

## Introduction

Several years ago, I decided that aircraft miniatures would be something I'd find interesting as a fun diversion from the regular cardboard games that are my livelihood (read: work). I was searching for a hobby that wasn't what I did for a living...combined with a love of aircraft... and there you are.

I looked around and was told by several players I knew that JD Webster's "Fighting Wings" system (several games, now being published by **CLASH OF ARMS GAMES**) were the best available. These were hex-based, cardboard-counter games, but I figured the conversion to miniatures would not be that big of a deal and I didn't want to design a game engine...I wanted to play (not work, remember?)

I found the conversion to miniatures to be not that big of a deal. I bought the big hex grids on cloth from Geo-Hex, so I had an enormous hex grid to work with (and 1.5 inch hexes). I devised a stand set up based on some things I had seen in other miniatures games at conventions. The stand would have a base on the hex grid, but allow freedom in all axes of movement, plus full altitude rendition.

Once I was into running the game using JD's rules and my models, I ran into a number of things that didn't sit well with me. Because I developed the system just for myself (no publication intent), I felt free to add, embellish, and change to my heart's content. Some of the physics and math models I saw were obviously simplified for the mass market. I was a market of one...and I was perfectly willing to do the extra work for my purposes...namely I wanted to see what it was like to fly these planes, to be able to fully examine their performance characteristics and such.

JD's game revolves around the operational conduct of air campaigns. Of this I had no interest...for me, I wanted to look at the aircraft themselves as well as to run ACM tests between players and their aircraft. I fully understand that most ACM in WW2 consisted of hit and run, blind-side bounces. That didn't (and still doesn't) appeal to me. I was more interested in a gladiatorial look at the aircraft themselves and the tactics needed to take them out.

Anyway, I found that because of the Operational emphasis of the FW system, several corners were cut in the tactical modeling (the only part I wanted to do). For example, deceleration due to gravity was determined by the number of altitude increments the plane climbs. This looks fine on the surface, when one thinks of different planes all at the same speed...the more increments climbed, the steeper the climb. However, a problem occurs when you compare planes of different speeds. Suddenly, the faster plane, climbing at the same pitch as a slower one, slows more due to gravity. This is incorrect as the acceleration due to gravity ( $G$ ) is a constant, and so is the length of the game turn...both planes should slow the same amount for this reason. Yes, there is more drag on the faster plane...but if both planes were in level flight, there would be no slowing...therefore, all we are seeing is supposedly the effect of gravity.

Other things have been "worked over" as well. Since the goal of the operational system was to generate tactical bounces (followed by a quick kill) which were designed to be as rapidly executed as possible, the rates of deceleration for other causes (G-loaded turns and such) were exaggerated so their influence would show up as fast as possible.

Seeing these things and knowing I really didn't care how complex the thing got, I went to work revising the flight mechanics and such to suit my tastes. This process took about two years. The result was very complex and took quite a bit of effort to play. (This was supposed to be fun, right??!) I grew tired of the work needed to play, plus training guys to play the game took far too long and the learning curve was very steep. Those willing to give it a shot could (or would) not devote the time and attention to becoming proficient at the game...so I had to contend with a never ending string of raw rookie opponents (even if they had played before, the lack of retention of the system made them rookies again). This was not fun.

Thinking it over, I decided I could create a computer spreadsheet engine that could go back to the raw aircraft data, and aerodynamic formulas themselves, in order to calculate the answer directly at each step. The really nice part of this was that all table breaks (which players love to find) would be eliminated (a seamless blend as altitude and airspeed changed) and aircraft would behave in the fluid, cross-linked manner they really do. Luckily for me, I had no comprehension of how much was involved in doing this...so, blissfully ignorant, I dove in head first.

I wanted this system to calculate as much as possible from the roots of the aircraft database when run through the numerous aerodynamic formulas available. I wanted the system to have an input interface that would use the same basic controls as the actual aircraft (stick, rudder, throttle) and that one's skill in using these controls and exacting the maximum use of his plane's performance determined the winner, not some microscopic difference in performance that the underdog player could never overcome.

I wanted this to be a game where you were the pilot.

The game does not model everything. It does not, for example, worry about ammunition. With 2 second turns and a "long" game being 60 turns (2 minutes of real time), the occasional shots made just don't add up enough to make this a concern. Shots are plenty rare (hard to line up). What happens after the game is over is none of my worry. I feel it isn't important at this level. Originally, I did have some ammo rules...and I found players "playing" their ammo...something I'm sure pilots in combat did not spend a lot of time doing...rather than jerking around that stuff, I want to see players executing maneuvers and learning how to better control their aircraft. Other things that were made as assumptions or "guesstimates" are listed in the program below the flight information in column F for all to see.

The program is under continuous development. As we find anomalies or bugs, I fix them and issue a new version. So, to keep current with this system, check in on the web page every once and a while to

see if a new program edition has been published. There are also some esoteric effects I've been refining in the program anyway, as I get these tested and finished, new editions will be put up with the results in their guts. If anyone sees something in the aircraft stats that makes them wonder, please bring it to my attention. I did my best with the sources available to give the best possible numbers, but contradicting information exists and some data was chosen from a number of competing sources. If you do have data different than mine, let me know what it is and what source was used in determining it.

Lastly, several have talked about working up a stand alone version of this program. When this comes available, I will endeavor to get it distributed inexpensively. Until then, please accept my apologies for requiring Excel (DOS) or Works (Mac) to run this program.

At any rate, this game is something I want others to be able to enjoy (which is why we are distributing it as freeware).

Enjoy!

Dean

### **The Basics**

One step at a time...the use of this program requires a bit of understanding as to how aircraft fly and how the flight controls work. For example, if you believe aircraft turn using the rudder or that a stall occurs due to slow airspeed (or worse because the engine quits...), I suggest you do some preliminary reading on the subject first. One of the best primers on just these matters is Wolfgang Langewiesche's *STICK AND RUDDER*. This little volume is a gem written many years ago, but has never been beaten in giving a realistic feel for what the flight controls do or how an aircraft flies. It is readily available and should be read by anyone wanting to master this game.

Note: For training purposes below, we will be using column E as "current". In a normal game, column D is "current" for a turn, while column E is really nothing more than a "forecast". This will become more understandable in the section on Macros below.

First, You have the basic program sheet open with the Dora (it comes with an Fw-190 D-9 loaded as base) on it open, right? That is the main program sheet. The other files you have just contain the different aircraft stats.

Each aircraft in play needs its own copy of the master spreadsheet running. To start a plane, you'll first need to make a working copy of the master, then open the copy and the data file containing the plane you want to run.

Copy the column containing the plane from the data sheet and paste it in column A of the working copy.

Your program must be set up for manual calculation only...check to see that it is and get the keyboard short cut for making the machine calculate.

Also, look up how you do a "paste special". You'll need this when it comes time to make the thing run as you'll have to cut column E and paste it (values only) onto column D. If you paste it straight, a bunch of formulas will port over and mess everything up...if your program suddenly goes belly up, check column D for formulas, chances are that is what happened by accident. Also, watch to make sure you don't accidentally type over formulas in column E...it has been done in the past!

I strongly suggest setting up a Macro (if your program allows them). This makes play mechanically easier and less prone to error. See the section below for the exact order required of this Macro.

There are a couple of things that need to be set up ahead of time...

1) **The trim setting.** A safe number to set this at is 0.5. I like to tweak mine so that the plane is completely balanced at initial cruise speed (the planes always start at cruise). It really doesn't matter, since the actual trim setting is only valid at one airspeed. The trim is not to be changed during the game. Trim is set in G16. Trim reading needed for balanced level flight at cruise will vary from plane to plane, airspeed to airspeed, and throttle setting to throttle setting. For WW1 planes, set a trim of 0 in G16 (these aircraft didn't have trim settings), select (and test) some values between 1 and 3 for D11 and E11 (Stick Y) and calculate to get the pitch (E5) to get pretty close to zero...it will take a few experimental values to do this. Make sure the same value is in both D11 and E11 each time.

2) We always play with 300 foot (100 yrd) hex scale for WW2 planes. The scale can be changed to suit different eras...WW1 works well with 120 feet, Korea with 750 feet. Hex scale is set in G17. Check your altitude sticks against the hex grid being used...type in the number of altitude increments per hex in G18.

3) You'll notice a number in E8. This is what we call your Movement Allowance or MA. Rather than dealing with your plane's movement across the map, this is the movement allowance you have to move your control stick. I'll get into the details of how it does this below, but for now, you'll need to hit recalculate until you get a "3" in that slot. This will be different for different eras (WW1 is higher, Korean Jets are pretty low) due to the aerodynamic pressures on the stick, but for WW2 "3" is a good starting figure...at least make sure all players start out the same.

Now, let's talk about your controls....

Now that the sheet is initialized, you can start playing around with it to see what it does.

You have three controls: Stick, Rudder, and Throttle.

Your MA governs what you can do to change these controls. Your MA determines how far you can move the Stick or Rudder, and you must have a 1 or more MA to change your Throttle. The value you get each turn is determined by your pilot's situational awareness (greyout, blackout, etc.), force needed to move the stick, aircraft damage, and so on.

On occasion you'll get a "-1". That means your pilot has pulled his stick a touch further than he has the strength to pull it. When you get a -1, you must reduce the stick and rudder (not throttle) at least by one (or more, if you want) in both axes and cannot do anything else. "Reduce" means to move back toward zero, but not beyond, in both directions (X and Y as well as rudder). That will make more sense below.

**Values:** For the controls below, we allow 0.5 values (half steps) for the stick only, all the other controls come as integers only.

Each turn, copy column E and "paste special" into Column D. Then, you'll need to type in your new control inputs in column E from E9 through E12. Do this and then when you are happy with the entries, hit calculate. That will show you the new altitude, airspeed, bank, heading, and so on for the new turn (so as to move your models).

**Throttle:** This can be changed to any position from any position provided the pilot has a 1 or more MA. Values range from 0 to 11. 0 is idle, 11 is full emergency. We usually set it at 11 and forget it...there is a chance of engine seizure due to combat damage, but we figure its worth the risk. ;-) There are two special restrictions on the throttle. In the case of Rocket propelled aircraft (the Me-163), only those throttle positions with an "R" can be used. For WW1 aircraft, only "WW1" positions can be used. These are due to limits on what the throttles of these types of aircraft could do. Also note that the control sheet gives some restrictions on early jets due to slow turbojet response (the throttle had to be moved slowly to avoid flameout).

**Rudder:** This can be changed based on MA. It ranges from -5 to 0 to +5. Negative values are left, positive right. The rudder yaws the plane...but be careful, this yaw translates into pitch when the aircraft is banked. Also, yaw will cause bank to change (because one wing is moving faster than the other). Try running a few tests with the plane at 0 bank and pitch...kick rudder one way or the other and watch what happens. An MA of 2 allows you to change the rudder by two...for example go from +5 to +3 and so on. An MA of -1 requires a shift back of at least one. Keep in mind there is a lot of drag involved in rudder use...trying to turn the plane using rudder alone will slow you down quite a bit.

**Stick:** This is the big one. You can fly all day w/o throttle or rudder changes...but if you don't use your stick, you're going to die ;-) The stick is given as two values X (lateral) and Y (vertical), making up a simple grid of potential values around the origin (0,0). Values range (in both direction) from -10 to +10.

Remember, the "special" "-1" ? When one of those comes up, remember you must move toward (0,0) in both axes...

Now, let's look at what they mean...(both are exactly the same as the movement of the control stick in the real plane).

**X (Lateral):** This controls Bank Change. Current bank is given in E2. It is given in 360 degrees rotating clockwise around the nose. Negative X stick values rotate the plane counterclockwise, positive goes clockwise. Remember to stop a bank change, you must neutralize the stick...the stick positions do not correspond to a given bank location, rather they show the rate of change.

**Y (Vertical):** This controls Pitch Change. Current Pitch is in E5. This ranges from +90 (straight up) to 0 (Level) to -90 (straight down). Generally, pulling "back" on the stick (0 to +10) will jerk the nose up, while pushing forward (0 to -10) will push it down. This is reversed if the plane is upside down. Also, you turn the plane by banking and then increasing your G-load by pulling back on the stick. Remember: You can stall an aircraft at any speed according to the adage: To pull the nose up, pull back on the stick, to make it go down, pull back further...

**Movement of Stick:** Your MA is used to move the stick. It costs 1 MP to move away from (0,0). Count each move as one, no diagonals allowed...for example: going from (0,0) to (1,1) requires an MA of 2. All moves back toward either or both axis are free...your MA only represents that movement pulling the stick away from the axis. For example, if your stick is currently at (10,5) and you have an MA of 2...you could go all the way to (-2,0) in a legal move. Remember all back moves are free...

All of this will take some getting used to...so I recommend running a few tests of the program w/o a game in progress just to see what the inputs do. Stick with the Dora for now and run with the following.

1) Type in the desired control inputs in E and calculate (you can change the inputs and recalculate here to see what they do...something you can't do in a real game).

2) Copy E and paste special into D.

3) Check the new MA...adjust controls as allowed by it in E and recalculate.

4) repeat 2 and 3 as long as desired.

## **Redos**

In a real game, no redos (recalculations to try different inputs to get better results) are allowed. The macro recalcopy & paste/recalc takes care of all that in one step. The only info the player has on his aircraft's potential movement is the information provided in column E forecasting what his move will

look like provided he keeps the same inputs as he had in the previous turn. This and his experience with the aircraft should tell him whether he needs to do more or less or change directions or whatever.

The only exception to this rule is new players. They should be given the benefit of the normal forecast plus one what-if attempt. The new player can look at the forecast given above, then he can make another input and recalculate manually to see the effects. Based on these two looks, he must then pick his final inputs (which can be any legal move...the two “look-sees” are only for reference) and do the normal macro to end his turn. This is designed to give him a little more information to avoid silly errors.

The definition of who is a “new player” and who isn’t (therefore eligibility to use this rule) is the “30 turn barrier”. If the player has 30 turns or less in the system (total turns ever done) he can use it, if not he is cheating if he does. Children playing the game can always use the “Newbie rule”.

### **More details**

#### **Stalls:**

Take a plane, one with a big prop engine...the Dora will do. Make sure it has a 0 pitch and 0 bank. Cut the throttle down to 0. Hold altitude using the stick back pressure alone. Each turn, pull back on the stick just enough to maintain altitude (don't worry about speed, it will go down)...if your initial entry doesn't maintain altitude, change the input and recalculate. Don't worry about your MA for this test—just do whatever is needed. As you keep pulling back, your plane will slow up such that further pulling actually does a worse job of holding the nose up than less pull (this is the beginning of a stall). The stall flag will come on in E13. This indicator shows the approach of the stall...5 being fully stalled, and 0 meaning no stall. You can also see the approach of the stall in the percentage in G10 (G10 gives you more warning as it tells you what is going on while the indicator in E13 is still set firmly at zero.

Keep the pressure back there and try to fight the stall, to maintain altitude.

Doesn't work, does it? ;-)

The nose will drop and keep dropping as long as you maintain pressure. So, let go of the stick, back to (0,0). You'll see the stall flag drops instantly and you are back flying (true the nose is dropping like a rock...). OK...**BEFORE** you cut and paste (don't cut and paste until I tell you to do so below), try (0,5) instead. That will also break the stall.

All you need to kill the stall is to relax the pressure. Point is, you can control it. It matters not how fast you are going or what attitude you are at, your plane will always stall with excessive stick pull back. After I'm done below, try a fresh plane at cruise speed and just input (0,9) and watch what happens...

#### **Prop Wash:**

Single engined prop planes (and tri-motors, for that matter...) have a great deal of airflow forced over the control surfaces from the “wind” generated by the engine. Because of this, your throttle setting will vary how far back you can pull the stick before a stall sets in. In effect, high throttle settings exaggerate the effect of the elevator and rudder controls. You may find that at max power (especially when combined with slow airspeeds), you cannot pull the controls back as far before a stall begins. In those cases you have two choices: reduce the throttle, or don’t pull as hard. The program accounts for multi-engined aircraft, jets, rockets, and odd planes (like the Do-335) when computing this effect.

### **Torque:**

This time (leave the stick at (0,6)), slam the throttle full up (to 11) and recalculate. Notice the bank change, etc? This is due to engine torque (used loosely to describe natural left turning tendencies here...not only the pure engineering sense). The amount of engine torque is given in E21. To give the player in the model a chance (he doesn’t see it coming like the guy in the real plane...) torque takes effect with a one turn delay...so you want to take a hard look at the torque given in D21...as that is the torque that will apply in the current turn. If you apply right rudder equal to D21, the torque will be canceled out. Enter a right rudder equal to the torque showing and recalculate. This should eliminate the torque effects. This is something to look out for when your planes start getting slow in maneuvering. Try it with a big enough engine, no rudder, and a slow enough airspeed and you can get a torque roll out of it...heck, in some planes at certain speeds, torque will be so high you can’t give enough rudder to get out of it!

Ok, now take that rudder input back out (make it zero), and try a few other throttle values (less than 11). Recalc each time. See how the effect reduces as the throttle goes down? It disappears at zero, which is why we started this exercise with the throttle cut. Beware the huge engine at full power at slow airspeeds...’nuf said.

### **Spins:**

Take your plane (still with the same turn in Column E, I hope...), jam the throttle to 11, put in no rudder, and a (0,9) stick. Recalculate, cut-n-paste, and recalculate again...

Note that the stall (E13) and spin (E14) flags pop up...and your nose dropped.

Keep those inputs and recalc for a new turn. Your spin has flattened...you should have a -10 pitch. Look at your heading and cut-n-paste for a new turn. When you recalculate, check your new heading. Still spinning, right? If the spin stopped, look at the torque in D21...your bird has gained enough airspeed to reduce torque to “safe” levels. If you had (or were able to...) balance this torque with right rudder, you could have killed the spin (if not the stall) earlier.



Now, cut the throttle and relax the stick to (0,5). Run a few turns and watch the recovery. You can also enter a spin with a stall compounded by excess rudder and aileron use...We'll stay away from tail slides and such right now ;-)

### **High speed Stalls:**

Take your plane at cruise. Bank over to about 70 degrees. Pull back on the stick to turn. As the plane starts turning, pull back a little harder each game turn. When you get to (0,6) or higher (depending on the throttle and the airplane) the plane will stall as you are trying to pull too many G's...this is a high speed stall.

Mix a high speed stall with rapid rudder use and you get a snap roll, of sorts. These are hard to control, but can be used as an evasion maneuver when there is some guy on your tail.

### **Minor Features**

#### **Stall %:**

This indicator is in G10. Its information can be used to determine if you want to pull harder while turning, or not. It is of limited value in play, as the actual G-load it measures against changes from instant to instant...but it can be used to determine just how far you are from a high-speed stall at any given time. At times, you might get a full stall indication in E13 (a "5"), but the Stall % indication in G10 will be less than 100%. At times like those, the aircraft is in a Slow Speed Stall, which means it is not flying fast enough to generate 1G of lift (that needed to stay airborne). A plane can "fly" reasonably normally while in a Slow Speed Stall, it just cannot keep its nose from dropping. In a turn or two, airspeed will naturally build up to allow normal flight—unless the aircraft makes contact with the ground before this happens!

#### **Max Safe Speed %:**

This one is in G11. As a generality, all planes in the game are assumed to have the structural strength needed to withstand up to 150% their max speed before obtaining excessive speed. The figure is then modified for strong or weak structure, whether the aircraft is of WW1 manufacture, and damage. Should you see this number creeping toward 100%, it is best to slow down...should you exceed it, you will start accumulating speed damage (E20)...get enough of that, and your airspeed will immediately drop to zero and you are out of play (your wings came off...)

#### **Orbits:**

An "orbit" (coined term here, so bear with me) doesn't seem that complicated to me, but it does seem to confuse even the best players. If you take a vertical loop, and a plain horizontal turn (90 bank...ignoring the effects of gravity on flight path for the moment) and set them up together to define a sphere (the loop being a line of longitude, the "turn" being the equator), you will have defined all the possible flight paths from any point on that sphere (given a variable radius defined by airspeed and G-load).

All of these flight paths go through the two points where the line of longitude (loop) intersects the equator (turn) with the angle of the "orbit" around this sphere being determined by the bank angle at the moment.

This sphere is a transient thing...it only exists for the current instant, next turn will have a new one defined based on all the changes occurring to the flight parameters.

Enough theory...

What happens in the game is this: During any non-flat (pure Horizontal) "turn" around the sphere described above, bank will constantly change as the aircraft goes around. In some cases, this change happens all at once...as is the case when you do a loop...but in any of the off-angle "turns" you'll see a creeping change to your bank angle which will cause the aircraft to (in time) oscillate across a knife edge bank (90 or 270) back and forth as it goes around the sphere.

Put the Dora into a 60 bank (type this bank directly into D2), and put the stick at (0,3). Run a bunch of game turns, and watch the bank changes. Run enough turns so you can watch the plane orbit up and back down, etc. That way you can see the max and min pitches...make a note to yourself as to what you got. It won't be uniform over a series of reps, as the aircraft's speed is changing and gravity has its effect on both airspeed and flight path.

Now, try the same thing but with an initial bank of 30...watch those max and min pitches (as the airplane slows, you'll see some torque effects...so not all the bank changes you see will be part of this orbit stuff).

Lastly, run the same experiment at 80 degree bank...

As you can see, the closer to 90 you are the smaller the max and min pitches are. If you start at 0 bank, you'll get the full range (+90 to -90...your basic loop). Also note the effects of gravity on this performance which pulls the nose down in spite of most everything.

During the course of your maneuvers, you will find the need to apply small amounts of roll input to maintain the current bank. In normal flight (reasonably level, with modest bank amounts), this amounts to a small amount of aileron to fight what pilots call "the overbanking tendency"...a "tendency" that is nothing more than the above spherical orbit path applied to light aircraft trying to pull themselves

through an orbit (an orbit the aircraft does not have the power to accomplish, anyway) while their pilot resists the aircraft's urge toward knife-edge flight.

## **Movement**

Time to move into how planes move on the hex grid. First, the aircraft have the full 12 facings possible (all hexsides and hex corners). Second, aircraft move using both hexes and hexsides (exactly the way JD does it in "Fighting Wings").

### **Hexes moved, turns made, and increments climbed (or dived):**

Look at the spreadsheet. E17 gives the number of hexes the aircraft moves in the turn. If the flight is straight, simply push it forward that number. E18 says how many 30 degree turns are made while making that movement. "+" is to the right (looking along the direction of flight) and "-" is to the left. We try to even these turns out the best we can. So one turn in a three hex move would end up being move two, reface, move one. The same single turn in a four hex move would be move 2, turn, move 2. Two turns in a three hex move would be move 2, turn, move 1, turn again. Where no exactly even way exists, we tend to "justify toward the end of the game turn" (which is why the first turn in the 3 hex example is the same in both the one-turn and two-turn versions).

E19 shows the number of increment marks on the aircraft stands the plane moves up (+) or down (-) during the game turn. These marks can be any actual size, provided G18 accurately reflects the number of increments in a map hex from hexside to hexside.

I use the cloth maps available from Geo-Hex. These maps have hexes which measure 1.5 inches which is easily converted into 1/2 inch altitude increment marks on the stands.

## **Fire Combat.**

To do this, you'll need the Shot Calculator. Also, you'll need the combat tables. These are all available at the Web site. For the time being, we will deal with fixed guns. Flex guns (those free wheeling or in turrets) work the same way, but players must carefully justify the firing arcs with respect to the firing aircraft. Use the same shot calculator in each case, in the case of Flex Guns, be sure to check off the box in column A identifying the shot as coming from a flex gun (this disables some of the fixed gun features that do not apply to flex guns).

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Before doing anything about a shot attempt, look at the firer's aircraft spreadsheet, cell G5. If there is a 1 there, the aircraft can make a shot, if not, it cannot. This will avoid any wasted effort below on an aircraft that just cannot make a shot at all...this would be because the pilot has blacked out, the guns are jammed, or the firer is in a spin.

After many, many games using a more complicated Shot Calculator, I decided that a good approximation could be made which would allow much of the detail of the original system, but would allow shots to be resolved much more rapidly. As the game revolves around positioning, the loss in detail in shot resolution is a good thing.

This system merely replaces the old shot calculator functions (and data entry). As an aside, it eliminates the resolution of off-angle shots (those with limited potential of anything greater than a fluke hit).

The Range Mod Calc spreadsheet can be used to determine the Range Die Roll Modifier, or players can make a range ruler with the following markings. For simplicity, your hexgrid is used to generate the unit of measure (one hex). Use the Modifier most appropriate for the scale you are playing (WW1 or WW2).

Hexes	Modifer (WW1/WW2)
1	0 / +1
2	-1 / -1
3	-2 / -3
4	-3 / -5
5	-4 / -6
6	-6 / -8
7	-8 / -12
8	-10 / -16
9	-12 / -20
10	too far

Use this stick distance (or the calculated mod) plus the gun values and the target and firer mods from the two plane's spreadsheets to determine the final firing mod. See the Range Mod Calculator for an “instant” means of figuring these modifiers.

Resolve shots only if the target is in the firer's frontal 30 degree cone (plus hexes potentially making up the boundary) and if the firer is in the target's 180 degree rear cone (see also the stall/spin exception below). Do not allow dead-on beam shots against the target, so you have a 180 degree rear cone of the target, less the boundary lines.

For flex guns and turrets, use arcs (other than the forward 30 of fixed guns) appropriate to the guns involved and ignore the usual vertical cone limitations, below.

If the target is dead on center of the firer's front facing, give the shot another +1. Likewise if the firer is dead on center of the target's rear facing, give the shot another +1.

The target's rear arc requirement is eliminated if the target aircraft is fully stalled or spinning. There is no additional +1 mod for being dead-on the "rear" of such an aircraft.

Vertical cones require the use of the Range Mod Calculator program. This not only automatically tells you the range mod (or 999 if you are too far away), but uses basic trigonometry to figure out the actual vertical angle off. Enter the raw altitude of the firer and target as well as the horizontal hex distance between the two (make sure the hex scale is set correctly to what you are doing). Compare this to the firer's shot pitch (G1). If the difference is equal to or less than 30 degrees, allow the shot. Otherwise it is out of cone and not allowed.

Put a 1 into the firing aircraft's G7 cell to take the shot. This simulates the pilot pressing his trigger...no shot can be resolved unless the player types a 1 into his G7 cell. Each shot fired slows the plane down a little according to the physics of the lead flying out the front and Mr. Newton's laws...

Ok, now that you have your legal shot and a Shot mod. Get the Target Modifier from the target aircraft's spreadsheet (G4) and the Firer Modifier from the firing aircraft's spreadsheet (G3). Add these three together. Now, go to Column A in the firer's spreadsheet and move down that column until you find the guns on the plane. Each gun has its own entry. You'll get a color and a number (+5, Blue for example). The color rates the gun's destructiveness (Orange, Green, Blue, Black w/ white, Black w/ red and Red in ascending order). I have a whole set of colored 10-sided dice that match these colors so that before play I can give each player one die of the correct color for each of his guns.

The number (+5) represents the gun's rate of fire induced ability to hit. Add this number to your sum generated by the three numbers added earlier to determine the final mod to be used when you make your firing roll. Each gun firing in the shot (you must use all of them, for simplicity), roll the appropriately colored 10-sided die and add this final mod.

The final modifier, then, is the sum of the Shot Calculator Mod, the Target's Target Mod, the Firer's Firer Mod, and the Firer's Gun Mod. Each firing gun will have the first three the same, but will add its own Gun Mod (if the guns are of different types).

At this point, you will need the Combat Tables from the web page.

Roll one 10-sided die for each gun and add the final mod appropriate to that gun. Compare the result to the modified roll values in the Firing Hit Table. Each "hit" allows a die to be rolled on the Hit Damage Table. Some die rolls can generate two hits, some require a second roll to determine if a hit occurs. Roll the number of dice equal to the number of hit rolls allowed keeping the colors organized (roll by color on the Hit Damage Table).

The total of all the results off the Hit Damage Table gives the actual number of hits made on the target aircraft. These need to be added to that already typed into the target aircraft's G13 cell and typed into G13 (if the number now exceeds G20 the aircraft is shredded and killed by raw number of hit damage points).

If any of the Hit Damage Table rolls have a raw value of 1, 5, or 10 on the dice, each such roll entitles the player to a single roll on the Critical Hit Table. Roll two 10-siders for each such hit (one as tens, the other as ones) and look up the result. Apply the result called for...note that if the pilot is wounded, you'll need to put a "1" in cell G14 of the firer's spreadsheet.

In an e-mail game, one trusted player will execute all the shot mechanics, roll the dice and so on.

### **Gyroscopic Effects**

WW1 aircraft with rotary (not the radial popular in WW2) engines suffered from strong gyroscopic effects as that hunk of metal in front spun about. Because of this major spinning weight, changes in direction (nose up, down, right, or left) are not pure with respect to the controls, but rather precess 90 degrees clockwise. Therefore, a nose up input will give a nose right effect as well.

For this reason, only veteran players are advised to try flying things like the Sopwith Camel and such. These aircraft are difficult to handle and take some practice...especially when the engine is turned up high and the airspeed is slow. Take some time to practice at home before committing to battle in such a bird...it will take careful and slow control manipulations to fly one of these planes successfully. This is not a job for the beginner at your table!

At any rate, this gyroscopic effect is linked to the rate of control change. Zero to five all at once is a big deal, zero to five one point at a time is not. Try it for fun first...BEFORE trying it against an opponent.

### **Taking Off...**

A recently added feature is the ability to start on the ground and take off using the model. To do this, set "0" in D3, D4, D11, and E11. The game ignores ground elevations and uses only sea-level (0 MSL) as the ground.

At this point, and only this point, you can use G22 to turn on your brakes. Place a "1" there if you want to run up your engine before starting to move. Change it to "0" when you want to begin your roll. Be careful though, the brakes only work so well...and your F-4 at full power will drag along on the ground brakes or no brakes...not good piloting! There are no brakes on WW1 birds, so don't expect it to work...

Run up your engine slowly..."2" throttle increments at a time. Once rolling, you'll want to let the plane accelerate enough to keep torque under control...don't jam the engine of a P-51 all the way and

expect to control torque with the rudder at 25 mph! Some aircraft have such powerful engines that they cannot be put at full throttle until after airborne and at a decent airspeed.

I won't go through the details of how to take off in any specific aircraft (this is fun to experiment with)...rather, I'll leave you with a few pointers:

A) There are two sorts of planes you'll encounter: those with conventional landing gear (taildraggers) and those with tricycle gear (nosewheels). If there is a "1" in A56, you have a trike, if not, you have a taildragger. How you take off will depend on which kind you have.

B) Tricycle Gear Take Off. This one is easy. Run up the engines according to the above. release the brakes, correct for torque with the rudder, allow the airspeed to build, when you get up to about 30 mph, pull back on the stick to raise the nose (increased angle of attack)...about a 4 is good...and continue to build speed. When the G reading in D15 approaches 1.0, pull back on the stick a little more (5 or 6...but not more) to get airborne.

C) Conventional Gear Take Off. These birds require a bit more effort on the part of the pilot to get airborne. While it is possible to roll in a three-point attitude until take-off occurs, such a take-off will take much longer to accomplish. While the taildragger accelerates from the beginning like the trike above, once some airspeed is established, the pilot must lift the tail by pressing forward (-1 is good) on the stick. The model does not require the pilot to hold that force while airspeed builds, as a real aircraft does, so once you have popped the tail up (angle of attack in D33 is less than 15), release the -1 back to 0 on the stick. Airspeed will build faster in the tail up attitude than it did before (less ground friction and less induced drag). Once the airspeed gets to a point that seems "flyable", slowly pull back on the stick as you did with the tricycle gear aircraft until you are airborne.

D) In either case, if you suddely get a really weird bank readout, your airspeed drops to zero, or any other abrupt change happens to your normal flight readouts, congrats: you have crashed...

E) When taking off with any aircraft, use careful and slow control movements. Don't go from 0 to 6 on the stick for example. If you jerk up the nose too quickly at a slow airpseed another part of torque (P-Factor) will come back to bite you. Take your time and use smooth, easy control movements.

Once you are at an altitude of 5 feet or so, relax the pressure to stay there...this will allow your aircraft to stay in "ground effect" which reduces drag and allows you to accelerate faster. Climb out at a safe airspeed and at a pitch that allows the aircraft to maintain its airspeed...this will be a relatively shallow angle in most aircraft.

Take offs can be a lot of fun solitaire. Mess around with some easy ones first, then tackle a WW1 rotory bird, like the Camel. That is a whole 'nother ballgame...and takes some deft control inputs to avoid catastrophe!

## **Macros**

During a real game, it is best to set up a macro that uses this exact order:

- 1) Recalculate
- 2) Copy column E

- 3) Paste Special (Values only) into column D
- 4) Change G7 to zero
- 5) Recalculate
- 6) Select E9.

This changes the “current” conditions column of a plane’s spreadsheet to column D from column E which was used for training purposes here. It also resets G7 automatically after any shots that might be done and gives a “forecast” in column E to show the player what to expect in the next turn if he keeps his control inputs the same. We recommend this sequence very highly as it gives the player an inkling of what he is headed toward without the excessive information available to a player when “redos” are allowed.

### **Legal Moves**

The program always checks to see if the player has made legal stick and rudder inputs. To help new players, the allowed range of values for both is given in E23 through E28. Any input within the given ranges is legal.

Should a player input an illegal move, that will be recorded in the program (for future mocking by the other players!) and will contribute damage to the player’s aircraft. If an aircraft “mysteriously” comes apart for no reason at all, check E30 to see how many illegal inputs the player has done during the game. His embarrassment will be punishment enough.

### **No Pilot Effects?**

Players used to other air game systems wonder why (it seems) ACM has no pilot effects. The truth be told it has greater pilot effects than any other air game system...it is just that these effects are not given to the player as a bonus (or setback?), but rather are incorporated into the player himself.

Remember, the player is the pilot here.

In other systems, most (if not all) players can (if they know the rules) operate every aircraft to the maximum of its performance envelope, every time. Everyone knows you can move three and turn once at this speed and so on...also the plane that can move three and turn twice has an advantage that is always there and can easily be accessed by every player.

Not so here. Sure, a plane might have more usable G than another at any given point, but it is how the player uses it (and manages his airspeed...) that will determine what happens. Is he afraid to pull his stick back too hard (fear of stall)...or can he come right to the edge of stall and keep flying? Does the player know how to handle the plane? Does he know how to use the rudder? Can he pull out of a spin successfully or (better yet) keep from getting into one? Does he know how to time a scissors right (or at



least know what one is)? Can he do a barrel roll? Does he pull excessive G for what he wants to accomplish and ends up too slow?

In short, how well does the player know how to fly his plane and how close to max performance can he push it?

That is what separates pilots in this system, not some modifier handed out from above. The better the player the more he will be able to make his plane do. Just putting a new guy into a hot plane will not generate great performance.

In other systems, a quick look at the aircraft stats will show who has a chance and who doesn't...here a great player in a crummy plane will mop up mediocre players in great planes. Elsewhere, the plane is everything and the pilot isn't much (most guys can control right up to the limits) so a modifier or two to show differences in pilots is needed. Here, the pilot is very important, and the player is the pilot. The difference in player skill is the pilot effect.