# POSSIBILITIES USAGE OF THE AREA POSSIBLE ASSAULT AT OVERFLOW AIR TARGETS

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**Abstract**

The article analyzes maneuvering capabilities of fighter aircraft in order to determine proper maneuvers with regard to full utilization of their tactical and technical capabilities during air target interception. Initial presumptions for mathematical model build-up are mentioned, as well as development diagram and results with graphical outputs, which show the possibilities of a successful engagement under given conditions.

**Keywords:** Aircraft, dogfight, performance, subsonic, air missile.

## 1 Introduction

As a result of modern local conflicts, the high airspeed and high altitude is not anymore the most important attributes of modern aerial warfare. However current fighter aircraft have high performance, the highest number of recent dogfights were taken place in altitudes below 13,000 feet. As well as fighter-bomber aircraft flies their missions mainly in low altitude due to better penetration of enemy's AA defense. Airspeed of the dogfighters during combat was significantly narrowed to airspeeds in interval between 0,5 and 0,9 M. This is determined by conditions of dogfight and lower altitudes of combat. Where was the body of the plane highly stressed and thus airspeed is considerably limited. It is proved that maximum angular speed during any maneuver is in interval between 0,6 and 0,9 M for every combat aircraft without exception. As a consequence air combat at low distances is still basic form of air combat and main form of gaining air supremacy. Dogfight is approaching to new stage of advance, which is based on this four circumstances: armament, aircraft, crew and tactics.

## 2 Dogfight against more powerful aircraft with worse maneuverability

Subsonic aircraft can very likely join into dogfight with aircraft which have better thrust to weight ratio. If hostile plane has higher wing load, every aircraft have pros and cons against the other. First rule of dogfight is to never try to outmaneuver the opponent with maneuvers where is his aircraft better. Correct strategy is to exploit his weaknesses and gain maximum from your advantages. Subsonic aircraft's assets are better angular velocity, lower minimal airspeed, tighter turn radius and lower minimal speed for vertical maneuvers. And it's weaknesses are lower speed of climb and lower acceleration. One of basic problems with subsonic airplane is chase to the firing range to more powerful enemy. Because subsonic airplane cannot out-climb or out-run the foe, it have to try hold the combat in horizontal plane as long as possible. Gaining advantage is possible with same or opposite turns as the enemy. Another possibility is performing horizontal scissors and outmaneuver rival's plane. In vertical scissors is this advantage less effective. Another advantage is in the turning same turns with competitor. In this case subsonic aircraft have better angular velocity, in contrast of turning the opposite turns, where subsonic aircraft can perform tighter turns and lower airspeed. Opposite turns, usually have higher angular gain to the unit-loss of airspeed, and they are also energetically more effective. That's why subsonic aircraft's crew should choose tactics based on opposite turns. Crew of the subsonic aircraft may not be afraid too much of outflying by the high-powered opponent during dogfight because of rival's loose turn ability and higher airspeed, which plays against him to gaining his dominance in combat. Nevertheless, crew of the subsonic aircraft should be aware of making significant mistakes mainly in vertical plane, as they open way to foe for gaining superiority, maybe even short time for fire after performing scissors maneuver. Crew of subsonic aircraft should carefully keep an eye on the minimal vertical velocity at final phase of attack, in case of steep climb and pursue of the foe. In addition, they should be aware of taking angular advantage before aircraft characteristics allows, do that. When chased aircraft cannot gain angular advantage at speeds greater than speed that is needed for vertical maneuvers, it slows down to speed of subsonic airplane or even below it as well as it is not able to do any vertical maneuvers. Crew of subsonic aircraft can slow down without danger as well as it is able to gain tactically tweaked position for fire. In moment, when aircraft have favorable course, it has to try reaching the best position for begin next turn as soon as possible. It is usually reached by using maximum acceleration power and turning with low G's e.g. with low angle of attack where airplane have best acceleration and thus gaining

back airspeed which has been lost during the turn. This power can be used only for five seconds due to engine limitations. Crew of the subsonic aircraft should not accelerate too much to speed where it loose an advantage.

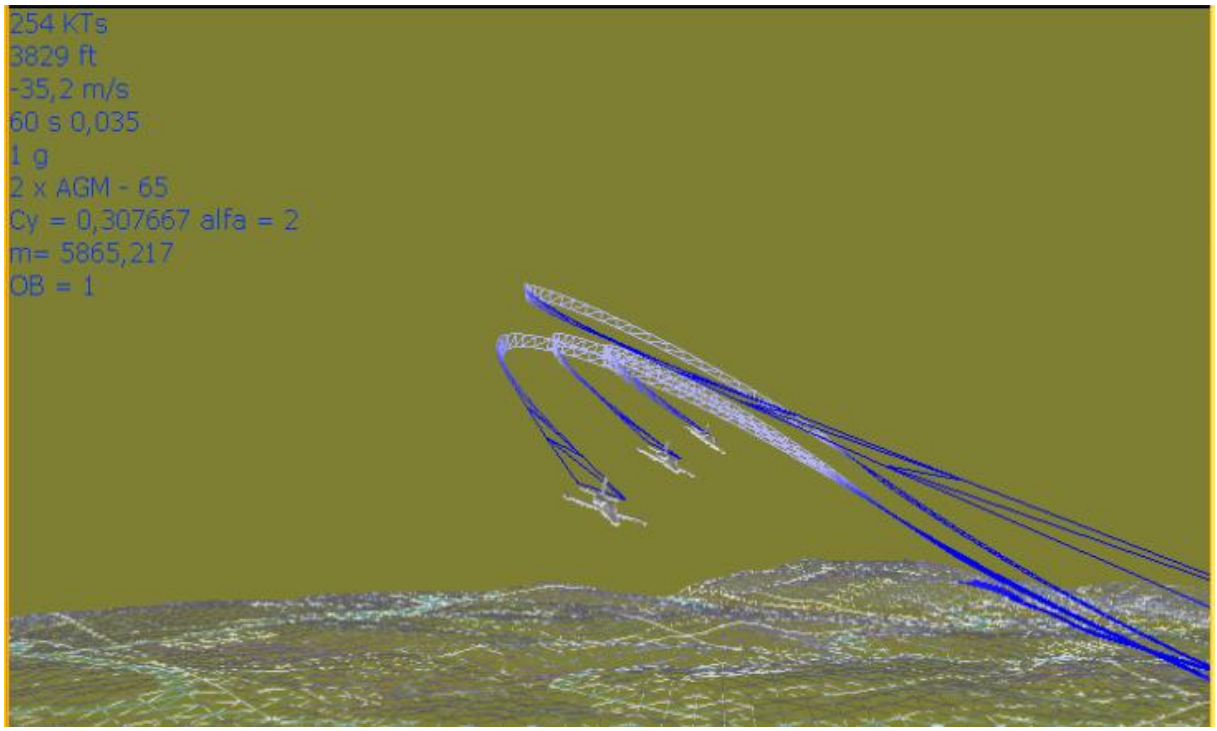


***Fig. 1*** *Calculation of manoeuvrability of the airplane mathematical simulation*

When aircraft reach the point where it should start turn, this turn should be performed as tight as possible for holding the distance from the enemy's airplane. Turn with minimal radius e.g. steep turn can be performed by starting at the maximum speed followed by performing turn with maximum G's. In case that this speed is reached before the turning point, airplane should start climbing for making better distance in vertical plane (Fig 1). This can be used later for gaining speed for pursuit. Point where turn should be started is determined by crew experience. In perfect world, aircraft get to the close range from the enemy after finishing the turn with nearly maximum G's and gaining best possible advantage. There is also short-time possibility of firing from this position. But it is essential to monitor flight properties, mainly airspeed. It should not decrease below minimal speed for vertical maneuvers, where enemy can escape by steep climb maneuver.

In case, when crew of subsonic airplanes saw that they are out-climbed, they have to get aircraft on horizon to direction from enemy but they should hold enemy in sight. This way is secured separation and gained speed for defensive maneuvers.

When is airspeed of subsonic airplane deeply below optimal climb speed, it is better to use maximum acceleration of the power. This power level significantly increase energy of aircraft in contrast of chased airplane which can increase his energy only slightly in high-G climb. In same time, crew of the subsonic airplane is able to gain horizontal separation and lower the height advantage.

Subsonic airplane wouldn't be able to perform required maneuvers to fire missiles due to lack of thrust. It should also use tactics of advance chasing to decrease distance from enemy. When enemy loose enough energy and have same speed as the ally or lower, crew of the ally's airplane can use lossy chasing to gain best position for firing.

Described tactics for the crew of subsonic aircraft is intended to make due to its superiority in the maneuvering capabilities gradually gained predominance of angular and forced the enemy to defensive maneuvers, at which loses some of its energy benefits. If the crew does not respond in time persecuted the airplane, the airplane gets into tactically advantageous position to hit. The crew of the airplane has persecuted in this case the only possibility to design a well - timed maneuver transition to the vertical or leakage of air combat commenced. With a greater impact air missiles adversary is much more limited in the transition to the vertical or discontinuation of air combat.

In aerial combat, the crew is more powerful enemy aircraft maneuver through the pitch after the first minute. If subsonic aircraft armed with air missiles, aircraft crew not hesitate and can also immediately maneuvered zoom. May initiate a chase plane hit air missiles before they ever reach the top of the climb. Just the possibility

of firing air missile forces the enemy to increase the power drive unit for maximum or afterburner is turned on as quickly went over the top, the increased course before it's done draining air missiles. Without subsonic aircraft crew started shooting missiles, forcing her maneuvering loss of energy supplies, rised smaller amount, and hence to transition to sink if forced execution turns. Although the crew of the airplane adversary manages to create enough course, which is outside the nominal cover to launch missiles and missile guidance system has sufficient information to guide can be successful missile launch as adversary aircraft is slow and the crew is unable to effective defense.

One possible defense is that the crew of enemy aircraft starts to climb towards the sun. The crew of subsonic aircraft will be difficult for them to visually track a target and a dark label on the helmet can at this point to prevent loss of air targets. Assistant in this situation is also on-board radar. Once subsonic aircraft crew discovers that the enemy intends fly the sun, he should carry radar lock. In the event that the adversary aircraft lost in the sun, on-board radar provide information as to where it visually search. It is necessary to carefully monitor the situation that the enemy failed to maneuver reversal in the sun.

The crew of subsonic aircraft can appropriately maneuvering difficult opponent to escape the sun. If the enemy aircraft soaring the sun, subsonic aircraft crew can turn left or right at right angles to the trajectory of the enemy. Similarly, it is sufficient for the crew of subsonic aircraft flying horizontally from or toward the sun or made steep up or down when the opponent goes high and the sun on one side.

Impact air missiles greatly complicates the possibility of enemy detachment of combat. In a situation when trying to get out of the possible assault, the crew of subsonic aircraft finish sharply at him and opened fire before he moves away out of reach. The probability is greater if the adversary breaks scramble on the defensive, his speed is not enough aircraft and has an angular advantage. If the launch of missiles, the enemy made a defensive maneuver, but at the expense of losing power. Continuing the defensive rotation and zoom course or attempt leads to that haunted the aircraft subsonic aircraft around the arc. Subsonic aircraft and crew can use called. persecution leading to reduced distance and thus continue in aerial combat. Air missile launch, even when the target is out of range, is also very effective because the opponent's defense maneuver and will not continue thus escape from their reach.

Another tactical element to use air missiles is to use counter-turn that makes the effort to obtain small angular advantage at every passing. This method is generally less favorable than the consensus turns tactic, because it takes longer and usually produces smaller spacing for shooting. However, this method makes it easy to maintain visual contact with the enemy and also makes it difficult to escape the aircraft more goals.

In the case of subsonic aircraft armed with air gun or air missile, the crew of the airplane option, in which the possible assault to begin shoot will try to get first. An air gun and air missiles are the appropriate complementary equipment for subsonic aircraft. Missiles allow threaten enemy aircraft, although subsonic aircraft has a distinctive energy disadvantage and also serves to prevent the persecution of the airplane to break free of air combat. Using of the air cannon, it is preferred when the pursuit plane located at a distance less than the minimum distance air missile launch.

If both aircraft equipped with an air gun and missile air, then the fastest way is consenting turn and launch missiles from the front hemisphere. Since in this case the capture target missile less favorable conditions, there is a risk that there will be interference target. In this case, subsonic aircraft subjected to retaliatory fire enemy. Conservative tactic is the use of air combat tactics maneuvers using an air gun, trying to stay as close to the persecution of the airplane, for example. Opposed curve, and thus maintain a minimum distance for missile launch crew enemy. The crew of subsonic aircraft has very meticulously monitored and evaluated flight parameters, to lose too much energy in an attempt to shoot an air gun, because it could not attract enough to climb in order to launch a missile at the haunted aircraft, which carried out the maneuver zoom. In this tactic, the air gun was used more as a threat than a primary weapon for use. Must serve to make the enemy lose excess energy trying to come out of the air combat either ascent or descent, which can be for him in the end very critical. Subsonic aircraft crew should take every opportunity to fire a cannon, but the missiles should be in most cases the primary weapons to destroy the enemy. The biggest disadvantage of using tactics for air gun is a relatively long time to phase alignment and thus the total time of air combat.

## 3 Air combat maneuvering more powerful aircraft with better maneuverability

Currently fighter aircraft designed with the requirement of high maneuverability. These aircraft have a large excess of tension in addition to the weight and the ability to achieve a high-speed maneuverability at lower speeds, e.g., that are capable of achieving small radius curves, large angular velocities in the corner and have a relatively low speed for vertical maneuvers. This is particularly true for aircraft with so-called. thrust vectoring. The crew of subsonic aircraft should avoid committing to maneuver air combat aircraft such as the situation allows. Fighter with such dominance has speed and acceleration to forcing the enemy to fight and maneuver and achieved dominance over him necessary to achieve victory. When the crew gets to subsonic aircraft air combat with this aircraft can achieve victory only when errors and bad tactics the enemy. When the subsonic aircraft already has such enemy hemisphere in its rear, the best counter-rotating turn maneuver by moving to a descent

with a large overload if it has to carry out this maneuver sufficient height. This tactic allows the crew subsonic aircraft to maintain a sufficiently large course due to enemy aircraft to enemy aircraft crew could not perform its launch missiles. Despite the subsequent sharp decrease power drive unit and engage air brakes, will be relatively rapid convergence with enemy aircraft. At the specified time is necessary to make a swift turn towards the enemy aircraft and subsonic aircraft outfly. If the opponent does not recognize the time this maneuver does not dump a climb, the defending garrison subsonic aircraft maneuvered reversal and so easy to get to tactically advantageous position to launch their missiles. If the adversary through time and will continue to climb the vertical maneuver, you can go to the maximum acceleration in the sink, get great spacing and thus extend the aerial combat. It is also possible that during this phase of air combat adversary aircraft crew completely lost visual contact. Furthermore, it is expected that the adversary runs a short shooting before overrun. In this case it is necessary to prevent short sharp twisting out of the plane assault.

The crew of subsonic aircraft must lead maneuver during air combat pay more attention to its immediate energy supply of the aircraft. It should not allow the adversary zoom maneuver performed to obtain spacing without any danger. Whenever opponent carrying out the maneuver should crew subsonic aircraft missile launch, even if only a small hit probability, and carry out sales below those visual contact. It is very important that the crew of subsonic aircraft strictly comply with angular air combat tactics. It should revolve affirmative bend that was below the minimum distances launch missiles as lower whenever he finds himself in front of his hemisphere. Tactics departure and transition to climb for subsonic aircraft will not work because the opponent has an advantage in performance parameters of its drive unit. Other energy air combat maneuvers, resulting in loss of energy in a favorable turn, can only be effective against enemy aircraft crew inexperienced.

## 4 Air combat maneuvering slow and low-flying airborne target

As slow and low-flying target, we can classify each objective, which is above the area of interest in a small ground-floor heights up to a speed of approximately 160 kt. It is a small propeller aircraft, unmanned aerial vehicles and helicopters especially different tactical designation.

Among the peculiarities of this air combat include:

- takes place in a small ground-floor heights
- due to the small distance is difficult finding guidance on these objectives
- difficult search these objectives
- large convergence speed to low speed flying
- shooting is necessary due to the greater speed of convergence initiated at larger distances.

Low-altitude flight in these types of goals are the first team to perform tasks in close contact with the ground, then the climb and also by the fact that a small amount of them by a large number of hiding places where they can hide from airborne search radar and visually. Small amount to protect against attack with lowering and also limit the attacking of the aircraft in maneuvering.

Guiding the slow and low flying targets among the most complicated ways of prompting, because the reflector given small size of these airborne targets tend to be small and the impact of ground radars is at this altitude is relatively small and the actual radar field is discontinuous, then the distance detection of small targets or may not even occur to detect targets at all. In this case, it is advisable to cooperate with AWACS airborne beacon habitat. Searching using airborne radar is also very convenient, which is due to close country, the diversity of terrain and ground targets difficult to detect the correct target. The main requirement is the guiding principle that the crew of the aircraft was able to visually or by technical means on board the airplane find the target.

Typical maneuvers guidance:

- horizontal sweep of 90-180 ° with subsequent descent
- descending turns
- vertical twist and turn split-S.

The final phase guidance is important to the on-board radar, where the team subsonic aircraft has information about target azimuth, the distance and height, speed and acceleration. With this information, the crew of the aircraft to intercept tactically advantageous position for visual search targets. Altitude, and visual search air targets is chosen depending on the flight altitude and the estimated distance detection. Search should be carried out in the direction of the side where the viewing angle downward from the horizontal does not exceed 30°. In all cases, the search should make low- flying targets at altitudes from 2600 to 4000 feet above the ground.

Great influence on detection distance will be color planes and terrain over which the fly. For example, the findings do without camouflage paint or coating substantially different from the terrain 8-10 km. On the contrary, using masking coating which blends with the terrain, the distance detection target 600-800 m. Also determine the distance has a significant effect and the actual horizontal visibility, which is dependent upon the

clarity of the air and the position of the sun above the horizon. In the morning and evening hours when the sun is low on the horizon, the visibility of the sun goals more difficult, and therefore must seek to do after the sun, because in addition to good visibility you can find to do with his shadow or light flash. Also shadow of cloud can affect the visibility of the target.

Attack is a critical stage in air combat. It is the end of a series of complex maneuvers performed to ensure that the aircraft crew took the best possible position to successfully destroy targets. Subsonic aircraft crew should close do use slow speed, which ensures a sufficient margin for maneuver. Should therefore move at the speed of about 300 kt, but not less than 250 kt. Maneuver method depends on the position and the distance and target detection. Approximation must be conducted so that the crew of subsonic aircraft soon took the starting point for assault and actual assault took place with aimed fire. Small speed and relatively small distance detection of these objectives makes time approximation, the maneuver and assault is short. For this reason, requires concerted action and its crew airplane.

The result of convergence and maneuver must be attracting the starting position for the attack. The implementation of the operation is dependent on the angle of alignment with the target. If the convergence to take place from the front hemisphere 30° or 45° in the case of very slow targets, the attack can be run. In the case of convergence on friendly courses but is more efficient to create a lateral spacing of 1.5 to 2 km and perform a 180° turn back to hemisphere do. Turns with 60° to 70° should be initiated at the level of the target. In this turnover may temporarily lose visual contact with the target. The crew of the attacking aircraft must reckon with the fact that the adversary can at this moment to make a sudden change in flight path and thereby impede its retrieving.

In the case of convergence on courses friendly to which velocity is close to the maximum speed for marking slow and low flying targets (e.g. about 130 to 160 kt), can be used maneuver turns 270°. This maneuver should be initiated at a distance of 0.5 to 1 km before the finish. Disadvantage of this maneuver, the crew attacking aircraft has no visual contact to a longer period of time than in the previous case.

Getting tactically advantageous position in the two previous maneuvers is conditional on the target will not change the trajectory. If the enemy begins to maneuver, then to maintain tactically advantageous position, attacking the crew of the aircraft may use delaying roll maneuver so-called, high yo - yo.

The crew of subsonic aircraft would not accede to maneuver in the horizontal plane, because slower opponent will have the advantage of a smaller turning radius curves. Also, efforts to reduce the speed of the subsonic aircraft meant to limit the scope for maneuver. The attacking aircraft should use forceful tactics of air combat maneuvers and use the zoom to maintain power for maneuvering. In this tactic is more difficult to maintain visual contact with the target, particularly if it is a small airplane. Departures from the enemy and climb leads to an increase in distance from each other. In addition, the crew of the airplane must often look over his shoulder, which further complicates the maintenance of contact and also the difficulty and control of the airplane.

Basic weapons in action against slow and low flying targets, the air cannon. Using air missiles AIM - 9 is limited, because the type being analyzed airborne targets has a small amount of infrared radiation. Attacking the crew of the aircraft should be maneuvered so that paved the way for shooting an air gun. Shooting should be undertaken of the dive. Transition to dive is best to start from a height of 2000 to 2300 feet. The attack from the front hemisphere should be starting the dive angle 15°, because the assault is raised to 25° to 30°. The attack from the back hemisphere is better to use an angle of 20° and more, on the other hand because it decreases to 10° to 15°. Dive resulting angle should not be greater than 30°, to ensure safe recess. The assault on the target is very slow, the use of large course advantageous for increasing the effectiveness of firing. Fire should be initiated at a distance of 2 000 – 2 300 ft from the target. This distance provides adequate efficacy and safety of fire recess assault.

## 5 Conclusion

The article considered the possibility of action against various types of air targets. Different types of air targets require different tactics of maneuver air combat. If subsonic aircraft to undertake air combat aircraft, which has more power, but less maneuverability, the crew of subsonic airplane fair opportunity to exploit the opponent's weaknesses. They should be able to use its advantages when maneuvering and should seek to maintain air combat maneuvering in the horizontal plane. Opposed curves are horizontal effective means of obtaining tactically advantageous position against a faster airplane.

Major threat to subsonic aircraft could mean confrontation with powerful aircraft with better maneuverability. Such a fight would be the crew of the aircraft should be avoided and if the opponent is forced to fight for this, it should rather concentrate on tactics leak away from his arms.

In case of attack subsonic aircraft can be equipped with self-protection, which consists of a radar warning receiver and chaff dispensers. This system is appropriate for the aircraft category. Radar warning receiver captures RL signals from all directions, which identifies and sends the impetus for launching decoys. Radar or infrared targets are then fired automatically or manually manned aircraft. Automatic fire gives space crew subsonic aircraft, which is burdened with stress in a combat situation, pay the full defensive maneuvers.

Particular advantage of this aircraft in aerial combat maneuvering is relatively small compared to the value of thermal radiation more efficient airplanes, making it difficult to capture missiles with infrared guidance system.

In aerial combat maneuvering plays an important role in weaponry. An air gun and missile air forms in subsonic aircraft complementary equipment. Greater range missile reduces the possibility of enemy detachment of air combat. In the case where the destination is smaller distance, than the minimum distance for the missile launch, on the other hand efficient use of the air gun.

When exposed to low and slow flying targets remains an essential weapon air gun, because this type of intercept missile targets with infrared guidance system is almost impossible. Although the goal will be armed with weapons that could threaten subsonic aircraft, ground proximity and high speed convergence will be another threat to the attacking aircraft. Here the crew of subsonic aircraft should use the tactics of air combat vigorously the principles of maneuvering at low altitude.

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