible causes of such interference are bulky equipment (or bulky passengers) and leg movements induced by g-suit inflation. (The latter was recently reported by an F-16A pilot, so no one is immune!)

Two things can be done to minimize unintentional interference:

1. The "dash one" says, "Adjust rudder pedals so that legs are flat on the seat cushion to prevent leg from hitting stick." As we have seen, however, a problem can arise when a passenger rides with his feet on the floor. This information should be considered by the pilot in command when briefing passengers or other pilots on what to do with their hands and feet during flight. This is not to say that passengers should be briefed to ride with their feet on the pedals, nor is it to say they should be briefed to ride with their feet on the floor. It is simply to point out the necessity to advise caution not to interfere with the stick, and to point out that the danger of interference is increased when passengers ride with feet on the floor.

2. B and D model aircraft have a flight control take-command function, via the paddle switch, that can allow override of unintentional control inputs. The take-command function was primarily designed to allow instructor pilots to override incorrect control inputs made by students, and to resolve a "transfer of controls" problem that resulted from introduction of the F-16's fly-by-wire flight control system. Flight controls in conventional two-seat aircraft are mechanically interconnected. When one pilot moves the controls, the other one can feel it in his controls. While this is a time-honored method of transferring controls from one pilot to the other, it doesn't work with the F-16's fly-by-wire flight control system which is characterized by limited displacement stick and rudder pedals. In this system, simultaneous inputs to the fore and aft sticks or rudder pedals are added together and the flight control surfaces are positioned accordingly.

The take-command function allows lock-out of any undesired input from the other cockpit—including inadvertent controller interference—provided that the STICK CONTROL switch is properly positioned prior to flight. The pilot in command should use the paddle switch to take control (i.e., lock out the other station) if interference is suspected—even if the occupant of the other cockpit insists he has not touched the stick. Such interference can easily go unnoticed by the guilty party, especially when caused by an inflating g-suit.

With feet on the floor and a fully inflated g-suit, a passenger can unknowingly interfere with the stick, as this photo so graphically illustrates.
AIS
Maintaining the "Code One"

No fighter aircraft in aviation history has enjoyed an operational readiness rate greater than that of the F-16 Fighting Falcon. This statement is not public relations hype, but a fact borne out by records from close to a million operational flight hours since the first F-16 was delivered. USAF personnel have long sung the praises of this particularly satisfying aspect of the Fighting Falcon design.

The aircraft's reliability record is the result of superior design, attention to detail, and exacting production methods. But that's not the whole story...
Regardless of how well a particular aircraft is constructed, it must still be maintained if it is to remain operational. The lion’s share of the credit for this airplane’s enviable readiness rate should go to skilled maintenance personnel, a highly reliable avionics system, and responsive logistics support. A critical logistics support element involves available, easy-to-use support equipment. This article is about that equipment and its contribution to the success of the F-16 program.

The avionics intermediate shop (AIS) is a major part of the F-16’s support structure. It plays a big role in keeping the aircraft flying. A small number of trained maintenance personnel can use this test system to rapidly process a large number of line replaceable units (LRUs), perform accurate repairs, and return the units to service with a resultant turnaround time that significantly impacts aircraft availability curves.

A typical AIS consists of four automatic test equipment (ATE) stations, a complement of interface test adapters (ITAs), and the software necessary to test the stations, the ITAs, and the LRUs. The stations are manufactured by General Dynamics/Electronics Division at San Diego, while the ITAs are designed and built at the Fort Worth Division. Software is developed at both locations, depending on application.

The four ATE stations have much in common (e.g., mechanical design, computer and peripherals, interface circuits, circuit-board test equipment, and software) yet each station is different due to “add-on” items that allow testing of certain LRU categories. The stations have the following coverage and features:

- **Computer/Inertial (CI) Station** — Tests the inertial navigation unit (INU), several flight control system units, and the fire control computer (FCC). Peripherals for this station include a boresighted pedestal for mounting and testing the INU, and a rate table for testing rate gyros and accelerometers. The rate table spins to simulate aircraft g forces.

- **Displays/Indicators (DI) Station** — Tests head-down and head-up display system components, other flight indicators, a penetration aids indicator, and the generator control unit. This station interfaces with an optical bench to automatically evaluate aircraft electro-optical display units.

- **Processor/Pneumatic (PP) Station** — Tests stores management system (SMS) components, the radar computer, two of the flight control units, and some penetration aid LRUs. The major station accessories are a vacuum pump and associated pneumatic controllers to simulate many combinations of air pressure and aircraft velocity.

- **Radio Frequency (RF) Station** — Tests most radar system components, penetration aid receivers and signal processors, and communication system LRUs.

![Typical Interface Test Adapter](image-url)

**F-16A/B AIS Field Reliability Assessments**

<table>
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<tr>
<th>FIELD MTBF (Hours)</th>
<th>USAF field experience far exceeds the projected MTBF goal at maturity. (USAF AFR66-1 data Nellis, Hill, MacDill, Shaw, Hahn, Kadena, Torrejon and Luke AFBs)</th>
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<td>2</td>
<td>Projected growth required to achieve specified field MTBF goals of 9 hours.</td>
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**NOTE:** Data points are 3 months running average for development and 6 months running average for USAF.
The ITAs are attached to the station, one at a time, to interface between the LRU under test and the station test circuitry. They contain the special circuits, fixtures, and cabling required to run a complete LRU test. Some adapters include special fixtures to apply cooling air while the unit is under test. The general design philosophy is to keep the ITAs as simple as possible.

The last major AIS component is software. This is really the "brain" of the system since it (1) controls what the ATE does and (2) allows it to run tests on everything from the station itself to the LRUs. There are three basic types of AIS software:

- **Control and Support** — Allows the computer to control all station functions and allows the technician to control the computer.

- **Self Test** — Provides comprehensive testing of all station parts. It can find over 90 percent of hardware failures in the ATE.

- **LRU and ITA Test** — Sends proper stimulus signals to the unit under test and measures and evaluates the responses.

The first two software types are written by the Electronics Division and the last category is produced by the Fort Worth Division. Over 150 software programs have been written for the AIS, and many more are in various stages of development.

A typical AIS development task contains several significant elements. Requirements for testing airborne systems are translated into specific test specifications that are provided to the Electronics Division, where required ATE hardware and software modifications are defined. These same test requirements are translated by the Fort Worth Division into ITA design requirements. After ITA designs are established by Engineering, they are provided to the Electronic Fabrication Center (EFC) where the hardware is manufactured. Parallel with ATE hardware changes and ITA fabrication, test software development is accomplished by Fort Worth Division engineers.

The next major development milestone is to integrate the modified ATE, the new ITAs, the new software, and the LRUs in an engineering evaluation test. Following this, a formal system compatibility test is run in which product suitability is demonstrated to the customer. When the customer is satisfied, hardware and software deliveries follow.

For the F-16A/B program, 38 ITAs were developed by the Fort Worth Division to support 50 airborne LRUs. A total of 43 ATE shop sets were produced. This hardware and associated software has been highly successful at operational AIS bases around the world since 1978, with a record-breaking operational availability of over 92 percent.

For the new F-16C/D aircraft, expanded test capabilities were required to support 15 new subsystems. This called for some major AIS changes, such as expanded computer memory, more interface connections, in-station test equipment modification, and the addition of a lightning-fast, microprogrammable test subsystem to check the faster computers used on the C/D aircraft. By August 1985—five weeks ahead of schedule—formal compatibility testing of this new ATE system was completed. Technical orders for the Air Force are being developed concurrently with the hardware and software so they will be ready for simultaneous delivery.

Many C/D LRUs are direct carryovers from the A/B aircraft. The C/D ATE stations now in the field can test these LRUs, but not the new C/D "boxes." Beginning in January 1986, stations that can test all C/D aircraft LRUs will be delivered. At the same time, older C/D stations will undergo upgrading efforts to provide this same capability.

The Fort Worth Division is currently developing ATE capability for two new electronic countermeasure (ECM) systems and planning ways to test systems which will be on next-generation F-16s. Meanwhile, the new-generation AIS for the F-16C/D will continue to provide the high performance and reliability levels that have been the hallmark of this system. It is always ready and able to support the missions of the Fighting Falcon.
SPO Transfers F-16 Weapon System Program Management Responsibility To Ogden ALC

by R. L. (Roger) Matthews
Principal Field Service Engineer

On 4 October 1985, another milestone in F-16 history was attained when full responsibility for the F-16A/B weapon system was transferred from the Air Force Systems Command (SPO) to the Ogden Air Logistics Center, Air Force Logistics Command. Program responsibility encompasses full system management, including engineering and configuration authority.

Principal participants in the transfer ceremony were Maj. Gen. Charles McCausland, Commander, Ogden Air Logistics Center; Maj. Gen. Ronald W. Yates, Deputy Commander/Director for F-16 Aeronautical Systems Division, Wright Patterson AFB; and Mr. John Barton, Deputy Director of Materiel Management, OO-ALC. Witnessing the signing of the official transfer scroll were representatives of AFSC, AFLC, Belgium, Denmark, The Netherlands, Norway, Israel, TAC, USAFE, PACAF, and General Dynamics.

Gen. Yates expressed enthusiasm and delight for all functioning groups in the F-16 program — from the design engineers at General Dynamics/Fort Worth Division through the users who mastered the weapon system's capabilities. He credited outstanding planning and execution within the F-16 Program Office, formed in 1975, for the rapid production of this amazing aircraft which he said represents a giant step forward, technologically, being the first airplane in the world to fly at 9 g, the first with fly-by-wire flight controls, the first to incorporate a multinational coproduction program (with three production lines in three different countries), "and the parts fit," he added.

"From that basis," Gen. Yates stated, "the F-16 program has grown into the premium success story for a new weapon system. By exceeding the target design goal, the equivalent of over 100 additional aircraft were made available for duty." It was further noted that the F-16 has the lowest accident rate of any fighter, at this given point in its life cycle, in the history of the USAF. "We started out with a goal of technology transfer that has been accomplished on a greater scale and in a shorter length of time than any other Air Force weapon system," Gen. Yates said.

"In short," he concluded, "this PMRT is a classic; the airplane is a classic. It is loved by designers, it is loved by pilots, it is loved by maintenance men, and it is loved by managers." He also said that it was a pleasure to transfer management responsibility to AFLC, and specifically to the Ogden Air Logistics Center, "which has been a committed and involved partner in all phases of the program."

In accepting PMRT for AFLC, Gen. McCausland stated, "The F-16 is making history, and we are proud to be a part of that history."

Although the interface with General Dynamics/Fort Worth Division may vary in certain procedural respects, it is expected that the Fort Worth Division will continue to play a major support role as OO-ALC assumes this new responsibility.

The F-16 System Program Manager's Office, OO-ALC, is headed by Col. William Tomlinsen, Chief, F-16 Acquisition Division. Mr. Keith Dumas is Deputy Chief.
Australians Receive First

F-111C PAVE TACK

The Australian Defense Minister and officials of the Royal Australian Air Force expressed high regard for that country's F-111Cs at the recent rollout ceremony for the first F-111C Pave Tack aircraft that has been modified in that country. Defense Minister Kim Beazley said the Pave Tack, guided weapons, and Harpoon provisions will rank the F-111Cs among the most capable strike aircraft in the world. The RAAF, like the U.S. Air Force, will continue to use the F-111 until well into the next century, he added.

Air Marshal John Newham, Chief of the Australian Air Staff, described the F-111C as the country's major defensive deterrent, a position he said it will retain for many years to come. Wing Commander Dave Palmer, who leads the F-111 unit at RAAF Amberley, Queensland, the base where the modification was completed and the ceremony was held, said, "There is no operational aircraft in the world today which could replace the F-111."

The aircraft that was returned to operational service at the rollout is the second RAAF F-111C to be modified with Pave Tack systems. The first was modified at Fort Worth and has completed flight testing at McClellan AFB, Calif. Many of the personnel on the RAAF team that modified the aircraft at Amberley were among the 30 who were trained in Fort Worth.

The Pave Tack configuration for F-111Cs is similar to that for USAFE F-111Fs, using the same pod retraction and extension concept. Pave Tack allows F-111 crews to find and strike targets more accurately in any weather condition, day or night. The RAAF installation also permits F-111Cs to carry and launch Harpoon, a radar-guided, surface-skimming, anti-ship missile.

With some continuing General Dynamics technical support, the RAAF will use Fort Worth-supplied kits to modify 18 more of Australia's 24 F-111Cs to the Pave Tack configuration.
USAFOE
Surge Record
Broken

In USAFOE, the magic number is eight.

That was the average number of sorties per aircraft produced during a successful run at the USAFOE one-day surge record when 18 F-16As from the 496th Tactical Fighter Squadron, 50th Tactical Fighter Wing, deployed in October from Hahn AB, Germany, to Incirlik AB, Turkey.

The sortie rate broke the USAFOE record set last May by F-16s from the 612th TFS, Torrejon AB, Spain.

To establish the new record, 36 pilots from the 496th flew 144 sorties with 18 aircraft in less than 12 hours. One aircraft flew 13 sorties and 15 others flew eight or more. Only USAFOE flying first takeoff was at 5:25 a.m. local time. By 2:55 p.m. we'd broken the record and continued with the surge until 5:05 p.m." With 20 minutes remaining in the 12-hour surge period, flight operations were terminated because all 36 of the squadron's pilots had flown four sorties — the maximum number allowable under USAFOE regulations.

Of the 144 sorties flown, 136 terminated Code I (fully mission capable, no aircraft write-ups required), four terminated Code II (aircraft still partially mission capable), and four were Code III (aircraft requires maintenance, no longer mission capable). Fifteen of the squadron's 18 aircraft were still Code One when the surge ended.

For 16 days prior to the surge, 496th aircraft and crews averaged 48 sorties per day, prompting high praise from Col. Gommel for the squadron's maintenance personnel, both for their fine job prior to deployment, and for keeping the aircraft flyable during the recordbreaking surge effort.

"After 16 days, generating an average of 48 sorties — then producing the 144 sorties on the last day — takes a lot of pride and hard work," Gommel said.

The record-breaking team at Incirlik

As for the pilots, Gommel said they didn't just "fly around the flagpole." Each sortie averaged .774 hours, and the Colonel said pilots were required to complete 12 training events, including lowlevels, low-altitude intercepts, surface attack tactics, visual awareness training, and formation landings and takeoffs. ■
Homestead Gets
F-16 Fighting Falcons

The Fighting Falcon was introduced to the strategically important southern Florida region on 1 October in a ceremony marking the arrival of F-16A/B aircraft at Homestead AFB and the reactivation of the base's 306th Tactical Fighter Squadron, which will fly them. The ceremony also marked the redesignation of Homestead's 31st Tactical Training Wing as a Tactical Fighter Wing, with the 306th TFS being its first F-16 unit.

The ceremony began as Lt. Col. Ben Smith, Commander of the 306th TFS, and three other squadron pilots flew four F-16s over the base and landed near the flight line ceremony site. The air was again filled with the roar of a jet engine a short time later as an F-16C from Shaw AFB, S.C., piloted by Capt. Smokey Bauman, took off to perform an aerial demonstration. Capt. Bauman, of Shaw's 363rd TFW, highlighted the power and performance of the F-16 in a flight display that included Immelmann turns, rapid rolls, a high-g circular turn, and a vertical climb to 12,000 feet with aileron rolls.

Principal speaker at the event was Gen. Robert D. Russ, Commander of the USAF Tactical Air Command, from TAC Headquarters at Langley AFB, Va. "The F-16 is on the bow wave of technological change," Gen. Russ said. "The design of its aerodynamics and flight controls embodies bold advances that thrust us far ahead of our adversaries, earning the F-16 the enviable reputation of being the most maneuverable fighter in the world."

Gen. Russ listed some of the operational awards that have been won by F-16 units, and mentioned that the aircraft has "also proven itself in other ways. The most noteworthy is in posting very high standards for reliability, maintainability, and supportability. These factors combine to increase availability, and that relates directly to increased readiness, more defense, and more security for each defense dollar."

In his remarks, Col. Charles L. Henn, Commander of the 31st TFW, said the wing's redesignation to operational status "marks a return to the leading edge of the readiness sword. We will be ready to deploy anywhere, anytime, in support of our national security."
F-111 Team Wins Barrentine Trophy

The Barrentine Trophy for the best SAC Wing Competition Team for 1985 was presented to the 509th BMW, an F-111 unit from Pease AFB, NH, during the annual SAC Combat Weapons Loading Competition held at Ellsworth AFB, Rapid City, South Dakota. The 19-26 September competition culminated in an awards ceremony and banquet on the 26th.

The Barrentine Trophy was presented to Pease AFB by Gen. Lawrence D. Welch, SAC Commander, following competition between some 10 to 15 SAC units from all over the United States and from Guam. Pease AFB won several additional awards, including Best Munitions Maintenance Support Equipment and Best FB-111 Load. Dyess AFB, Abilene, Texas, won the award for the Best Security Police Unit.

The Ellsworth competition is one of two major SAC competitions held annually. The other is a bombing competition at Barksdale AFB, Louisiana. While the bombing competition focuses primarily on the aircrews, the loading competition features enlisted personnel from munitions and security police squadrons. The competition includes written examinations, equipment and personal appearance inspections, and performance contests in weapon loading and subsequent security of "combat ready" aircraft.

Throughout the week, Munitions teams were required to load B-52 and FB-111 aircraft — in a simulated combat environment — with various weapon configurations. Speed, accuracy, and safety were factors judged by the Maintenance Supportability Evaluation Team (MSET).
F-111 Safety Awards

The 366th Tactical Fighter Wing at Mountain Home AFB, Idaho, operating F-111As, has been named winner of a logistics award and two safety awards. The wing will receive the Tactical Air Command's Flight Safety Award and the Air Force Flight Safety Plaque in recognition of one year of flying without the loss of an aircraft or life because of pilot error or training deficiencies. In addition, it will receive TAC's Best Mobility Program Award, a logistics award honoring outstanding achievement in mobility readiness.

Next Issue

In the course of filming the General Dynamics' movie OUT OF THE SUN, a number of famous fighter pilots, all of them aces, were interviewed. For the movie, which dealt with the evolution of the fighter aircraft, use of these interview segments was mostly confined to the aces' experience and philosophy relative to fighter design and comparative merits. This material, however, represented only a portion of most of the interviews; leaving unused the sometimes humorous, sometimes soul-searching and poignant remembrances as well as the vivid, first-hand accounts of air combat.

To leave this material unseen and stored away seems to be such a waste that we have decided to solve the problem by publishing some of the most interesting portions of the interviews in Code One. So in the next issue we will begin a series of these interviews to be presented in their original question and answer form.

Logistics Management Award

Col. Clifford W. Bingham, Deputy Maintenance Commander of the USAF's 48th TFW at RAF Lakenheath, England, which flies F-111Fs, was named the 1985 recipient of the Gen. Thomas P. Gentry Award for logistics management. The award is presented annually by the Air Force Association.
EDITION'S NOTE: Cody will be a regular feature in Code One magazine. In future issues, our maintenance expert will bring you safety tips and maintenance hints to help you keep your F-111s and F-16s "code one."

HI! MY NAME'S CODY, AN' I'M THE BEST MAINTENANCE MAN IN THE ENTIRE U.S. AIR FORCE.

YOU NAME IT, I'VE WORKED ON IT.... IN SAC, TAC, MAC, ATC - AN' EVERYTHING IN BETWEEN!

IF IT FLIES, I CAN FIX IT. YEAH, I GUESS THEY JUST DON'T COME ANY SHARPER THAN ME!

YESSIR, THEY'D HAVE TO GET UP PRETTY EARLY TO PUT SOMETHING OVER ON OL' CODY!

KISS ME, I'M IRISH!
F-16 TEAMS SWEEP GUNSMOKE '85