THE MAN - MACHINE CONFLICT IN HIGH PERFORMANCE TAC AIRCRAFT

by

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I regard it as rather a privilege to have the opportunity to discuss with you a subject which I am certain is very close to all of you in your activities and pursuit of aircraft development.

It is my understanding that the discussion of the man-machine conflict is generated by the dilemma constantly confronting the aircraft designers on the one hand, and pilots and aircrews on the other.

Conflict is defined as mutual interference of opposing or incompatible forces or qualities.

For the purposes of this discussion, let us confine the man portion to the tactical fighter pilot, although in general the same situation prevails with other aircraft and crews, and since the conflict is more acute with increasingly de-

manding aircraft, perhaps we should think of performance characteristics reaching into mach numbers of 2.0 to 2.5, high tolerances such as characteristic of fighter aircraft and rather short take-off and landing distances, but most particularly a machine equipped with a fire control system enabling rapid, accurate delivery of the spectrum of weapons from conventional to nuclear in both the air-to-air and air-to-ground roles.

We started our activities over fifty years ago and ever since then the folks at the bicycle factory have been in a quandary attempting to guess how much assistance in the way of automation will fit the pilot's needs. With very little research, one can be convinced that since the days of the Lafayette escadrille and those renowned pilots with their inventiveness, initiative and courage, we have gone inexorably from the simple to the complex. Periodically, efforts to hold the line and prevent further increases in complexity of the air machine are made.

The safe haven of the womb of simplicity is very appealing. Every fighter pilot desires to return to it. He is riven, however, with the knowledge that our technical people can and will provide him with capabilities which will enable him to outstrip his contemporaries, foreign or domestic.

Very briefly, let us trace the highlight of combat fighter development and sophistication and I believe that you will immediately associate these and other changes with the intensification of the man-machine conflict. Advances in aircraft performance, increased capabilities in weapons, multiplicity of missions and tasks, day, night and all-weather use, altered tactics have inevitably led to more complex duties for the fighter pilot.

There is no need to go over the missions of close air support, interdiction, air superiority, reconnaissance and airlift. You are all completely familiar with these.

Beginning with the fixed sight synchronized machine gun of World War I, and dive bombing which required a sight or an aiming device, the introduction of so-called "blind flying" in the middle twenties as pioneered by Jimmy Doolittle brought us to the beginning of World War II, with the fighter pilot content to deliver his ordnance visually in daylight with what we look back on as rather primitive methods. Parenthetically, I might add, almost in the same fashion we are doing in Southeast Asia today. Later an elite lead computing gun sight was furnished, rockets were introduced and things began to get more and more complicated.

The involvement in the nuclear strike role with its inherent instrumentation or automation procedures appeared. Auto-pilots appeared in fighter aircraft. And some genius invented the LABS maneuver.

Long range deployments became necessary, generating requirements for more sophisticated navigation systems. The air defense fighter proceeded on a parallel course in constantly increasing complexity. I'm sure all of you are aware of these things and I could go on in much more detail and at greater length. The ultimate now found its expression in the F-111. The fighter aircraft had to be able to do all things at all times for all people under all circumstances everywhere in the world and a fighter pilot must be trained to do this.

Let's look at this tactical fighter pilot who is supposed to do these things. He is 27 years old. He averages two years of college, two thousand hours in a flying machine and today he's been on deployments almost everywhere on the globe.

He is a pretty capable individual.

And he won't turn down assistance.

Since we have about a million dollars invested in him, perhaps we should try to help him out, and hence provide him with some automation, mechanical assistance, pilot relief or aid in making a decision. AID IN MAKING A DECISION.

Here is the crux of our discussion.

This individual can be helped in a myriad of ways — mechanically, electronically, by advice from the ground, by ground based aids, by airborne aids, by drill and preparation, etc. But he still has to make the decision. There is nothing that we can provide him with which will make the decision for him 100% of the time and infallibly.

Unlike a bomber pilot's decision which can be made almost hours in advance, except for minor refinements, or a troop carrier aircraft commander's decision, which similarly can be made almost before he leaves the ground, or an air defense interceptor pilot's decision, which is oftimes made for him from the geometry of the attack by ground based environment. The tactical fighter pilot, on a dive-bombing, strafing, rocketry, bull-pup, shrike, napalm or any other conventional ordnance delivery, or for that matter, nuclear delivery, cannot can his attack program. Most importantly, however, the decision making processes which he must undergo in air-to-air combat defy automation.

We have tried to make this decision making process simpler. We have put two pilots in an aircraft. However, there comes a time when one man has to make a decision. He can be assisted by the second pilot but the pilot in command still has to make the decision.

The ups and downs of assisting the pilot can be seen in the narrow sphere of an interceptor decision. We have seen the F-86D, single pilot, F-89, and F-94, pilot and radar observer. Back to the 102 with a single pilot, thence to the 101B with a pilot and radar observer, and back to the 106 with a single pilot. We know the mission did not change, the pilots did not suddenly become dramatically more capable or less qualified so other factors must have caused the changing new composition.

I would like to digress for a moment and talk about the individual fighter pilot.

He learns and accumulates experience, and the more this takes place, and in some cases the more frequently it takes place, the more he improves. You can teach him with simulators and build up his experience, build up his learning process and complicate the problems which we present him until he becomes literally an expert.

Incidentally, this poses one of our greatest problems, because when we present an expert professional fighter pilot with ten years experience to someone who has not undergone this training and accumulated similar experience, unless he can lucidly explain it, we are literally tongue-tied and some peculiar conclusions are drawn.

We have found, also, that the pilot can transfer to a large degree this training and experience from one machine to another machine. Hence our conversion from one fighter aircraft to another is usually simplified.

This man makes mistakes. I recall once, briefing General Lemay, as was the custom in those days for fighter wing commanders at SAC to brief any accident to the commander. I was landing a flight of four at Eglin 6 after an air-

to-air gunnery mission in F-84F's. My number four man landed six inches short. There was no over-run. He hit the lip, bounced sideways on the runway, wiped out the gear, dug and destroyed the aircraft. General LeMay's comment, upon my describing this, was, I could build a runway completely surrounding or circum-navigating the glabe and one of your best fighter pilots would land short.

These fighter pilots are error prone.

Moreover, errors are unpredictable.

Not long ago, when I commanded the 4th Fighter Wing of 105's, I had a pilot who was returning to MacDill and on landing picked up the gear handle instead of activating the drag-chute. He realized his mistake in time and — this was a nimble act — slammed into burner and managed to get the aircraft off, having ground off the edge of the left gear joining the left pylon tank and the ventral fin. Thirty days later, the same pilot performed the same maneuver, only this time he didn't get into burner in time. And he wiped out the aircraft. I don't know how this could have been predicted even though it was a direct repeat by a highly qualified pilot.

The fighter pilot has some intense motivation.

In the first place, he wants to excel. If he doesn't, this soon becomes very apparent and he disappears.

Secondly, and associated with his desire to excel, is his desire to progress. He has to be able to sense responses in the aircraft, learn, and then predict.

Additionally, and not particularly minor, is his desire to live. And so he is motivated to make decisions which prolong his life.

He finds himself in a different situation at least once every flight. The more complicated the flight environment, the more decisions he is confronted with.

And then we try to help him.

We try to remove the indecisiveness by confronting him with instruments which enable him to make a positive decision; we try to provide him with assistance which will relieve his fatigue, such as an auto-pilot; we try to provide him with all the information we can assemble from the ground and transmit to him to assist him verbally so that he can make an intelligent decision, and then we, in our cosmic wisdom, present him with an aircraft and say, have at it.

Now let's talk about some specifics of the so-called man-machine conflict.

I think all of you will remember an apparently uncomplicated system for engaging the nose-wheel steering on the F-100. The original version allowed the pilot to hold down a button on the control stick and steer by moving the rudders. Then someone decided that it was an effort to hold the button over any prolonged period of time and incorporated a holding relay. Then all we had to do was press and release to engage or disengage. As you might guess, the inevitable happened since we had both systems and a pilot, in an emergency, held the button, cut off the holding relay and smartly ran off the runway. Then the safety people came into the picture and further complicated it by initiating the third modification, which incorporated the holding relay plus an over-ride circuit. And, in fact, this was a good mod, but several more accidents occurred before all the aircraft could be completed to one particular configuration. And I might add one additional point — the F-100 nose wheel steering had common junction points at the brake anti-skid, tail skid retract and landing lights. It needs very little imagination to visualize what an exciting night a pilot had when one malfunction left his aircraft without lights, brakes or steering.

The culmination of automatic weapons delivery occurred in the F-105. Pressure altitude and calibrated airspeed from a central air data computer ground speed and drift from a doppler radar. Vertical reference from a gyro platform and angle of attack inputs are fed to a toss bomb computer. The computer, in turn, gives an automatic solution for weapon delivery and release. All the pilot has to do is monitor the operation.

An accumulation of small solution errors places the aircraft outside the programmed release envelope where other program safety inputs prevent the release of the bomb. This effectively eliminates the pilot from the original delivery calculation, and hence the decision. It further adds the indignity of preempting his right to decide on an alternate release. Another example.

The popularity that air-to-air missiles enjoyed for the past decade resulted in the elimination of the gun configuration for the air-to-air role. Air defense fighters operating in a highly automated environment, utilizing sophisticated radar and missiles, obviously enjoy a high kill potential.

Almost no consideration is given to effectiveness of such missile armed fighters in an austere control environment.

Nor was adequate consideration given to the problem of sorting out a mix of enemy or friendly aircraft.

The F-4C, equipped with a high quality, complex fire control system, outstanding performance, is, unfortunately, missing in one vital item, the ability to positively identify friend or foe at radar range.

Without this the pilot is still reduced to visual identification of the enemy.

At this range, that is visual ranges, guns are very likely the best weapon for attack, particularly if the target is moving. And where do we find ourselves?

With a podded gun and a gun sight with less capability than that of late World War II.

Well, let's take an inventory on the conflict situation again.

Computers and sensors have far surpassed the expectations of most of us not only in their application, but also in their reliability. However, their decision making capability cannot substitute for the human mind.

Let me see if I can define where perhaps the automation begins to take over.

The unaided ability of a pilot limits his capability. Functions beyond the unaided ability of the pilot, either in an all-weather air-to-air or air-to-ground situation must, of necessity depend upon automation to some degree.

When such automation occurs, a manual over-ride ability must exist to provide for the prevention of disaster if nothing else.

One of the unfortunate but wholly natural characteristics of a fighter pilot is that he is fanatically opposed to removal of the decision from his hands to survive.

He insists on decision making prerogatives which either preclude his loss of life or enable him to complete his mission.

I doubt that any of us would argue, for example, that an automatic launch of an intercontinental ballistic missile based on an automatic threat level analyzer and other such devices should occur. Yet, when we consider a similar threat concerning the welfare of an individual fighter pilot, should we be surprised to find that he indicates a similar lack of enthusiasm for an automated response. When you trust a highly trained and skilled pilot with expensive equipment and a mission important enough to risk the loss of the equipment and possibly the life of the operator, then should you question or indict him for not

using automation when he is confronted with a decision which determines his effectiveness or his ability to survive?