How to be a Good Stick in LOMAC

by **Leon "Badboy" Smith**

Introduction

In this article, I would like to discuss how to get the best out of the fighters in LOMAC in terms of their maneuverability. When you are done reading, you may find the conclusions surprising, even counter intuitive, but if you bear with me, I believe you will see an immediate and significant improvement in your ability to out turn your opponents, real or virtual. With a little practice, everyone will be able to benefit from these ideas.

Let's begin with an example. You are engaged Within Visual Range (WVR) against a bandit and your assessment of the geometry and relative energy states involved, combined with your knowledge of BFM and weapon employment, suggests that a hard turn is required. Having banked so that the aircraft's lift vector is appropriately positioned you pull back on the stick, you pull back so hard and so quickly that you immediately lose peripheral vision as the screen begins to fade and the audible warning makes it clear that you are at the maximum G. The urgency of the situation, fed by the adrenalin rush, forces you to hold full aft stick, so that as the speed drops you overshoot the maximum angle of attack, and the audible warning changes to alert you of the new danger, you continue to pull back hard as the excitement mounts, but the bandit begins to gain angles and you sense that you are being out turned. As you take another ride on the silk elevator, you can't help thinking what it was you did wrong. You might wonder if your BFM was at fault, but few would suspect that the fight was lost due to an even more basic mistake.

Remember when you flew your very first flight sim? It didn't take very long to figure out that pulling back on your flight stick made the nose of your aircraft rise up into the sky. If you also banked the aircraft by moving the stick sideways, the aircraft could be made to turn in any direction. Nothing complicated about that right? Wrong! There are two important considerations. The first is relatively well known, it is about knowing when and in what direction to move the stick, and to do that you need to know where you are, where you need to be, and how to get there… That requires knowledge of Basic Fighter Maneuvers (BFM), and you can find a lot of information here at SimHQ on that subject. Much less well known, and even less well understood, is that how fast and how far you move your flight stick is as important as where you move it. Being a good stick is not only a question of just getting the stick where it needs to be as quickly as possible, although in some simulations or situations that can be true. How rapidly, how smoothly, and how far you move the stick has such an influence, that it can make the difference between winning and losing a fight. It was not what you tried to do, but how you tried to do it. The real question is not just about where you want to be, but about how far and how fast you should pull back on the stick to get there?

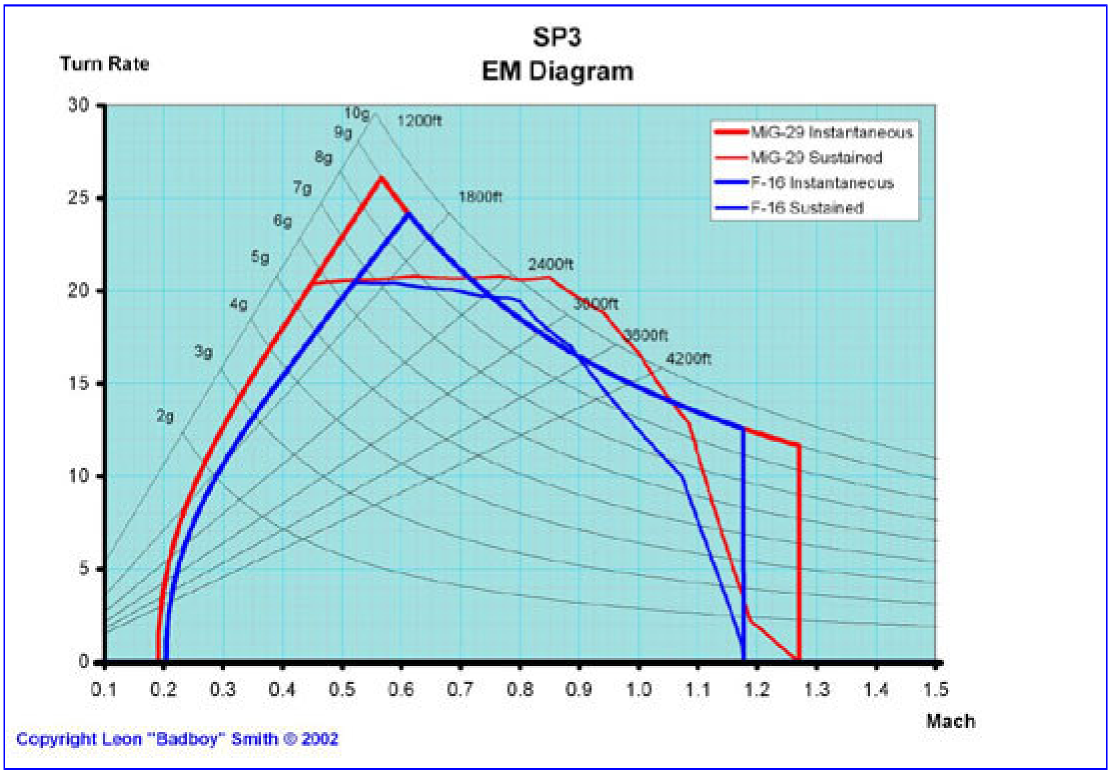
The answer to that question depends on many things, but let's just focus on some things that depend more on the nature of the modeling in the simulation than on the BFM requirements of the engagement. In many simulations, the pilot physiology model that controls how and to what extent black outs occur, have an influence on this. There is an old saying in air combat, "Lose sight, lose the fight" and so most flight sim' pilots will only pull back far enough on the stick to avoid blacking out. Many simulations also model the effects caused by how rapidly G onset occurs, and that isn't just about how far you pull the stick back, but how quickly you pull it back, with the possibility of overshooting into brief excursions of excessive load factors. So those considerations place an upper limit on the speed and extent that a wise pilot will move his stick, but that only applies when the aircraft is above corner velocity and thus fast enough to generate high G forces. The snag is that inexperienced flight sim' pilots, excited by the prospect of a hard turning engagement, and uninhibited by a lack of physical discomfort that would normally be associated with a hard turn in a real aircraft, find it difficult to control the urge to simply pull the stick back as rapidly and as far as it will go. They figure that the harder they pull on the stick, the faster the aircraft will turn. It takes a lot of experience and confidence to have the self control required to ease the aircraft into the turn and increase the load gradually to the edge of the envelope. The big question is of course, since flight sim' pilots don't actually suffer any physical discomfort in a turn, is there any point in holding back? Why not just get to the edge of the envelope as quickly as possible and stay there for as long as possible? Also, we all know that many WVR fights end up getting slow, so what happens when the aircraft is below corner velocity, where lower G forces aren't such an issue, what happens then? Why not just pull that stick back as far as it will go, as fast as you can get it there and hold it there for as long as possible? That is commonly known as using G for brains and in some situations, and in some simulations that is exactly what you should do, but why?

Simply because the problem is well known, and it has been solved for some pilots in the design of their aircraft. For example, F-16 drivers, don't have to move the stick very far at all, control commands are obtained from the force applied to the stick, rather than its movement, and the response is computerized so that sudden and large control forces commanding pitch or roll motion are interpreted and suitably damped into acceptable pitch rates so that angle of attack and load factor overshoots are prevented. The control laws that are hard coded into the software of the fly by wire system solves the problem for you, and can easily make an average pilot good, the snag is it can also make a great pilot good.

The Falcon4 simulation did a fine job of modeling the F-16, including its fly by wire system. Those of you who are familiar with that simulation will have enjoyed the benefit of the F-16s control laws, and will have been given the ability to haul your flight control stick back as hard and as fast as you wanted, confident in the knowledge that the consequences of flight envelope excursions, departures, damage to the aircraft or the pilot, or rapid energy loss, would either not happen, or be within tolerable limits.

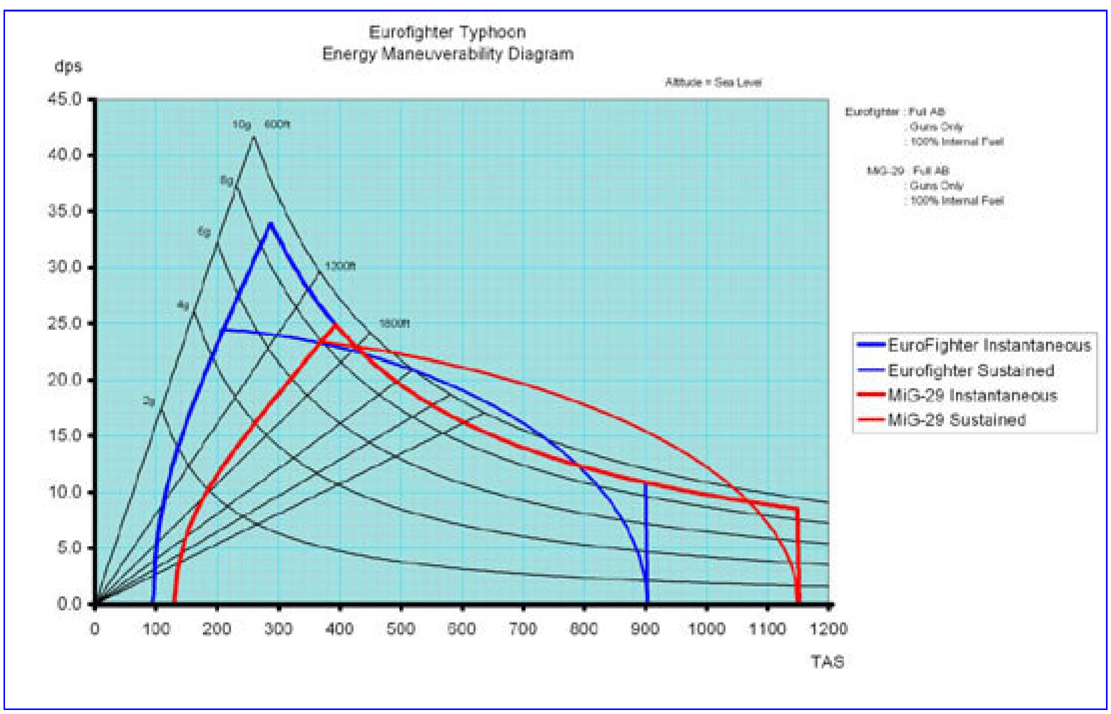
Just to press that point home, let's take a look at the energy maneuverability diagram for the F-16 as modeled in Falcon4's SP3 and to make it interesting, let's overlay it with the diagram for the MiG-29 as shown in *Figure One* below. Notice that for the F-16 the sustained turn curve (Ps = 0 curve) actually rises continually to the left, so that the sustained turn rate increases as the aircraft gets slower. In that situation, as you pull back harder on the stick, not only will your speed decrease, but your turn radius will decrease, and your turn rate will increase… So, it is clear that you should ideally pull back hard on the stick and keep it there!

Figure One



A similar situation can arise in simulations as a result of the combined drag and thrust model that results in a Ps = 0 curve that also rises as speed drops. An example of an overlay for the Eurofighter and MiG-29 from the Eurofighter Typhoon simulation is shown in *Figure Two*. Notice again that the sustained turn rate actually increases as the speed of the aircraft drops, so holding full aft stick and allowing the speed to decay actually improves your sustained turn rate and decreases your turn radius, a similar situation to Falcon4, but for different reasons. In Falcon4 it was due to the Angle of Attack limitations imposed by the control system modeling, and in Eurofighter, and many other simulations it is due to a combination of the thrust and drag model. However, neither is true in LOMAC, G for brains won't work!!

Figure Two

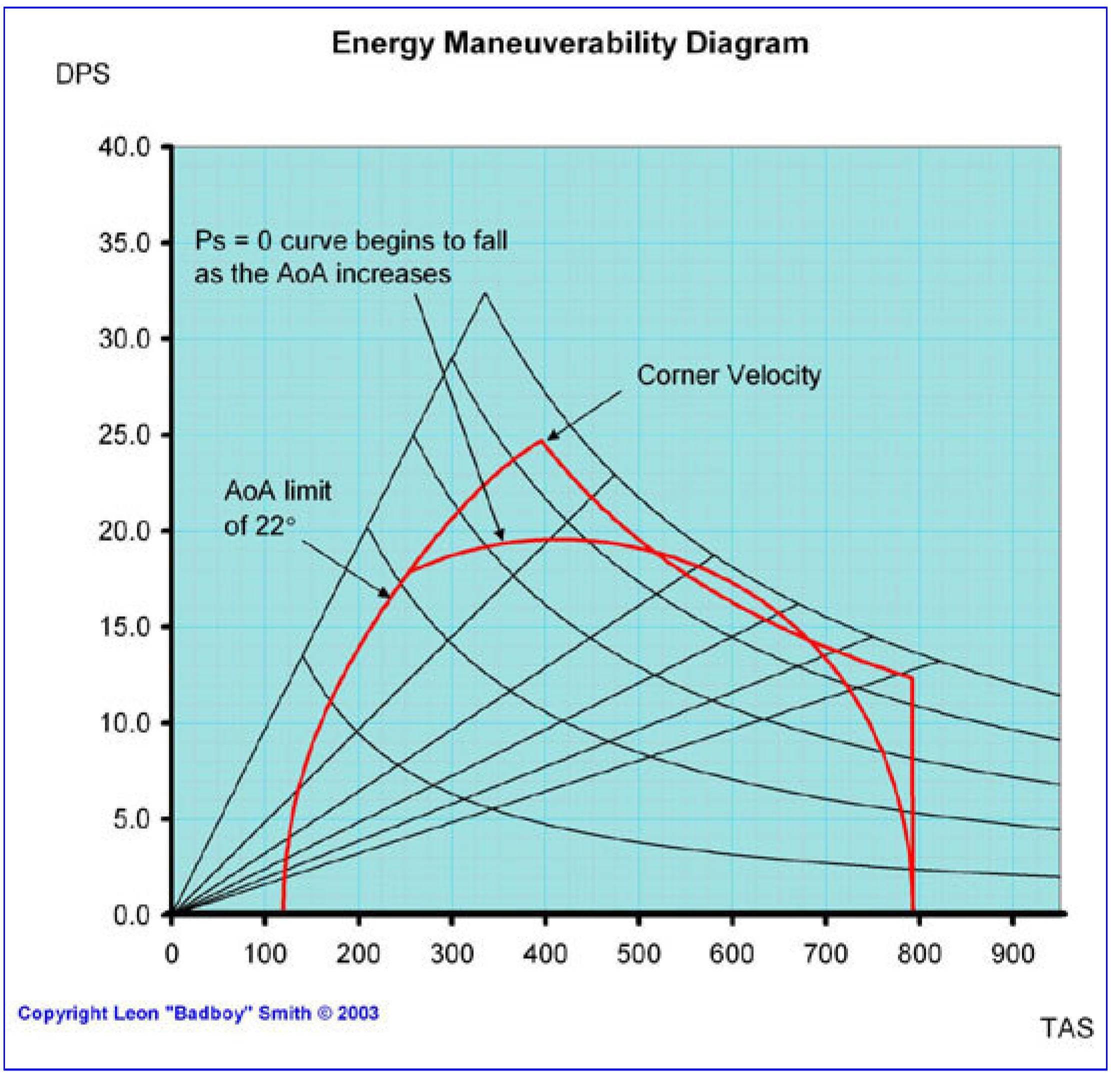


As an aside, notice that the Ps curves in the Falcon3 EM diagram are slightly bumpy, while those in Eurofighter are smooth, the reason for this is that Falcon4 uses a table based model where thrust and drag data exists in tabular format, the steps between discrete values in the tables and the fact that software uses linear interpolation to determine intermediate values, is what causes those bumps. In the Eurofighter flight model the thrust and drag values are calculated continuously and so the curves are smooth. There are advantages and disadvantages to both modeling methods, but a discussion of the merits of each would probably be a better topic for another article.

So, some simulations reward the use of G for brains, others won't, and LOMAC is one of the ones that don't. The difference lies in the flight model, in some simulations it is due to the way that thrust and drag are modeled, and in others due to the way the control system has been modeled. In order to understand this situation a little better, we need to look more closely at the slower end of the envelope, that is for speeds below corner velocity where we need to look at what happens as aircraft approach their Angle of Attack (AoA) or lift limits. Continuing then with the example of the F-16 and the MiG-29, the F-16's AoA limit is around 25° (It is worth noting that the characteristics of the F-15's control system is similar to that of the MiG-29 according to a test pilot who has flown both types) while the MiG-29 can safely exceed a 30° limit, providing no roll commands are given.

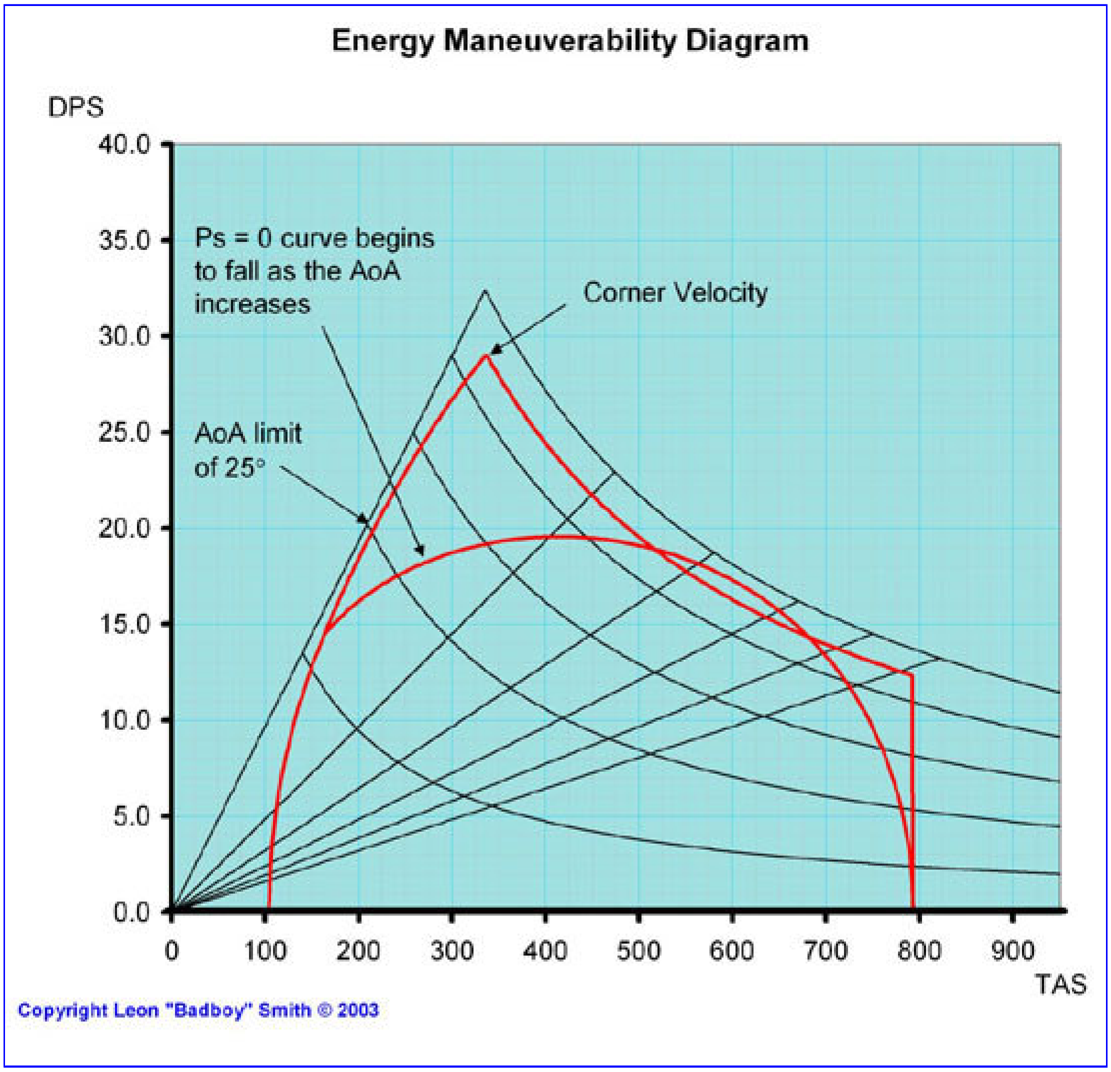
In order to illustrate what happens as these aircraft approach their AoA limits we need to examine the next sequence of EM diagrams. These diagrams are not for any one of these aircraft in particular, they are a generic set of diagrams that can apply equally well to any of these aircraft, and are intended simply for the purpose of illustrating the point. So let's see what happens to the same aircraft with different AoA limits imposed on it.

Figure Three



In *Figure Three* you will see the EM diagram showing the envelope with a 22° AoA limit and you can see that the maximum sustained turn rate occurs at a speed very close to corner velocity and that the sustained turn rate drops slightly at lower speeds. That is typical behavior for a jet fighter and becomes more significant as the AoA increases. Take a look at *Figure Four* for an AoA limit of 25° and you notice that as the AoA increases, the sustained turn rate drops more dramatically.

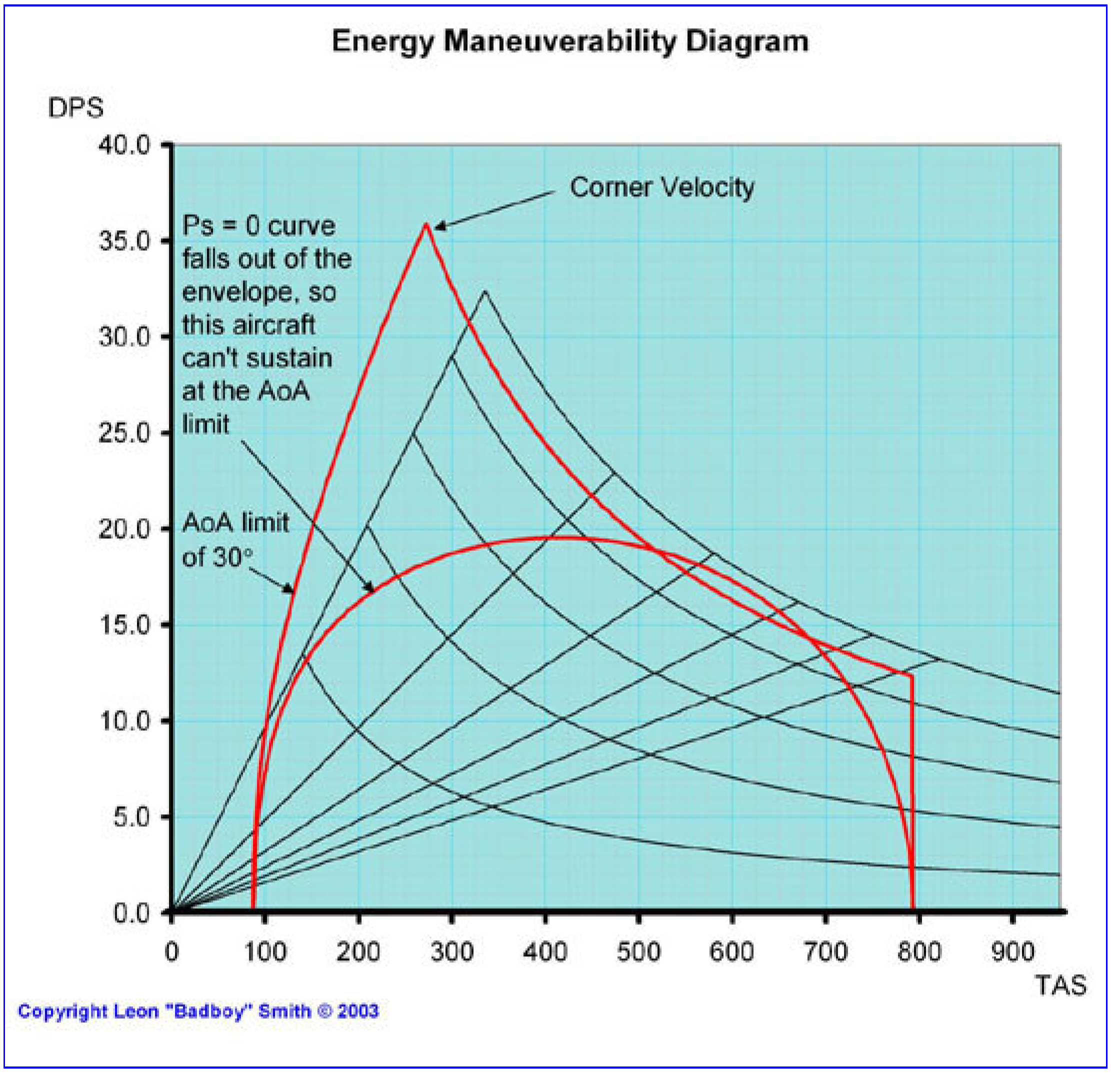
Figure Four



Now examine the diagram for a 30° AoA limit shown in *Figure Five* and you notice that the aircraft will bleed all the way down to a zero sustained turn rate. By now it should be obvious that pulling all the way back on the stick is very undesirable. The harder you pull back on the stick, the slower you will end up turning. Now temper that thought with the idea that in aircraft like the F-15 and MiG-29 there are actually no hard AoA limits imposed by the control system, if you pull back hard enough and fast enough you may well have the control power to generate high pitch rates and exceed safe AoA limits, with the associated risk of rapid energy loss or departure.

The real penalty for being heavy handed with the flight control stick is that at lower speeds, the sustained turn rate drops significantly… The simple fact is that restraint can pay off, because your best sustained turn rate occurs at a lower G value than you can actually achieve. One of those situations where less is more. The fact that this is counter intuitive, and because it is very difficult to exercise the self control required in the heat of combat, is what makes it difficult to do. It is also why the idea is lost to so many virtual pilots, and why those who understand, seem to win their online engagements more easily, and have less trouble against the AI offline. That's where practice and experience can help. So how do you use this knowledge in combat?

Figure Five



The short answer is simple, as a rule of thumb, modern jet fighters have their best sustained turn rates somewhere close to their corner velocity, so when you enter a hard turn starting above corner velocity, pull all the way to your G tolerance, and bleed off speed until you reach corner velocity. Once there, try to use only enough G so that you can sustain corner velocity. The advantages of that are three fold, firstly you can optimize your sustained turn rate. Secondly, being at corner velocity means that you have your maximum instantaneous turn rate available to you if you need it, and thirdly you may still be fast enough at corner velocity to execute an effective missile defense, while keeping your escape window at least partially open.

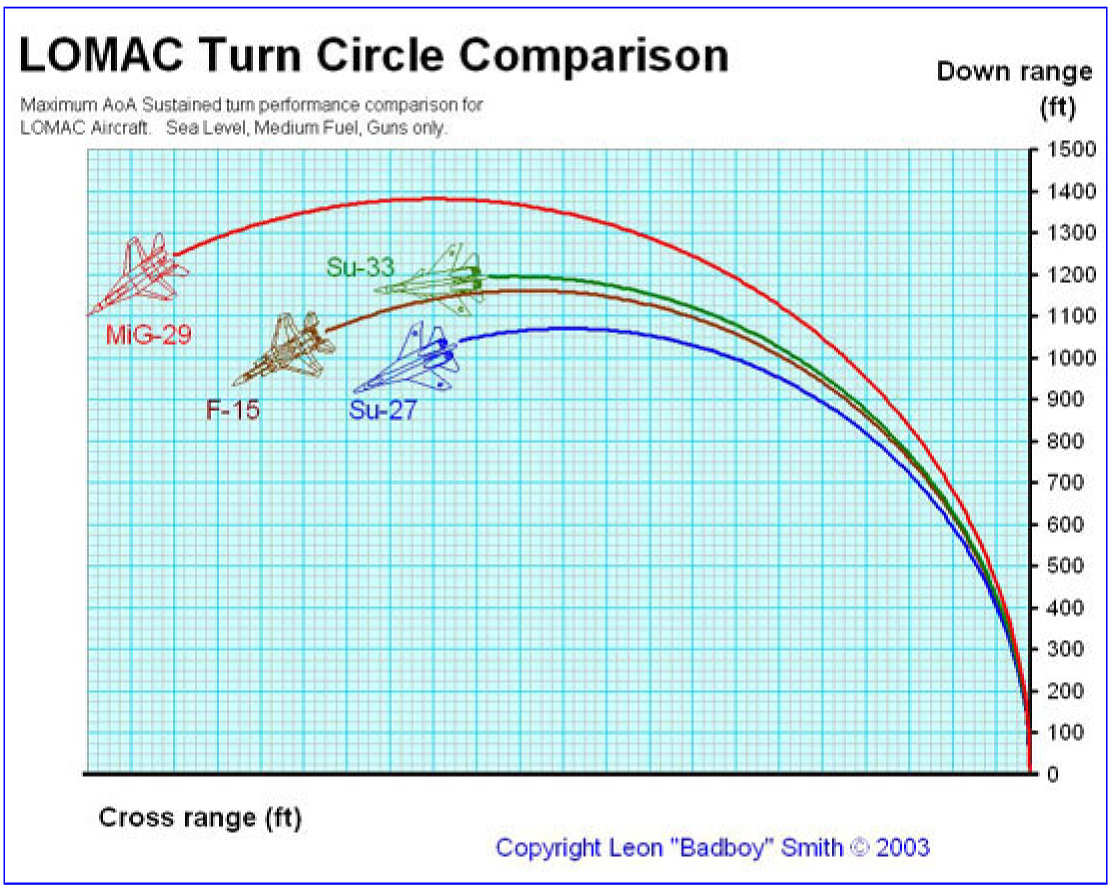
That begs the question, what are the corner velocities for the fighters in LOMAC? Fortunately I have been able to determine those values for the configuration available in the Fast Battle Planner of Medium Fuel, Guns Only and at Sea Level. The MiG-29 A and S variants have almost identical corner velocities of 685km/h or 370kts, while the F-15 has a lower corner velocity of 630km/h or 340kts, and the Su-27 has a corner velocity of 545km/h or 295kts. The Su-33 has a corner velocity of 590km/h or 320kts. It is worth noting that the corner velocity increases with aircraft weight, so with more fuel and weapons the corner velocities will be higher.

So how do those four aircraft compare in terms of their maximum instantaneous turns? In the configuration mentioned above, the F-15 is best with a maximum instantaneous turn rate of 26.5 degrees per second and a turn radius of 1250ft, the Su-27 is next with a maximum instantaneous turn rate of just under 25 degrees per second and a turn radius of 1150ft. Followed by the Su-33 with a maximum instantaneous turn rate of 24 degrees per second and a turn radius of 1280ft. The MiG-29 also has a maximum instantaneous turn rate of 24 degrees per second with a turn radius of 1490ft. Those details are presented in the following table for clarity.

Aircraft Type	Corner Velocity (Km/h)	Turn Rate Degrees/sec	Turn Radius (feet)
F-15	630	26.5	1250
Su-27	545	25	1150
Su-33	590	24	1280
MiG-29	685	24	1490

The last question then, suppose you just can't sustain corner velocity, and you end up flying at a maximum AoA sustained turn, that is right on the edge of the envelope? For the four fighters previously discussed, the turn rate and turn radius in that situation is shown in *Figure Six* below, each aircraft turning in full afterburner.

Figure Six



Now if you have been following the discussion so far, you will appreciate that the sustained turns illustrated above are what you will get if you pull all the way to the edge of the envelope, but that isn't the best sustained turn. You can get a slightly, but significantly better, sustained turn rate by sustaining a turn at corner velocity. That means pulling slightly less G than is available at that speed. The downside is that you will have a slightly larger turn radius. Which one is preferable depends on the BFM problem you are trying to solve at the time, and that once again, is material for another article. The bottom line is... You aren't flying an F-16 so don't use G for brains, only pull back as hard on the stick as you have to, and when you have to, sustain corner velocity for as long as you can to optimize your turn rate. That's it!

Now for a word of caution, this won’t work in every flight sim that models these aircraft, only those that have a particularly good flight model, the only other sim’ I know for sure that it worked in, was the Jane’s F-15 sim’. It won’t work in any simulation of propeller aircraft, because it isn’t supposed to. It does work in LOMAC, and rightly so!

Conclusion

At the beginning of this article I promised you a significant improvement in your ability to out turn your opponents, now you know what to do, you just need a little practice and you are well on the way to becoming a good stick in LOMAC... Good luck and happy hunting!

The testing was generated with the LOMAC Gold version.
