A New Approach to Flight Simulation

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Introduction

The military services are expected to endure huge budget cuts and are looking for new efficiencies and innovative ways to save money. If objectively evaluated and tested, realistic tactical flight simulation using a high performance motion system that provides sustained G motion could prove to be a key new capability. As one element of an advanced flight training program, a flight simulator that flies just like a fighter aircraft including realistic motion offers better training at lower cost. In the paragraphs that follow three respected military officers, all retired and experienced in aviation, physiology and training, offer their insights in their own words.

General Hal M. Hornburg, USAF (Ret) served as Commander, Air Combat Command. He is a Command Pilot with over 4400 flight hours in: T-37, T-38, O-1, O-2, OV-10, F100, F-4D/E, F-15A/C/E, F-16C, KC-10, C-21 and T-6 Texan II.

I have flown flight simulators since 1968, and with more than four decades of hands-on experience, I have seen lots of changes, mostly for the good. Until recently, the highest fidelity simulation was only possible for larger airframes due to the inability to introduce realistic motion and G forces into fighter-type simulators. That limitation no longer exists. Follow me on a trip down Memory Lane.

My first “sim” experience was in a T-37 trainer. We called it a simulator but now know it as a procedural trainer. It remained stable, always at 1G, and allowed the trainee to watch instruments change based on power, pitch and bank. The “advanced” T-38 simulator was more of the same, but the airspeed indicator moved more quickly! Later, in the F-4 simulator, not much, if anything, had advanced. Finally, in the F-15 simulator, there was limited motion which provided transient motion cues to represent the appearance of movement, but it did not provide sustained G motion to accurately replicate the simulated aircraft movement. Most of the time, the motion was turned off due to a malfunction in one of the motion axes. The F-16 simulator? More of the same. The simulation community had introduced “part task trainers” into the family of simulation, but true replication of the flight environment didn’t exist.

In these trainers, we were able to learn instrument procedures, practice “switchology”, accomplish checklist items and get a good workout in emergency procedures. What we could not do was do what we did in the airplane. An intercept was “procedures only”. Since we couldn’t see the ground, we could not practice air-to-ground gunnery; and since we couldn’t see another airplane, air-to-air training was non-existent, except for conditions simulating night/weather.

My first experience in a real flight simulator was in the KC-10, with similar experiences in the B-2 and C-17. These simulators, like those used by the airlines, were actually like the airplanes they simulated. Some might be surprised to learn that when USAF pilots learn to fly a large plane, they learn almost exclusively in the flight simulator; then get one or two rides in the real plane, followed by their check ride. What a savings in flying dollars, airframe life and overall wear and tear on the aircraft. By contrast, simulators only play an adjunct role in fighter pilot training and most training is done in the aircraft. Why the difference?

Up until very recently, introducing motion into flight simulators and trainers was...
counterproductive. It’s well known that no motion is better than bad motion. It’s unrealistic and only serves to detract from the training environment, which is why motion in flight simulators was forgone for greatly improved visuals and eventually linking in a DMO environment. However, recent breakthroughs in centrifuge technology have finally allowed for the right motion, with high fidelity, to be available today in a high performance motion system. Today’s realistic motion is superior to all previous concepts and has afforded an opportunity to inject realism into tactical flight simulation. So what’s the problem? It’s that the centrifuge has been the pilot’s enemy since the early 1990’s. The USAF was losing so many planes to G induced loss of consciousness (GLOC) that it mandated all pilots flying fighters go to Holloman AFB, NM for “G Awareness Training“. The problem was that if you didn’t pass this training, you had a great opportunity to lose your wings, or at the least your fighter aircraft assignment. The program wasn’t designed to be punitive, but pilots soon learned that a bad experience at Holloman could have long-term, adverse effects on one’s career. Most pilots would much rather have had a tooth pulled without Novocain than take a spin in a centrifuge.

This has created a negative mind set with some key decision makers (read: fighter pilots) with regard to the utility of centrifuge motion being the missing ingredient to true, full motion simulation for fighter aircraft. However, I’ve flown an advanced human centrifuge with tactical flight simulation capability and believe in it. Realistic tactical flight simulation is possible with today’s technology and reasonably priced in a high performance motion system such as the Authentic Tactical Fighting System (ATFS). This technology is ready for prime time.

I spoke to an A-10 pilot who used ATFS to practice night, pop-up attacks. He told me he “crashed” the simulator three times before he learned, under G force, when he needed to look outside and when he could afford to take a peek at his charts or instruments. I hate to think of the number of pilots who would have liked to have this opportunity. I think back to the number of times I’ve either been giving or receiving training in a fighter that could have been done in a simulator, had the environment been realistic enough to directly translate to the airplane. So much airframe life could have been saved and so much money spent on fuel could have been spent on something else.

I am not suggesting that fighter pilots should fly their planes every once in a while and get the rest through simulation. There is no substitute for the real thing. But what I am saying is that there are many tasks that can be learned from simulation – the planes can be used for the advanced work and not to practice and learn basic and apprentice level skills and tasks. Huge budget cuts may drive an alternative approach to flight training, and any alternate approach needs to be objectively evaluated.

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My Naval Aviation experience included 13 years in A-7E Corsairs (two squadron tours and a Fleet Replacement Squadron (FRS) Weapons instructor tour), and four (4) years in F/A-18 Hornets (squadron commander). During these years of operational flying, I spent hours in the state of the art simulators of the day – full motion cueing weapons simulators, carrier landing simulators and part task trainers. None of these simulators could compare to the realistic training that is currently available in sustained G simulators.

I support Gen Hornburg’s conclusion on the value added by sustained G simulation. Many of his experiences with tactical aircraft simulation are similar to mine so in the interest of brevity, I will add only one unique event in my flying career.

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As a junior Commander, I was selected for transition from the A-7 to the F/A-18. The performance difference between these two aircraft was extraordinary. Despite thousands of hours in the Corsair, I spent many hours in the Hornet learning to maneuver the aircraft at maximum performance. Although we had superb simulators, they were of little value in learning the performance envelope of the aircraft. If sustained G simulation had been available, a few missions in the trainer would have saved the far more costly flight hours and wing life of a Hornet. This technology exists today in the ATFS.

If a sustained G training system existed when I was Commander, Naval Air Forces, I would have invested in it.

Major General (Dr.) George K. Anderson, USAF, MC (Ret) served as deputy assistant secretary of defense for health services operations and readiness, Department of Defense, the Pentagon, Washington, D.C. He has ratings as a Chief Flight Surgeon and a commercial pilot.

As a young military physician, I had the good fortune to serve tours of duty in Korea and Germany providing aeromedical support at the fighter squadron level. I served with General Hornburg, and flew with him in the F-4E. This richly rewarding flight surgeon experience served as a stimulus for my career-long involvement with human performance related medical support and research activities. Over the years I spent many hours experiencing the high G environment on the human centrifuge at Brooks AFB and in research aircraft at Edwards AFB as we pursued programs to provide better equipment and enhanced training for fighter pilots.

Although G Loss of Consciousness (GLOC) had been experienced by pilots ever since they began flying high performance aircraft, this problem became acute for the USAF when F-16 pilots encountered that aircraft’s high G onset rate, which changed the game regarding physiological response to high G. An intense aeromedical research initiative was undertaken and an elaborate education and training program was developed aimed at reducing the number of GLOC events. Although successful, this program included a human centrifuge experience for pilots that provided an unpleasant exposure to G. Even worse was the fact that the experience was not a true simulation of G induced physiologic stress sustained by pilots in the aircraft.

Today we can provide pilots with accurate simulation of flight in the high G domain. From an aeromedical perspective, in order to improve the simulated flight experience, several factors need to be considered. Efficient learning transfer from the simulator to the aircraft and avoidance of the potential for negative training depend on the creation of an authentic learning environment. This environment must address all areas of simulation fidelity including: cockpit layout, flight controls, visual and avionics displays, aeromodel, environmental factors (vibration, noise, heat, smell, etc…) stressors, and sustained G motion. Because sustained G motion has been ignored over the past several decades, pilots could not receive the benefit from full flight simulator training. The lack of sustained G and continuous motion capability created a training environment that was benign when compared to an actual flight experience flying a high G capable aircraft. Simply put, because flight simulation without realistic motion cueing fails to provide accurate physiologic stress, it is not full flight simulation.

The ATFS presents a solution to this simulation shortfall. By providing the pilot with an authentic sustained G environment, skills learned in the simulator can transfer to the aircraft. Further, G tolerance is a perishable skill that must be periodically refreshed. Although the motor skill aspect of the Anti-G Straining Maneuver (AGSM) can be refreshed in a traditional centrifuge, the psychological skill involved with the AGSM cannot. This skill is a discipline that the pilot must execute correctly every time while in a dynamic, high stress environment. The pilot must have the discipline to know when to start the AGSM, how to modulate the intensity of the AGSM, and
when to stop the AGSM. This is the most sophisticated portion of G training and it cannot be trained in a traditional simulator or in a legacy centrifuge. Pilots must be allowed to practice and learn both skill elements of the AGSM in an authentic environment that stresses them in the same manner as they will be in the aircraft. By using ATFS technology, AGSM physiological training can be built into a realistic simulated aviation experience with the stress that comes with high G exposure and rapid onset rates.

The USAF experienced a significant reduction in GLOC episodes when it instituted G training in the late 1980s. While this represents a significant benefit, the fact remains that GLOC mishaps still occur. ATFS can address the remaining GLOC problems by allowing the pilot to refresh G tolerance skills in a safe, economical, and fully authentic environment. Additionally, from a human performance perspective, a pilot's G tolerance and G readiness (i.e., currency) should be evaluated as monthly flight hours are reduced and monthly hours of training in flight simulators are greatly increased. It's worth asking the question whether G tolerance and G readiness have been considered in the decision making process resulting in more flight training hours in non-motion part task-flight simulators.

**Summary**

The approach to and method of tactical flight training simulation has not changed substantially over the past 30 years. In order for tactical flight training simulation to become an effective tool for maintaining combat capability and operational readiness, particularly as more flight training is conducted in flight simulators, new sustained G flight simulation technology needs to be explored, evaluated and implemented as an additional training tool in flight training continuums.