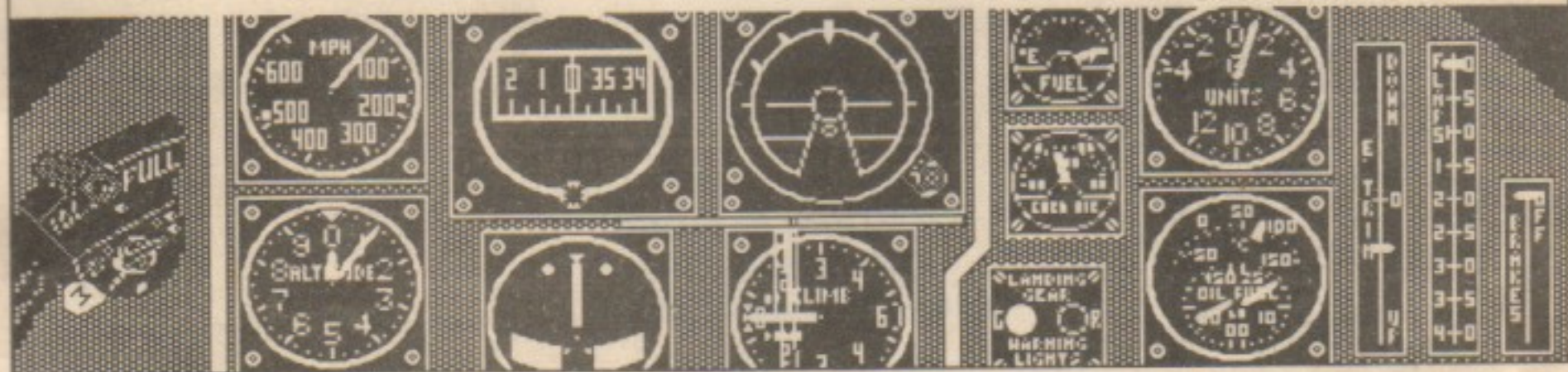


P51 MUSTANG FLIGHT SIMULATOR

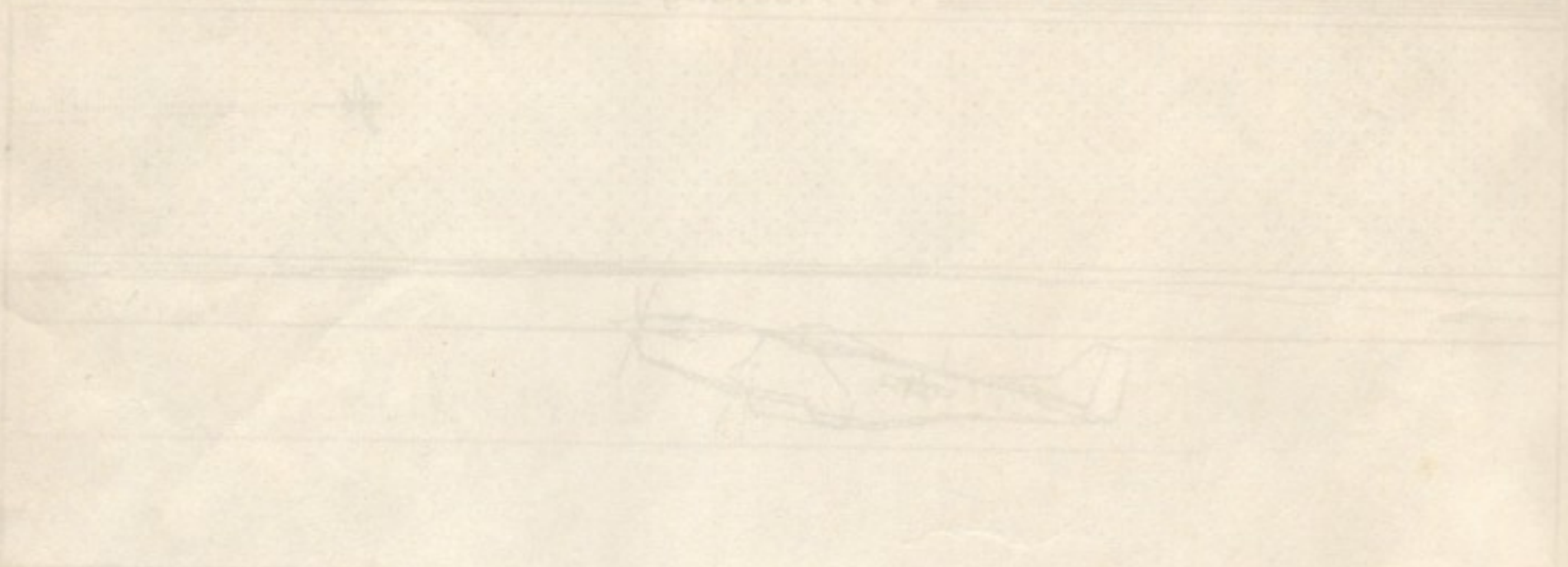
P51 Mustang



BY DONALD A. HILL, JR.

P-51 MUSTANG FLIGHT SIMULATOR

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For the Macintosh®

INSTRUCTION MANUAL

Bullseye Software
P.O. Drawer 7900
Incline Village, NV 89450



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Section LXXXIV - 4800mm Operations	835
Section LXXXV - 4860mm Operations	845
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Section LXXXXI - 5220mm Operations	905
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These are the keyboard commands. They are available while in the flight mode and will not work during pause.

Keyboard Commands (Select item, then enter one keypress)

- | | |
|---|---|
| <input checked="" type="radio"/> Engine Off = ` | <input type="radio"/> Right View = S |
| <input type="radio"/> Engine Idle = 1 | <input type="radio"/> Center Stick = (space bar) |
| <input type="radio"/> Engine Descent = 2 | <input type="radio"/> Sound Toggle = H |
| <input type="radio"/> Engine Cruise = 3 | <input type="radio"/> Flaps Down = F |
| <input type="radio"/> Engine Climb = 4 | <input type="radio"/> Flaps Up = U |
| <input type="radio"/> Engine Full = 5 | <input type="radio"/> Landing Gear Up = U |
| <input type="radio"/> Engine War Power = 6 | <input type="radio"/> Landing Gear Down = D |
| <input type="radio"/> Brakes On = B | <input type="radio"/> Cowl Toggle = C |
| <input type="radio"/> Left Rudder = Q | <input type="radio"/> 45/90 Up View (Toggle) = X |
| <input type="radio"/> Right Rudder = E | <input type="radio"/> Brakes Off = N |
| <input type="radio"/> Center Rudder = R | <input type="radio"/> Pause (or always backspace) = P |
| <input type="radio"/> Down Trim = T | <input type="radio"/> Heads Up Display Toggle = I |
| <input type="radio"/> Up Trim = G | <input type="radio"/> Replay Slower = - |
| <input type="radio"/> Forward View = W | <input type="radio"/> Replay Faster = = |
| <input type="radio"/> Left View = A | <input type="radio"/> Bail Out = \ |
| <input type="radio"/> Rear View = Z | |

Enter new key



OK

Cancel

To shoot your guns, press down and hold the mouse button.

Section I - Quick Instructions

Pop the Mustang disk into your Macintosh and launch the P51 Mustang program. You begin the program sitting on the north/south runway at Leiston Field, England. Leiston field is northeast of London, just inland from the coast.

P51 Mustang has two modes, pause mode and fly mode. The first thing Mustang asks for is your name, it then enters the pause mode. You see the customary arrow cursor, and are able to use the menu items just like any other Mac application. If you click the mouse button anywhere in the application window, you'll be in the fly mode. In the fly mode the arrow cursor disappears and now the mouse is moving the aircraft's control column or "stick". Go ahead and click in the window and move the mouse around. You should be able to see an outlined stick move around at the bottom of the screen. You'll also hear your Rolls Royce V12 Merlin idling. To return to the pause mode, press the "P" or backspace key (some keyboards say delete instead of backspace). You can always pause at anytime and as soon as you click into the window, the action continues. Where you click in the window to enter the fly mode determines where the stick is at, **click near the middle of the screen for a centered stick**, or press the space bar in the fly mode and the stick will be automatically centered.

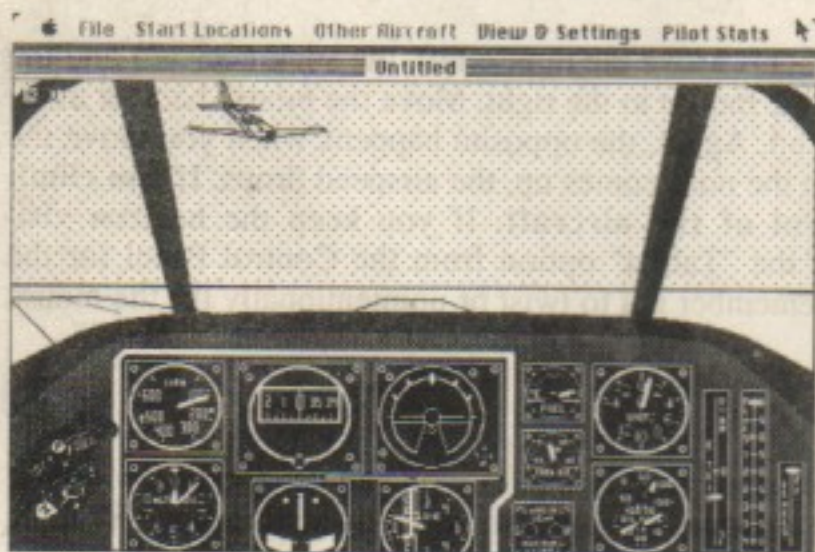
Of course, the program can't give you any physical feedback, so you must fly using visual cues only. On black and white screens, notice that the sky has a simple dot pattern and the ground is white, with light grid lines. When you are close to the ground, the grid becomes hard to see, and the ground looks mostly white. So remember, if the window is filled with dots, you're looking at the sky. If you see white only, or white with grid lines, you are looking at the ground. (Danger, you're headed down!) For most flying, you'll want to keep the horizon visible on the screen with the sky above. This insures a gentle climb or dive, in an upright position. See the illustration on page 24 or on the back of the map sheet, separate from the manual, to see what sky and ground looks like.

The aircraft is controlled by moving its control column or "stick". Move the mouse left, the stick goes left and the aircraft will bank left. The opposite happens when you move the mouse to the right. Move the mouse back or away from the computer, the stick comes back, and the nose goes up. Again, the opposite happens when you move the mouse forward or toward the computer. Remember that when the nose comes up, the airspeed drops. **If you climb too steeply, you will stall and temporarily lose control of the aircraft.** If you keep the horizon visible above the nose, you'll be okay. Also, it's best to select the "Tablet" option from the Control Panel for the mouse. This provides the best control from the mouse. And remember not to twist or unintentionally lift the mouse when trying to control the airplane.

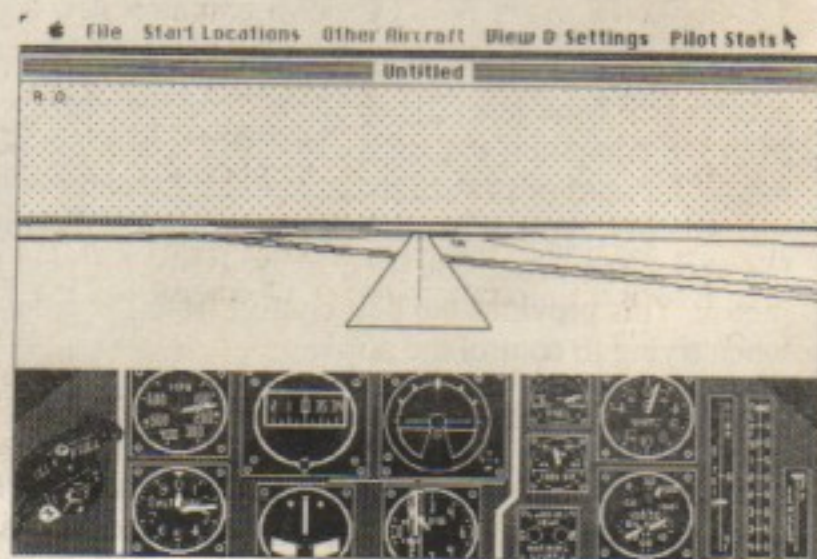
Getting In The Air. Now that you know about the pause and fly modes, you can use the P51 Mustang program. You now need to know some of the facts about the airplane. This aircraft normally stalls around 87 mph, takes off around 95 mph and cruises about 250-300 mph. It has retractable main and tail wheels and flaps. You must

be sure to raise the gear before you reach 175 mph. Flying with the gear down above 200 mph will quite likely cause damage. Be sure to lower your gear BEFORE landing. (Seems logical, right?)

Okay, let's take off. Enter the fly mode by clicking in the window. (If you'd rather not hear the engine sound, press "H", the sound toggle key. The sound toggle actually has three positions; all sounds on, all sounds except the engine sounds on, and all sounds off. Pressing the "H" key will continuously cycle through these three positions.) First things first, let's take a look around your aircraft. Press "A" to look left. (If nothing happens when you press "A" make sure you are in the fly mode, the keyboard commands will not work from the pause mode.) Move the stick (mouse) left and right and you'll notice the aileron moving up and down. When you move the stick to the left, it goes up which will push that wing down when you are flying. Now press "Z" to look backwards. The round thing is the head rest, and it's mounted to a bullet proof pilot shield. You can also see the rudder, press "Q" a bunch of times and you'll see the rudder move to the right. Now press "E" a bunch of times and watch it move left. Press "R" to center the rudder. Press "S" to look right, make sure that the aileron is free and moving. Finally press "W" to look forward again. Press "C" to cheat, and look over the cowl. See the other P51 Mustang ahead of you? Press "C" again to replace the cowl. To recap, W=look forward, A=look left, Z=look behind, S=look right, Q/E=left/right rudder, R=center rudder, and C=toggle cowl on/off. Try putting your left hand on the keyboard, middle finger on the "W" key. (If you don't like this layout, you can change the keys later.) Enough talk, press "5" for full throttle. Press the space bar to be sure the stick is centered. The P51 Mustang is a tail dragger and while the tail is down, you can't see the ground ahead very well. The tail will come off the ground on its own, then you will be able to see the runway. Keep the stick centered. If you push forward, you could nose over. The aircraft is flyable above 95 mph. Watch the airspeed, when you are going 95 mph or more, ease back on the stick by pulling the mouse back. You should visually see that you've lifted off. Also, the vertical airspeed meter will point up a little, and the altimeter will start up. (Ground level is 100 feet at Leiston.) Press "P" to pause. You can now review the gauges without the worry of flying. (Remember, to enter the fly mode again, click the mouse anywhere inside the window.)



Good climb angle after take off.



Looking back toward the runway.

The only hard thing about taking off is keeping the nose in a slightly up attitude. It's very easy to pull back too hard on the stick, stalling the aircraft. As soon as you lift off, push forward a little to level the nose so your aircraft can build up airspeed. You'll press "U" to raise the landing gear. Also, throttle down to "4" after you have reached a safe altitude and have airspeed above 150 mph. This will save your engine undue wear and tear. So do that now, click in the window, press the space bar to center the stick, make sure you are not climbing too steep, raise the gear and climb to 1,700 feet.

To turn, bank in the direction of the turn, then move the stick back to the center. Pull a little back pressure to hold altitude. Then move the stick in the opposite direction to bank out of the turn. To gain altitude, apply more thrust, and raise the nose a little. To lose altitude, reduce thrust, and lower the nose a little. Thrust is controlled by the number keys. "1" =Idle, "2"=Descent power, "3"=Cruise power, "4"=Climb power, "5"=Full power, and "6"=War Emergency power. The "" key will turn the engine off.

Now you know how to get your bird into the air, and fly around. Remember that the ground around Leiston field is at 100 feet. Also, don't fly the Mustang at over 500 mph, or pull more than 8 positive or 4 negative G's. Go ahead and have some fun, buzz the tower, do some loops, whatever, then come back and read about some of the other neat stuff you can do with P51 Mustang. And watch out for the other guy, he's shooting touch and goes at the same field, don't have a midair. If you do crash, you'll be positioned on the runway again. See the illustration on the back of the map sheet for a description of the cockpit instruments. See page 6 for complete keyboard commands.

Frustrating things about flying. After you've flown around a little, you probably have run into a few of the frustrating things the Mustang can do to you.

Stalling is not much fun. The most common stall happens if you attempt to climb too steeply with too little speed (just after takeoff, for example). A simple stall will happen when the airspeed falls below 87 mph. When the aircraft stalls, you have very little control over its attitude. To recover, apply full power and push the nose down. You'll have to sit tight and wait for the airspeed to build up. When the airspeed reaches 100 mph or above, pull the nose back level with the horizon. Remember, you can't just climb anytime you want, you must have airspeed to climb.

Another frustrating thing is breaking your aircraft. You may have been flying around, having a great time, when all of a sudden the aircraft spins out of control and crashes. This was probably a structural failure to the aircraft caused by excessive G's.

"G's" is the term used to describe the amount of force exerted on a mass. On Earth, we usually experience 1 G of force. On a roller coaster you might feel 2 or 3 G's of force, making you feel 2 or 3 times heavier than normal. When you pull an aircraft into a circle or loop, you increase the G force. But instead of just 2 or 3 G's, you may pull 6,7,8,9 or more G's. This has a dramatic effect on both you, as the pilot, and on your aircraft's airframe. For the pilot, the blood begins to pool in the legs, the heart being unable to pump blood into the brain. When this happens,

the brain becomes oxygen starved, creating a tunnel vision effect and, eventually, a total black out. That's bad enough, but think about the wings of your aircraft. They must support 8,9,10 times the weight of the fuselage (maybe 60,000 pounds!) At some point, the wings collapse and you hurtle toward the ground.

Okay, so what do you do? First, keep your airspeed reasonable (between 250-350 mph). When you get over 300 mph, move the stick gently. If you begin to black out ease forward on the stick. This will reduce the G forces. Be patient, it will take a few seconds to recover the blood to your brain. You can look at the Accelerometer or G meter when entering a tight turn. Try not to go over 6 G's. Remember, pulling back on the stick will increase G forces, pushing forward will decrease G forces. As a last resort, you can decrease the sensitivity of the stick. In a real aircraft it's a lot easier not to pull too many G's because you can immediately feel how many G's you're getting. Just be aware that you can break the aircraft, and you'll get the hang of it. Or you can select "G Force Limiter" from the "View and Settings" menu and this will keep you from pulling too many G's.

You can also break the aircraft by flying too fast. Never go over 505 mph.

You'll find it extremely hard to fly if you are looking in a direction other than forward. Fly by the artificial horizon when not looking forward. If you toggle the cowl off, remember to turn it back on. Without the cowl, it's difficult to figure out which direction you are looking.

If you haven't run into these things, you should try them now. Stalls are easy. Just fly level, throttle down to "1", pull the nose up a little and watch the airspeed fall. As the aircraft stalls, it will fall off to the left. Recover as described above.

To break the aircraft, climb to 10,000 feet. Apply full power and enter a steep dive. At over 400 mph, pull back hard and watch the G meter. Try the same maneuver again, but this time continue the dive. See how fast the aircraft will go before it tears itself apart.

One last item, you may find yourself unable to climb. Everything will seem okay, but when you pull the nose up, the aircraft stalls. If this happens, be sure to look at the gas gauge, you're probably out of fuel. If you have the engine sound on, you would hear the engine stop, replaced by the sound of wind whisking past the cockpit.

Installing the Mustang program on a hard disk. P51 Mustang is copy protected, but you can install it on your hard disk. If you launch the P51 Mustang program from the original disk with a hard disk online, the program will ask you if you want to install it on the hard disk. You can also remove the program from the hard disk. See "Hand disk install instructions" on the enclosed information sheet.

Section II - Menu Options

The menu items are "File", "Start Locations", "Other Aircraft", "View and Settings", and "Pilot Stats".

File Menu. The File Menu is typical of most Mac applications. It includes "New", "Open", "Save", "Save As...", "Open Replay...", "Save Replay...", and "Quit". If you select "New", the game resets all variables and restarts just like when the program was first launched (except that the start location may have been changed on the "Start Locations" menu, and the program will use that location).

"Open", "Save", "Save As...", and "Quit" are self explanatory. "Save Replay" and "Load Replay" will save the current situation and also save the replay buffer. Be aware that this will create a LARGE file. The icon for a replay file looks exactly like a normal save file except it has a small "R" in the lower left hand corner. Also, when you load a replay file, the program does not put you into the replay mode. You'll still have to select "Turn Replay On". If you load a replay file you will lose any data currently in the replay buffer.

Start Locations. Start Locations defines two things, where the aircraft will be put after a crash or its location when "New" is selected. It automatically moves the aircraft to that location, when selected. When you make a selection, the program will deduct fuel used from the aircraft, as if the aircraft had been flown to that location.

"Leiston", "Dedbon", "Wendling", "Deenethorpe", "Mount Farm", "Atcham" are air bases in England.

The next three items are "Near Eiffel Tower", "Smithsonian Exhibit", and "Air Race Course". Near Eiffel Tower puts you over what I laughingly call Paris. It's not really Paris because all that you see is the Eiffel Tower and the Arch of Triumph. It's fun to fly around here, though, and the tower makes a good landmark when you're lost.

Smithsonian Exhibit is the part of P51 Mustang that was used as a hands-on exhibit at the Air and Space wing of the Smithsonian Institute starting May 1989. During "Smithsonian Exhibit" the program will continually fly touch and go's. You can take control and land the plane yourself by moving the mouse after the countdown (the throttle is controlled by the program). While Smithsonian Exhibit is selected, "Return from escort" and "Go cross country" are not available. Select a different "Start location" and they will be available again.

Air Race Course is quite similar to the Reno Air Race course, except in this case, you'll find it in north England. Fly around the course counter-clockwise, staying outside the pylons. This is jolly good fun with a friend flying with you. Try to stay below 300 feet. And if you ever get to the Reno, Nevada area around the middle of September, be sure to go to the Reno Air Races at Stead Airfield. Nothing beats the sound of 5 Mustangs roaring overhead. It's a "must" experience.

Then comes "Start on Runway" and "Start on Approach". These two work in conjunction with the six air fields. They have no effect on "Near Eiffel Tower", "Smithsonian Exhibit", and "Air Race Course".

Next to last is "Return from Escort". When you select this item you will be positioned randomly somewhere over Europe, having just completed a B17 escort. Your mission is to inflict damage to enemy aircraft and ground targets. You will be told your position from Leiston field, so you know roughly where you are. The idea is to seek and destroy targets of opportunity, while navigating back to base. Be sure to write down your position from Leiston, or pinpoint your position on the map. If you don't, you can quickly become lost.

"Return from Escort" positions you at 16,500 feet. This is a great altitude for a dogfight, but not much good for strafing. Your mission is to locate and destroy any ground targets you can find. Look around where you are currently flying for any dots on the ground. A single dot has a good chance of being a ground target. You can swoop down and destroy it. Enemy air bases usually have one or more ground targets. One technique is to fly toward enemy air bases that are roughly on a route back to England (you want to get back to England before you run out of fuel). You can use "Go Cross Country" to speed this process. To put it all together, look around for ground targets, if none found, fly 5 minutes using "Go Cross Country" toward an enemy air base and look again for ground targets. When you reach the enemy air base, descent and look there for ground targets. While you are performing this seek and destroy mission, be prepared to defend yourself from Me109's. The bad thing about going down to strafe is that losing all your altitude puts you at a slight disadvantage for a dogfight. After you strafe, try to regain your altitude.

Last is "Go Cross Country". A lot of the time, flying equals boredom. Going from point A to point B can be tiresome and takes much more time than anyone would be willing to sit in front of their Mac. So this item allows you to fly from point A to Point B in seconds rather than minutes.

When you select "Go Cross Country" you get a dialog that asks for the heading and the number of minutes. The heading will default to your current heading. You can enter any heading 0-359 degrees, and any minutes 1-99. You will then see a minute by minute screen update as the aircraft moves the desired heading. The program may refuse to do this for you if your aircraft is damaged or does not have enough remaining fuel. You must be in the air to use "Go Cross Country".

Other Aircraft. Most of the items here deal with what the other aircraft looks like, is doing, or how it's armed. The first two items are "P51 Mustang" and "Me 109". This decides what the other aircraft looks like. You can change this back and forth anytime.

The next two, "Touch 'n' Go's", and "Dogfight" tells the other aircraft how to act. "Touch 'n' Go's" will make the other aircraft faithfully shoot touch 'n' go's forever. He does this at whatever air base in England you are currently flying at.

If you select **"Dogfight,"** you will be continuously approached by hostile aircraft. No matter where you are, high or low, enemy aircraft (one at a time) will attack. They begin fairly "easy" but as you shoot them down, they become more intelligent, and are able to pull more G's. Your victory count will continue until you die or select **"New"**. You can change to **"Touch 'n' Go's"** and back without losing your victory count. Anytime you fly over Europe you can be attacked by enemy aircraft, even if you have **"Touch 'n' Go's"** selected!

"Shooting Blanks" and **"Shooting Bullets"** refers to the enemy aircraft's ammo. Your aircraft always has real bullets.

"Realistic Ammo Supply" and **"Unlimited Ammo Supply"** refers to your and the enemy's ammo. With realistic ammo supply you have 1880 total rounds. This provides about 1 minute of sustained firing (not much time, really). Unlimited ammo supply means, of course, you and the enemy have unlimited ammo supply.

The last item is **"Connect Two Macs"**. Selected, it has a check mark by it. If you select it again, you turn this feature off, and the check mark will disappear. When you select this item you will be asked which port you have connected to the other Macintosh. The usual setup is to connect both modem ports. If you have a modem, you can probably use the cable that is already running from the modem port on the Mac to the modem. Unplug the modem end and plug it into the other Mac's modem port. Make sure AppleTalk is turned off. You cannot use a modem and communicate over phone lines, the communication rate is too slow. If you don't already have a cable, you can purchase one at your local computer dealer.

If you are on an AppleTalk Network, you cannot use this feature.

If you are going to use a port that you also use for printing, you may have to turn your computer off and on before using this feature.

Use the **"Shooting Bullets"** option to allow the other guy to shoot you down, and select Me109 if you want him to look like that aircraft.

When using the **"Connect Two Macs"** feature, the two Macs only communicate when in the fly mode, therefore, both players must enter the fly mode together. If either player exits the fly mode, the other Mac will also exit the fly mode.

It is possible to create a situation where a ground target is burning on one computer but intact on the other. If this happens, don't worry about it, it's not a bug. You can reset a ground target if you fly 30 miles or more away from it.

You can make copies of the original disk so you can run it on two machines. You'll use the original as a "key" disk.

When **"Connect Two Macs"** is selected, the **"Turn Replay On"** feature is not available. Actually, it's still

recording the action, but in order to turn it on, you must deselect **"Connect Two Macs."** When you are done with the Replay, you can then select **"Connect Two Macs"** again.

View & Settings. The first item is **"Turn Replay On"**. The P51 Mustang program is constantly recording most everything that's happening. It keeps track of about the last 4 minutes of action before it starts recording over itself, so, at anytime during your flying adventure, you can look at the last 4 minutes. But that's just the half of it. You can view the replay from any of the camera angles. So, say you do a roll, and it looks pretty good from inside the cockpit. Now you can turn the replay on, put the viewing location outside the aircraft and watch your roll again. Change the viewing location again, and see your mistakes. You can do this after a dogfight, strafing, landing, anytime.

When you select **"Turn Replay On"** from the Settings menu, you'll notice two things. First, the **File, Start Locations, and Other Aircraft** menu items are turned off, these items are not available when in replay. Second, in the upper left side of the window you'll see **"R 1"**. The **"R"** stands for Replay, the **"1"** is the speed of the replay. Speeds range from 0 to 5, where 0 is freeze frame, and 5 is 5 times faster than normal speed. You can also view the replay in reverse with the same range of speeds, -5 to -1. To operate the speed, use the **"-"** and **"="** keys while in the fly mode. When you enter replay the beginning of the buffer is what's being replayed. To see what you just did, you can press the **"-"** key twice to reverse back to the action you want to see, then press **"+"** twice to see it in forward motion. Otherwise, you'll have to wait all the way through the buffer (about 4 minutes, usually) to see the most recent action. To turn the replay feature off, select **"Turn Replay Off"** from the Settings menu. You'll have three options: Continue from position before replay, Continue from current position, and Cancel. The first option allows you to continue as if you never selected replay in the first place. With the second option you can pick up the flight from where you are. This is a little like cheating, for example, if you blow an approach, instead of flying all the way around the pattern (takes about 5 minutes) just replay back a ways, and try again. The 3rd option merely cancels the **"Turn Replay Off"** selection. If you select Cancel, you'll remain in replay.

You can think of the replay buffer as 4 minutes of Video tape. You can do fast forward, fast reverse, and freeze frame. If you select Continue from the current position, you, of course, record over those actions that you performed beyond that spot on the "tape". And, obviously, action 4 minutes old is constantly getting recorded over.

Next is **"Select Camera Position"**. This option will allow you to change your viewing position. You can do this while the action is live, or during Replay. The first two options are views from inside an aircraft. The one on the left is your aircraft, the one on the right is the enemy aircraft. Viewing from the enemy aircraft can be interesting just after you get shot down in a dogfight. Turn the replay on and put the camera inside the other aircraft. You can watch your own tail getting waxed! (A dubious thrill, for sure). When you view from the other aircraft, the cowl is turned off and you can't use the look around keys.

Next, there are two columns of five and six items each. The left column are camera positions that rotate with your

aircraft. If you select these items, the aircraft will appear motionless in the middle of the screen, and the world will rotate around it. It's as if the camera is mounted on, or attached to, the aircraft.

The right column, conversely, is independent of the aircraft. Select one of these and you'll see the aircraft, again centered in the window, but now the horizon stays level, and the aircraft will rotate around. Try watching some replay action and select different camera angles. Some things are more interesting with the camera attached, others with it independent.

The last option on the camera angles is the distance of the camera from the aircraft. If the camera is inside one of the aircraft, then this distance is meaningless, but for all the other angles, this is the distance from the object. You can view as close as 10 feet or as far away as 5,000 feet. (You might use the looking down angle from 5,000 feet for ground taxiing). If you select "View from Tower", then the distance is just like having a telephoto lens on the tower. If the distance is 100 feet, then the camera is zoomed into a distance of 100 feet. If your aircraft gets too far away from the tower, the angle will switch to inside the cockpit, minus the cowl. This lets you know that the viewing angle is supposed to be outside the cockpit, but the program can't do this. Also, the program will automatically pick the closest tower, so you can use this feature from Debdon or the other main air bases, or even the Eiffel Tower. Viewing from the tower is a lot like flying a radio control aircraft.

One other thing; the camera can end up underground under certain circumstances. This can look a bit strange, but it's normal.

"Stick Sensitivity" controls how responsive the stick movement is. With high sensitivity, it's very easy to break the airframe by pulling too many G's. But you can turn sharper at low speeds. As you fly around and become more familiar with your Mustang, you'll find the proper sensitivity setting for you.

You can also control the dead space, or "play" in the center of the control area. This is the distance the stick can move before it alters the control surfaces. When using a joystick you can select a lot of play. A joystick may not always center perfectly so you need center play. Also, with the joystick centered, press the space bar to center the aircraft's stick, matching the joystick's center position.

"Change Key Commands" is next. This will allow you to change the keyboard assignments, so you can layout the keyboard in a manor that suits you best. Simply click onto the command you want to change, then enter the key you want. To save the new keyboard assignments save a file and use it to launch P51 Mustang.

"Performance Enhancer". There are three options: Do not draw Roads/Coastlines during dogfights, Do not draw Roads/Coastlines at all, and Always draw Roads/Coastlines. The enhancer attempts to optimize the frame rate by not drawing roads and coastlines during the heat of battle. You can override this by selecting one of the other options. Use Always draw Roads/Coastlines if you have a faster processor than the normal Mac's.

"G Force Limiter". When selected, this option makes it extremely difficult to damage the aircraft from pulling too many G's.

Pilot Stats. The first five items, "Current Pilot is:", "No Name", "Victories" - "0", "Landings - 0", and "Rating - Dreamer", are static, informational lines. You cannot select these items. "No Name" is where your name is displayed "Victories" is the number of downed aircraft, "landings" is the number of successful landings, and your current "rating" is determined by your victories. Five victories = Ace. You will not get credit for shooting down an aircraft if he is shooting blanks, or if he's flying touch 'n' go's.

"New Pilot Name..." allows you to change the name under "Current Pilot Is:". You can change the name anytime.

The last items are static and cannot be selected. These are a record of the top five pilots, the victories, landings, and the rating.

Section III - Flying Around the World

Takeoffs and Landings. Takeoffs, which have been previously discussed, are not terribly hard. Trouble areas are nosing over, because of forward pressure on the stick, stalling on takeoff, because of pulling off too steeply, and catching a wing tip from a non-level lift off. These items are pretty easy to avoid, and you'll be performing perfect takeoffs, with a little practice. Do remember to raise the landing gear once in the air.

You can always tell the current position of the landing gear from the landing gear indicator lamps. When the landing gear is down and locked, the lamp on the left, the "green" lamp, will be lit. When the gear is up and the throttle is advanced past setting "2", both lamps will be dark. With the gear up and the throttle retarded to "2" or below, the red lamp will come on, warning you that the gear is up. The landing gear indicator lamps look like this:



Landings are a little bit harder than takeoffs, but nothing you can't handle with a little practice. I'll tell you right now, the hardest thing about landing is lining up with the runway. Once you've lined up, it's a piece of cake. So I'll break landing up into three parts, preparing the aircraft for landing, lining up with the runway, and the actual landing of the aircraft.

Preparing for landing consists of:

1. Slowing the aircraft.
2. Dropping 15 degrees of flaps.
3. Lowering the landing gear.

To slow your Mustang, throttle down to "2" or "1" and raise the nose a little. You can also lower the flaps as the speed drops. Here are the speed restrictions for flap angles:

ANGLE DOWN	MAX. I.A.S.
10°	400
20°	275
30°	225
40°	180

As the airspeed drops below 200 mph, lower the flaps to 15 degrees. You do this by pressing the "F" key, each press equals 5 degrees. The flap position indicator on the right of the screen will read the current flap position. Once the

airspeed falls below 175 mph, you can lower the landing gear by pressing the "D" key. Check for a green light on the gear indicator that tells you the gear is down and locked. Okay, the aircraft is now prepared for landing.

The next step is to line up with the runway. This is by far the hardest step in landing. The knack here is knowing when to turn "final", or turning down the length of the runway. This is something you just have to try and practice to get right. Select the Smithsonian Exhibit option for help. This option cycles through the line up and landing steps. Enter the fly mode and then don't touch the mouse. As long as the mouse is not moved, the program will fly both aircraft. Watch when the program turns final and note the altitude and visual cues. This will help you visualize your own approaches.

Now try your hand at lining up with the runway. The trick here is to level the wings as you look down the runway. Now keep the wings level and use the rudder to make minor heading corrections. It's imperative you keep the wings level as you get closer to the ground. It's better to land off the runway then to catch a wing tip and cartwheel across it.

Once lined up, the hard work is done. If the wings are level, you no longer need worry about ailerons or rudder. Your only concern is with airspeed and sink rate. Sink rate is displayed on the vertical airspeed indicator. You are attempting to reach the ground as the aircraft stops flying (airspeed below 90 mph) with a sink rate at or below 5 feet per second down. You control airspeed and sink rate with the nose angle to the ground. If you pull the nose up, airspeed drops and sink rate slows down. Push the nose down, airspeed raises and sink rate increases.

So the final actions as you reach the threshold (cross the end of the runway) is to be at 120 mph, throttle at "1" and at 30 to 50 feet above ground level. As you get close to touching down, you perform a flare. To flare the aircraft, pull back on the stick to bring the sink rate down below 5 feet per second, and airspeed to 90 mph or so. You'll touch down with a squeak of the tires.

Using the "Smithsonian Exhibit" option you can practice this last step of landing by allowing the computer to fly the aircraft until it's lined up. When you are ready to take over the controls, pull back on the stick a little. Throttle is taken care of by the program, so just use the elevator and practice landing gently.

Another fun practice routine is to try to follow the other aircraft around the pattern. When you first start the program, the other aircraft is sitting just in front of you. He is waiting for you to throttle up. You can then takeoff in formation.

You must adjust your throttle to match his airspeed. If you are close to him, you can see when his gear is up or down. Be sure to raise and lower your own gear.

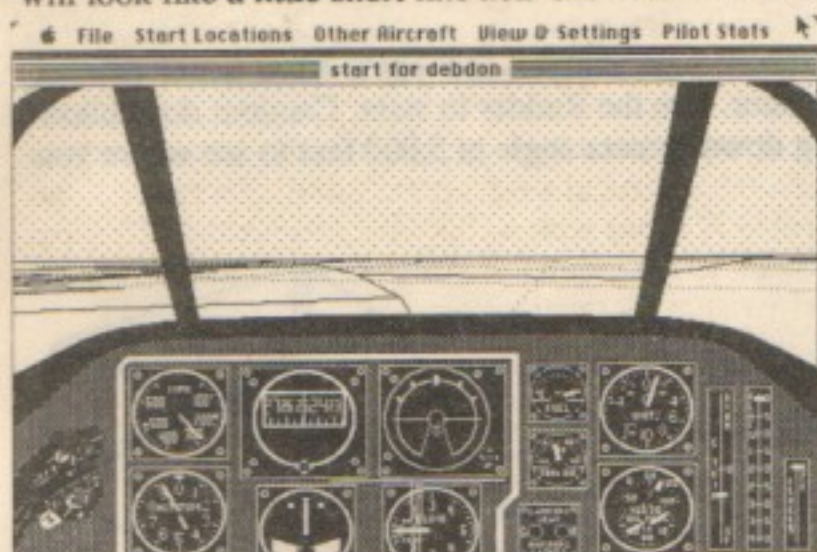
If you find yourself in a situation where your gear will not lock down (you'll know this by a red indicator light), you'll have to land on your "bell". Make your approach basically the same as with your gear down, but keep the

nose of the airplane up a little so you don't plow in too hard. Go ahead and practice a belly landing or two.

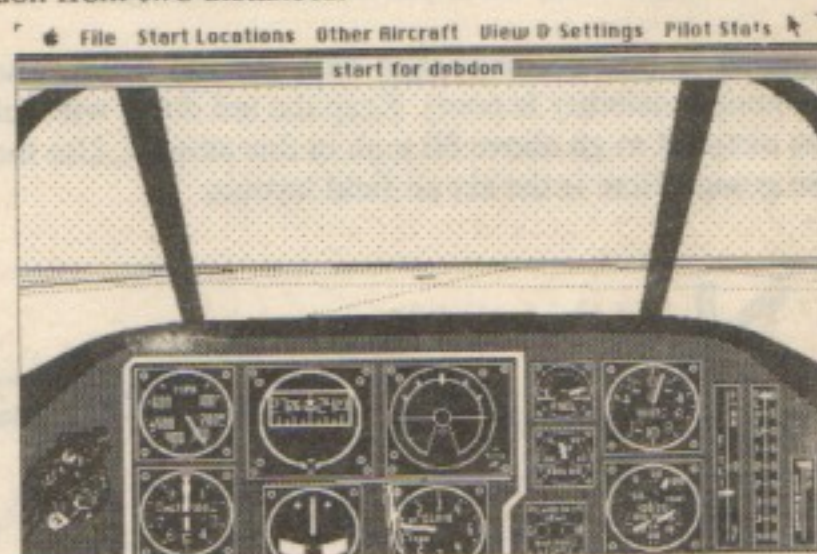
If you land too hard with your gear down, you will either bounce, break one or both of your landing gear, or die. Pilots say any landing you can walk away from is a good landing. Good luck.

Other Air Bases. It's time to take a trip to another air base. There are five other air bases scattered in England. (Actually, during WWII there were many more than the six included in this simulation.) Take a look at the map and see where the other bases are.

Take a trip over to Debdon field and practice some landings over there. Here's how, takeoff from Leiston field, turn to 250 degrees, and climb to 5,000 feet. In about 5 minutes, you'll be able to see Debdon field off in the distance. It will look like a little short line near the horizon. Here is Debdon from two distances:



Debdon barely visible (small line at horizon)



Debdon somewhat closer and easier to see

Fly until you can make out the runways, then make some landings. On the way back to Leiston, try using the "Go Cross Country" option. The distance between Debdon and Leiston is about 11 minutes using "Go Cross Country".

To navigate between two points on the map, figure out the compass heading using the direction finder overlay. You can either fly this heading or enter it into the Go Cross Country dialog. To figure out how many minutes to enter, measure the distance in inches, multiply by 100 to create miles, and divide by 4.5 for minutes. The Go Cross Country feature will move the aircraft at 270 mph or 4.5 miles a minute irrespective of the aircrafts current speed.

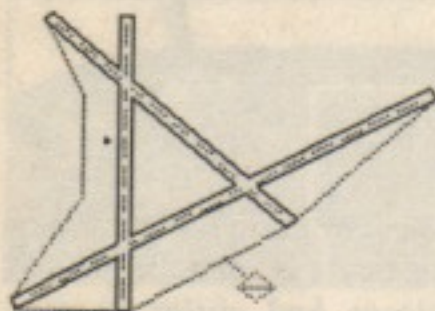
You'll notice that when you are flying low, it is very hard to make out coastline and road patterns. As you ascend it becomes easier to pick out landmarks. Takeoff and climb to 10,000 or 15,000 feet. Look around and pick out a distinctive coastline or road intersection. Now see if you can find the same coastline or road on the map. This is a skill you'll want to develop. There's not many things worse than being low on fuel and lost in the air.

Roads, in this simulation, are really just lines. Coastlines are double lines; the bottom line is dotted and at sea level, the top line is solid and at a somewhat higher altitude. This resembles a cliff face. Also, at times, roads and coastlines will appear to end right in front of you, then an instant later, they will extend to the horizon. This is a normal by product of the programs ground drawing routines.

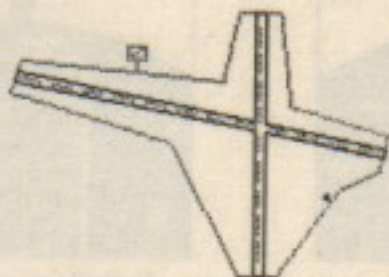
Fly around to each of the air bases and practice your navigating skills.

Refueling. After you take a couple cross country trips, you'll want to refuel your Mustang. Each airfield in England has a fuel dump. You'll recognize it as a square with a dotted diagonal line through it. All you have to do to refuel is taxi over and into the fuel square and come to a complete stop. Turn the engine off (press the "E" key) and watch the fuel gauge. Your Mustang will also be repaired if any damage has occurred. Use the brakes to stop, but be sure to release them when you want to move again.

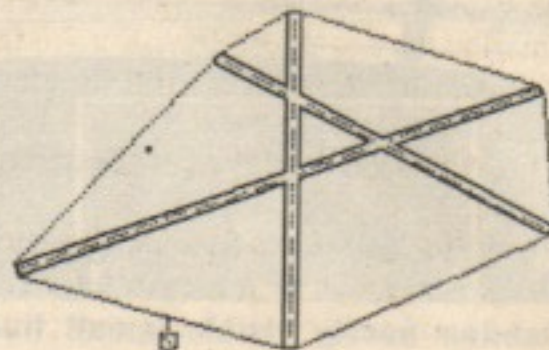
Taxiing is best accomplished with the tail down. The aircraft will turn sharper and you'll have better control (although visibility is poor). Keep the tail down with full up elevator. Use the Rudder to steer. Caution: don't allow the airspeed to go above 60 mph in this attitude. Use the looking down camera angle at 5,000 feet to see where you are going. Here is the six air field layouts:



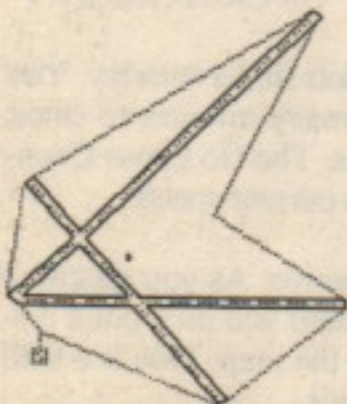
Leiston Field



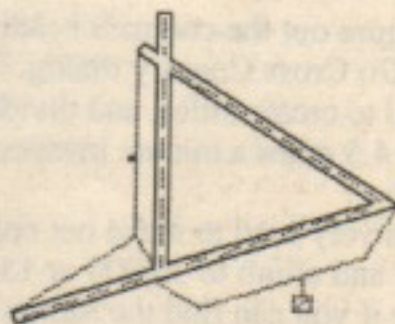
Debdon Field



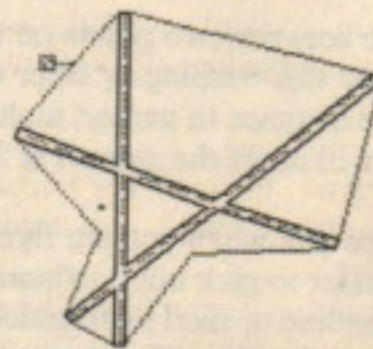
Wendling Field



Deenethorpe Field



Mount Farm Field



Atcham Field



Section IV - Military Flying

Maneuvers. Takeoffs, landings, flying cross country, and recovering from stalls are skills you should be already familiar with. We'll now go on to more advanced maneuvers.

Roll: Fly straight and level. Pull the nose up a little and use hard left aileron (left stick). As you go inverted, use forward stick to keep the nose glued to the horizon. Continue with hard left aileron until you complete the roll, then apply right aileron to stop the roll and return to straight and level.

Try to end the maneuver at the same heading and altitude that you began with. Additionally, you can use a little rudder as the wings go perpendicular to the ground, to keep the nose from falling below the horizon. Practice rolls to both the left and right.

Loop: Loops are easy. Enter straight and level, at least 2,000 feet above ground level (AGL). Throttle up and drop the nose until 250-300 mph is achieved. EASE back on the stick, pulling the nose all the way up and over. Very important to watch the G meter. Do not go over 6 G's in your pull up. Also, keep the wings level or your loop will be slanted. Look left or right to watch the horizon rotate around you. As you come over the top, throttle down. (It's smart to always throttle down when the nose is pointed down.) Here again, it's important to watch your G forces. As you get back to level, ease off the elevator, throttle up and you are done.

This maneuver should be exited at the same altitude that it was began at.

It's difficult to make round loops, most end up being egg shaped. Fine tuning can be done by easing off a little on the elevator, allowing the aircraft to climb on the way up, and staying off the elevator (elevator is controlled by forward and back stick) all the way past inverted. Then pull harder as the aircraft points down. And, of course, watch those G's.

Split S and Immelmann: Both of these maneuvers consists of a half roll and a half loop. The Split S has the half roll first (you roll inverted), followed by a half loop. The Immelmann is the exact opposite, half loop, then half roll (you roll right side up). Both maneuvers can be considered turns because the aircraft ends up going in the opposite direction.

High G Turn: This is a very important maneuver to learn if you expect to be successful at dogfighting. Most dogfights seem to deteriorate into turning battles, the guy who can turn sharpest, wins.

A high G turn is accomplished by banking the aircraft 60 to 90 degrees. Then pull back on the elevator. This pulls the aircraft around in a circle. The higher the bank, the sharper the turn can be. Here again, (and I know I sound like a

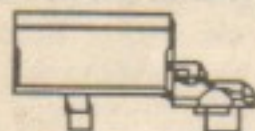
broken record), watch the G forces. Adjust the bank and elevator to hold altitude and desired G's. The higher the bank (approaching 90 degrees) the more elevator that is required to hold altitude. Of course, the more elevator, the higher the G forces. More will follow in the dogfight discussion about high G turns.

Barrel Roll: Enter a climbing turn to the left. Now use full back and right stick. Use the rudder to correct any mistakes or to create a desired heading on exit. Of course, you'll want to practice barrel rolls in the opposite direction also.

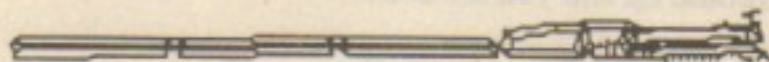
Snap Roll: You don't get much of a snap below 200 mph and above 300 mph, this maneuver is dangerous to your aircraft. Here's what you do, pull back full on the stick, then apply full right stick and full right rudder. Do this all very quickly, within a second. The aircraft will snap around it's axis. All you have to do is center all the controls when you see "straight and level" come around.

After you attempt one of these maneuvers, select one of the outside camera angles and replay your maneuver. You can stop at any point to check the instruments, or whatever. Play it forward and backward and figure out what you did right and wrong.

Ground Targets. There are a variety of ground targets including trucks, trains, planes, and even a motorcycle or two. Some targets move, others are stationary. Here is what some of the ground targets look like:



Truck



Train



Ju88



Me109

You will see other objects on the ground that are not targets. These objects are houses and hangers, and they will not blow up. (You may, once in awhile, see a moving target disappear. This is because when a moving target reaches the end of its travel, it resets to its original position.) From high in the air, ground targets will appear as a single dot. You'll find ground targets out in the open in Europe, and usually at enemy air bases. See page 12 under "Return from Escort" for a description of how to find targets over Europe.

Strafing. You'll find some trucks and houses at 271 degrees, 21 minutes from Leiston. You can use these trucks to practice on.

There are two things to work on with strafing. First is the approach and line up, and second is the pull out. Begin the approach at an altitude and distance you feel comfortable with. If you are too low, it's hard to shoot at the target without crashing into the ground. If you are too high, the dive angle becomes so steep that the pull out is dangerous.

To fire your guns, press down and hold the mouse button.

Here's the look of two typical strafing runs:



Attacking a truck between two houses



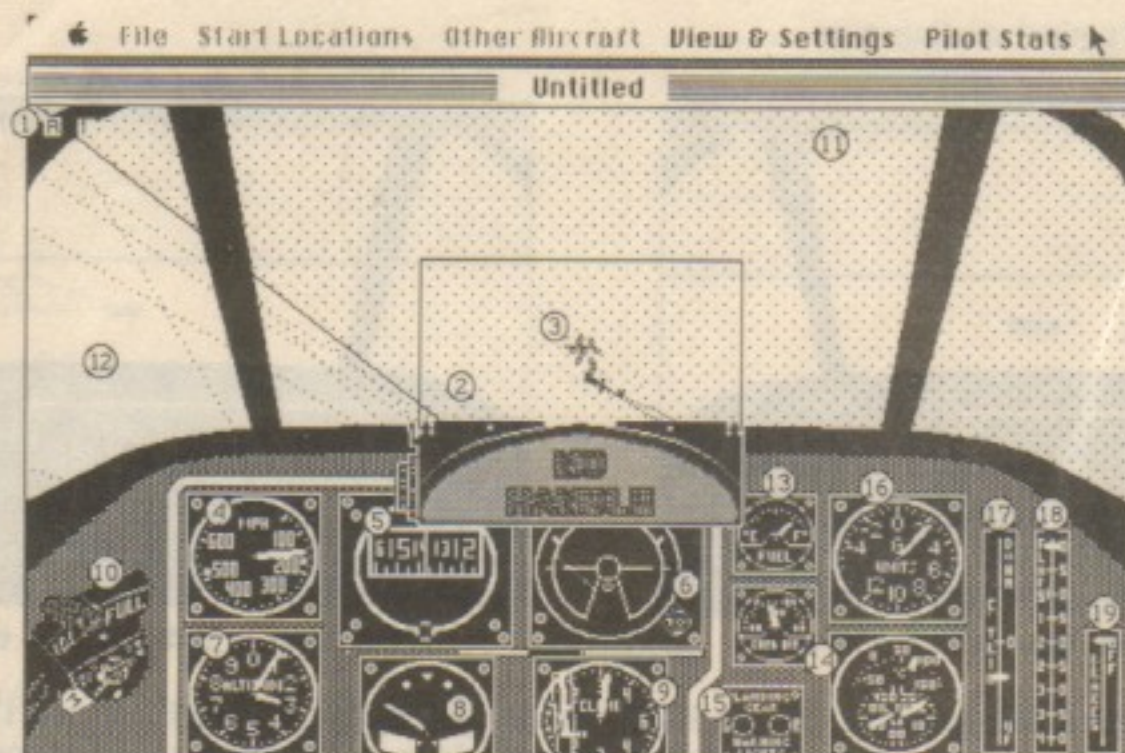
Attacking a Ju88 at an enemy field

You might find it easier to hit the target with the HUD (Heads Up Display) removed (use the "I" key to toggle the HUD). Point the nose at the target and level the wings. Throttle down to "1" or "2" to get a longer firing window. (If you come at the target with a lot of speed, you go by it with only a brief burst of machine guns.) With the wings level, you can use the rudder to make minor heading corrections. While still too far away, fire a short burst from your machine guns (depress the mouse button briefly). You'll see the tracers head toward the target. Now use the rudder or elevator to adjust the nose direction at the target. As you come in range, begin firing. Try to keep the tracers hitting the target.

When you get to the target, hits or no, you must pull up. If you haven't blown the target up, the urge is to fire "just a little bit longer". Be aware of the infamous "Target Fixation". Don't become so intent on the target that you fly right into it!

Shoot into the middle of most of the targets, to blow them up. The train is a little different, shoot it in the boiler. As you get better at strafing, you'll learn the right "touch" to blowing up each individual ground target.

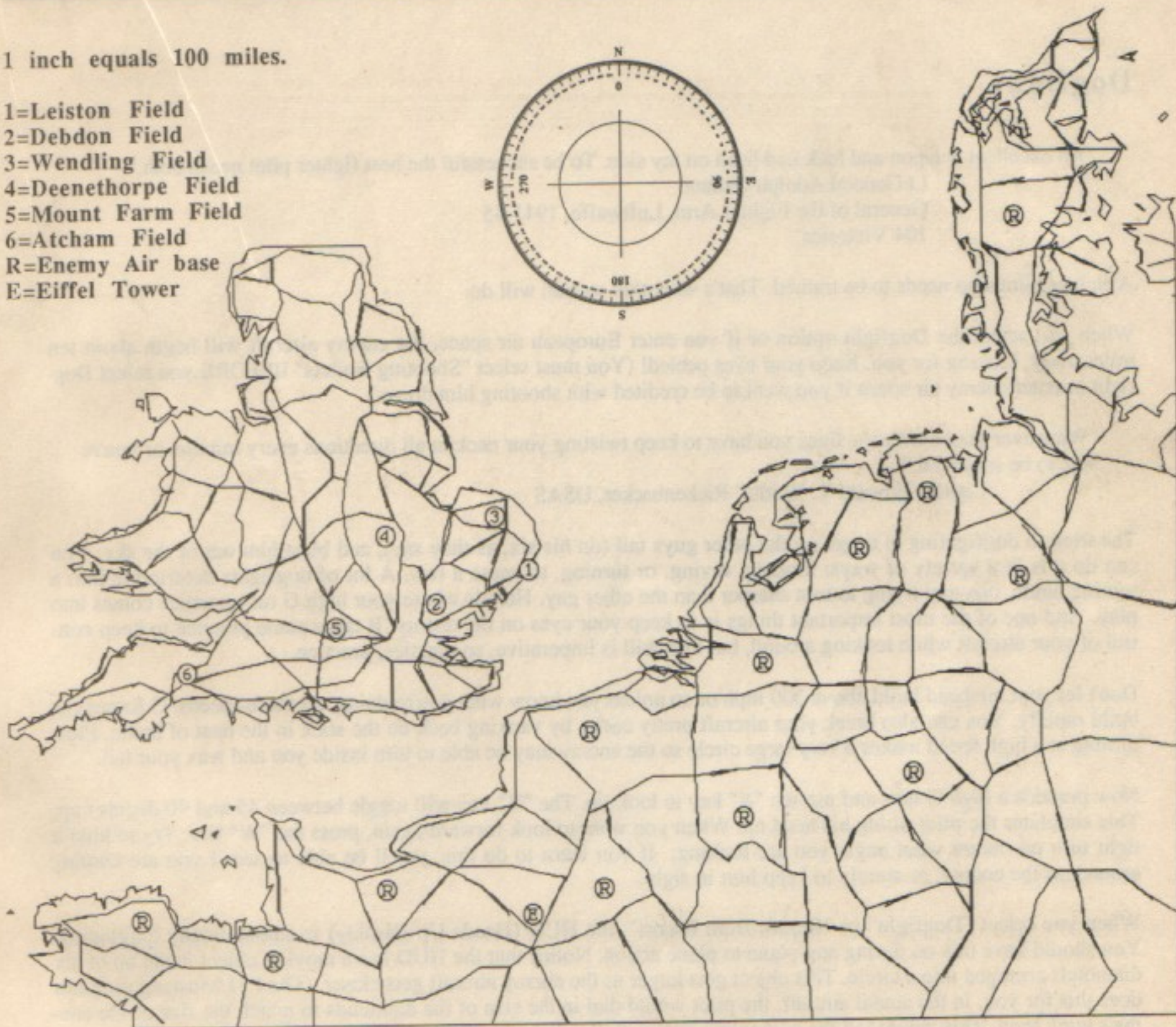
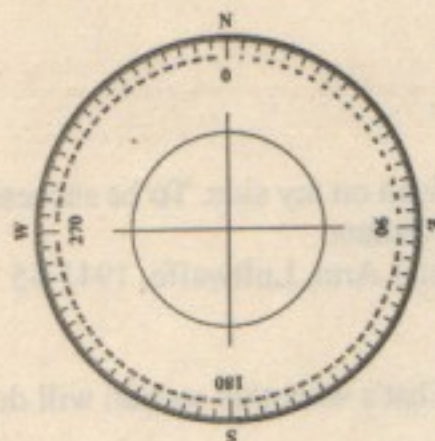
When you fly around Europe (after you select "Return from Escort", for example) keep your eyes open for a dot on the ground. This will quite probably be one ground target or another that you can dive on and blow up. You'll also, almost always, find ground targets at the enemy bases. You can find these bases on the map, designated with the letter "R".



1. "R 1". You'll see this if you are in the Replay mode. The number designates the speed of replay, -5 to 5.
2. This is the Heads Up display area. Don't grab on to it when you climb into the aircraft.
3. The cross hairs and diamond targeting object. Notice the enemy aircraft has just blown up.
4. Airspeed indicator, in miles per hour. The white squares denote maximum speed and maximum gear down speed.
5. Heading indicator. The trailing digit is not displayed so 9=90 degrees, 26=260 degrees.
6. Artificial Horizon. Use this gauge to see where the horizon is, when not looking forward.
7. Altimeter, or altitude indicator. Big arm is hundreds of feet, small-thousands, and the triangle is tens of thousands.
8. Turn and Bank indicator. Put the bank arm on a white square for a typical turn. The ball does not move.
9. Vertical airspeed indicator or Climb gauge. The numbers are tens of feet per second, up or down.
10. Throttle position indicator. The handle will move to the throttle selected. The other knobs do not move.
11. Sky. The sky is shaded with this loose dot pattern.
12. Ground. The ground has a light grid pattern on it. The grid work becomes more visible the higher you fly.
13. Fuel gauge, you know what this does.
14. Engine gauges, non operative.
15. Landing gear position indicator lamps.
16. Accelerometer, or G meter. This important display shows the G forces the aircraft is currently pulling.
17. Trim position indicator. This is best used when a joystick is connected to trim the aircraft at center stick.
18. Flap position indicator. The numbers are degrees of flaps, 0 to 40.
19. Brake position indicator. Off is all the way up, full brakes is all the way down.

1 inch equals 100 miles.

- 1=Leiston Field
- 2=Debdon Field
- 3=Wendling Field
- 4=Deenethorpe Field
- 5=Mount Farm Field
- 6=Atcham Field
- R=Enemy Air base
- E=Eiffel Tower



To create the number of *minutes* to enter in the "Go Cross Country" dialog, divide the number of miles by 4.5. The "Go Cross Country" feature assumes aircraft speed at 270 mph, irrespective of the aircraft's actual speed.

Dogfight.

"An excellent weapon and luck had been on my side. To be successful the best fighter pilot needs both."

Lt General Adolph Galland

General of the Fighter Arm, Luftwaffe, 1941-45

104 Victories

A fighter pilot also needs to be trained. That's what this section will do.

When you select the Dogfight option or if you enter European air space, the enemy aircraft will begin about ten miles away, looking for you. Keep your eyes peeled! (You must select "Shooting Bullets" BEFORE you select Dogfight or enter enemy air space if you want to be credited with shooting him down.)

"Whenever you're over the lines you have to keep twisting your neck in all directions every minute, or you're sure to be surprised."

Captain Edward V. "Eddie" Rickenbacker, USAS

The trick in dogfighting is to get on the other guys tail (on his six, as they say), and blast him out of the sky. You can do this in a variety of ways: looping, diving, or turning, to name a few. A lot of dogfights deteriorate into a turning battle, one guy trying to turn sharper than the other guy. Here is where your high G turn practice comes into play. And one of the most important things is to keep your eyes on the enemy. It takes some practice to keep control of your aircraft while looking around, but this skill is imperative, so practice, practice.

Don't let your airspeed build above 300 mph or so unless you know what you're doing. At these speeds, G forces can build rapidly. You can also break your aircraft pretty easily by yanking back on the stick in the heat of battle. Plus, turning at a high speed makes a very large circle so the enemy may be able to turn inside you and wax your tail.

Now practice a high G turn and use the "X" key to look up. The "X" key will toggle between 45 and 90 degrees up. This simulates the pilot tilting his head up. When you want to look forward again, press the "W" key. Try to hold a tight turn no matter what angle you are looking. If you learn to do this, you'll be able to see if you are coming around on the enemy, or simply to keep him in sight.

When you select "Dogfight" or "Return from Escort", the HUD (Heads Up Display) is automatically toggled on. You should have this on during any plane to plane action. Notice that the HUD has a moving object made up of six diamonds arranged into a circle. This object gets larger as the enemy aircraft gets closer. (The P51 Mustang program does this for you, in the actual aircraft, the pilot would dial in the size of the diamonds to match the size of the enemy's wing span. This would tell the computing gun sight the distance of the aircraft.)

The diamonds compute the lead angle of the shot for you. Put the diamonds on the enemy aircraft and shoot. The screen display on the lower left hand of page 30 shows proper targeting. The greater the G's and the farther the target, the larger the lead angle that's computed. You can hit the target and inflict damage as far as 800 yards away, but it's difficult. The best thing to do is get CLOSE. Less than 300 yards is good, less than 100 yards and you can't miss.

NOTE: The program performance (frames per second) is slower near airports. It becomes much harder to dogfight with slower frame rates. Therefore, it is advisable to go cross country away from an airport when practicing dogfights.

You and your aircraft can get hit and damaged in a variety of ways. You may get injured and have a hard time moving the stick and bailing out. Or, the aircraft can be damaged in such a way as to lose one, two, or all three of its control surfaces. You may lose your engine, fuel, landing gear, flaps, guns, or even have your canopy get stuck. (If you canopy gets stuck, you cannot bail out.)

"There are only two types of aircraft-fighters and targets."

Major Doyle "Wahoo" Nicholson, USMC
Fighter Pilot

I want to make sure you are flying a fighter and not a target.

"Great pilots are made not born... A man may possess good eyesight, sensitive hands, and perfect coordination, but the end product is only fashioned by steady coaching, much practice, and experience."

Air Vice-Marshal J.E. "Johnnie" Johnson, RAF

Let's get into some specifics of dogfighting. There are three phases to a dogfight. The first phase is when you pick up the enemy visually and make your first pass. This ends up being a head on pass many times. Pilots talk about getting a "snapshot", or a brief opportunity to fire the guns. You can try for a snapshot on a head on approach, but remember the enemy will be doing the same. If you keep your aircraft pointed a little to the side of the other aircraft it becomes extremely difficult for him to hit you.

Next comes the middle phase. Immediately after you pass each other, you must try to get on his tail, or prevent him from getting on yours. The enemy in P51 Mustang begins stupid. His only response is to do a tight turn. He will only pull 3 G's or so. You can practice a variety of responses to get on his tail. The easiest is to pull a higher G turn. Look behind to see which way the enemy breaks, then turn so you are both circling in the same direction. As you begin to reel the opponent in, you enter the final phase, the end game.

Another technique after a head on pass is to perform a half loop. While you're inverted, pick up the enemy and see which way he has turned. (Use the "X" key to look out the top of the canopy.) You can then perform a diving turn onto his tail. You'll need some extra airspeed for this maneuver.

Or you could try a Split S. It's up to you to decide which type of maneuver applies, and which one you can perform best.

"A good fighter pilot, like a good boxer, should have a knockout punch... You will find one attack you prefer to all others. Work on it till you can do it to perfection... then use it whenever possible."

Group Captain Reade Tilley, RAF, 7 Victories, WWII

In the middle phase, you are both circling, trying to come around on the other guy. There are three types of pursuit curves; lead, pure, and lag.

A lead pursuit occurs when you place the nose of your aircraft ahead of the target aircraft. This will decrease the distance between the aircraft, and will also be necessary to hit the target during tight turns.

Pure pursuit is when you point the nose of your aircraft directly at the target. This will also decrease the distance between the aircraft, assuming the same airspeed, but will not usually create a shooting situation.

Last is the lag pursuit. To perform a lag pursuit, point the nose of your aircraft behind the target aircraft. Use this when you are overshooting the enemy (about to pass the enemy by). This will increase the distance between the aircraft if speeds are close to the same.

While you're trying to pull the enemy into your sights, he will be doing everything possible to elude you. (Well actually, the computer controlled opponent will not be doing anything very smart until you rack up a few victories. These victories have to be while the opponent is shooting bullets.) One thing he will try to do is make you overshoot. In other words, he will slow down and attempt to make you pass him by.

It is extremely deadly to overshoot your target. If this situation is imminent, and lag pursuit is not enough to prevent overshooting, try doing a barrel roll. Another technique to prevent overshooting the opponent is the High Yo-Yo.

"The Yo-Yo is very difficult to explain. It was first perfected by the well known Chinese fighter pilot Yo-Yo Noritake. He also found it difficult to explain, being quite devoid of English."

Squadron Leader K. G. Holland, RAF, Fighter Pilot

To perform a High Yo-Yo pull into a climbing turn. This will allow you to slow down and turn sharper than the enemy. Pick the enemy up visually again by using the "X" key, then dive onto his tail.

The Low Yo-Yo is useful if you are unable to turn with the opponent, perhaps from lack of airspeed. A Low Yo-Yo consists of pulling into a diving turn. This increases airspeed and allows you to come around quickly. You should be able to pick up the enemy above you. Pull up into him for a straight on shot.

Now suppose you're on the defensive with the enemy on your rear quadrant. If you see tracers in front of you, and you are not shooting, things are bad.

One defensive maneuver is called Scissors. The scissor is simply a series of high bank turns, first left, then right, then back left, and so on. You are attempting two things. First, to escape any shooting opportunities for your opponent, and second, to get your bank opposite the enemies. When this occurs, simply continue the turn, instead of reversing it. This will disengage the enemy.

The computer controlled opponent will use scissors as a defensive maneuver from time to time. You can always try Major Johnson's advise:

"When he saw me behind he began to whip back and forth, left and right, as violently as he could. I followed, but it was hard to line him up for a shot. Finally, as we kept whipping back and forth, right and left, I began to shoot before he whipped and he had to fly through my fire."

Major Robert S. Johnson, USAAF

You'll want to use the rudder to fine tune your aiming, also watch the enemy closely while you are shooting him. Sometimes, even though the airplane has not blown up, the pilot will bail out. If you are watching closely, you can see him exit his aircraft. When this happens, you can stop firing at his aircraft, it's going down on its own. See the screen display on the right hand of page 30.

Also, keep an eye on your airspeed and throttle. It's a lot of things to coordinate, and it takes practice. I'd advise you to keep the enemy shooting blanks until you start shooting him down.

"When one has shot down one's first, second or third opponent, then one begins to find out how the trick is done."

Baron Manfred von Richthofen
Leading Ace of WWI, German Air Service, 80 Victories

"No guts, no glory. If you are going to shoot him down, you have to get in there and mix it up with him."

Major Frederick C. "Boots" Blesse, USAF, 10 Victories, Korean Conflict

It's like Bubi says, you gotta be close. The easiest way to blow the other guy up is to fly right up his tail pipe.

"You can have computer sights or anything you like, but I think you have to go to the enemy on the shortest distance and knock him down from point-blank range. You'll get him from in close. At long distance, it's questionable."

Colonel Erich "Bubi" Hartmann, GAF
World's Leading Ace, Luftwaffe, 352 Victories, WWII

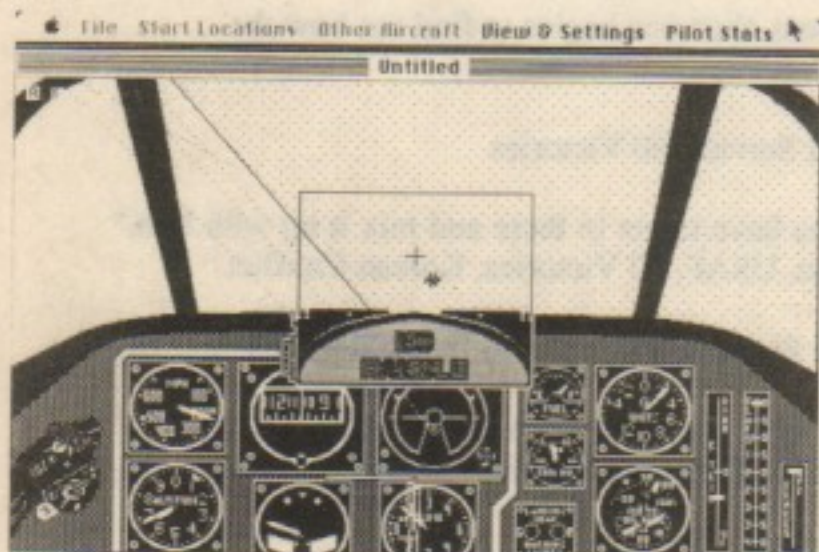
I have only just scratched the surface on dogfight strategy. These quotes were reprinted with permission from, and some of the basic ideas were inspired by, "Fighter Combat, Tactics and Maneuvering", written by Robert L. Shaw and published by the Navel Institute Press. This book is widely available and I recommend it highly.

Bail Out. Eventually, you will find yourself in a situation where you need to bail out. It's quite simple, just press the "N" key. You will see your aircraft flying off without you. In a few seconds, the chute will automatically open and you will be floating quietly toward the ground. You can use the look around keys; look up and you'll see the parachute above you.

If you bail out over enemy territory, you'll have to take your chances. Over the ocean is even more dangerous. If you do make it back to your base, your victories will be preserved.

Sometimes when you press the "N" key nothing will happen. There are two possible explanations for this. One, the canopy has become jammed shut, for whatever reason, and you can't get it open. The other possibility is that you are injured and it's hard for you to get the canopy open and get out of the aircraft. If this is what's happened, you must keep pressing the "N" key in an attempt to escape. You may eventually get out okay, so be sure to press the bail out key continuously.

For entertainment, you might try bailing out over a friendly air base or the Eiffel Tower. See how close you can come to a specific spot on the ground, the tower for instance. You cannot guide the parachute in any way, so you'll have to jump at precisely the right spot. It's also real fun to watch a friend bail out when you have two Macs connected.

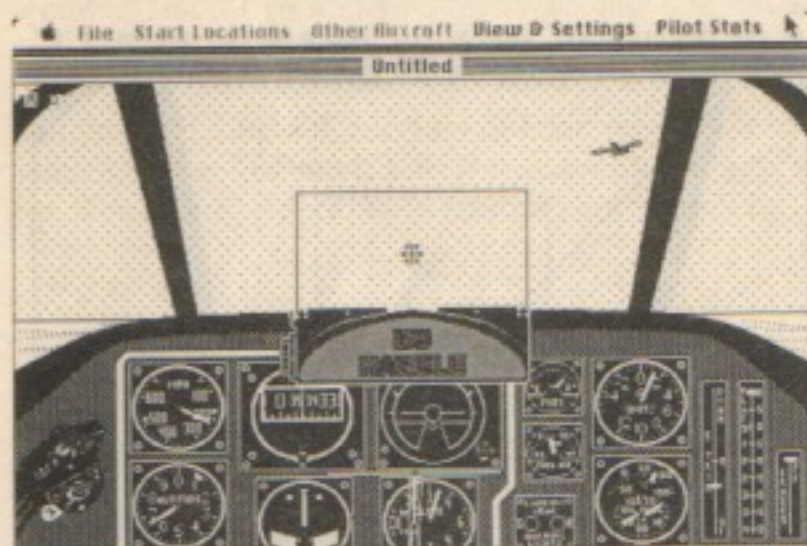


Proper use of computing gun sight.

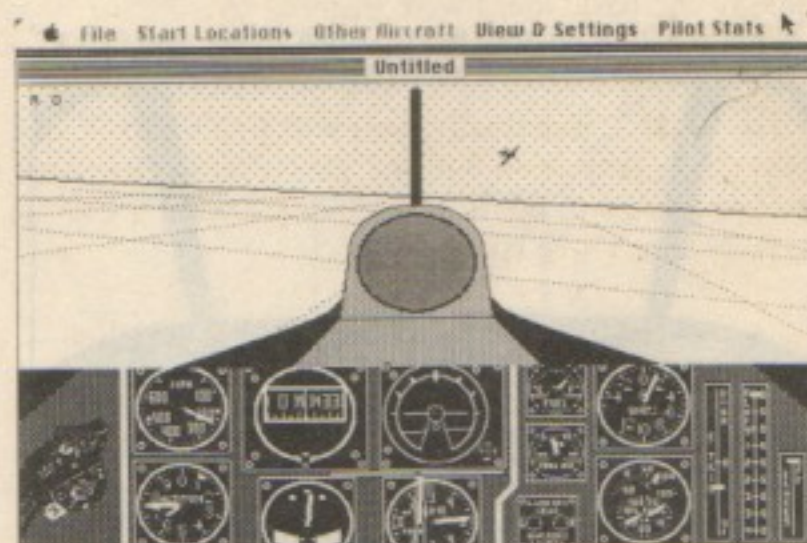


Other pilot bailing out.

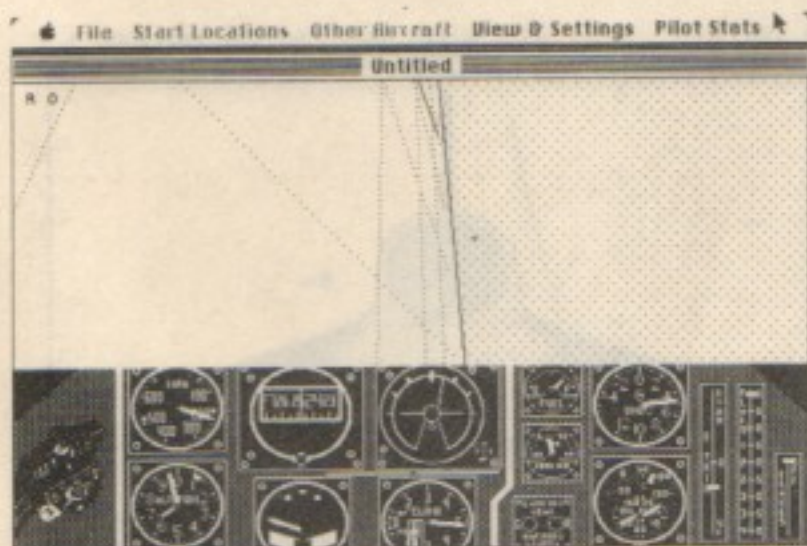
The four screen shots here, and the four on the next page recap a sample dogfight session.



1. This dogfight begins with a head on pass.



2. As the aircraft passes by, look behind to see which way the other guy is turning. I'll turn same direction.



3. Here I'm looking 90 degrees up and turning hard. It's important to keep my eyes on him as much as possible.



4. I'm looking up 45 degrees here. I'm keeping him in sight as I come around on him.



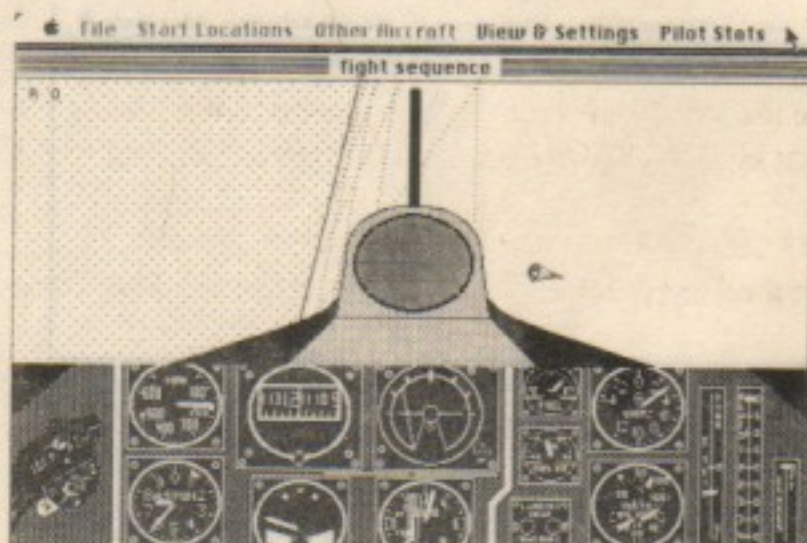
5. I'm now reeling him in. I'm trying to put the circle of diamonds on the enemy aircraft.



6. He's smoking now, I've put several rounds into him already. It's just a matter of time before he's history.



7. Bam, he got hit good. You can see parts of the aircraft flying off in the explosion. If you get this close, it's hard to miss.



8. Looking backwards, I can see the other pilot got out okay and is floating toward the ground.

Section V - Original Flight Manual

This section is in part, reprinted from an original 1945 air force issue P51 Mustang instruction manual. Some details have been left out or changed to conform to the P51 Mustang simulation. I'd like to thank Charles Cumiford for providing me with a copy of this very rare document.

Description.

AIRPLANE

The F-51D, built by North American Aviation, is a single-place, low-wing monoplane powered by a Packard-built Rolls Royce engine. The airplane is equipped with six .50-caliber machine guns as standard equipment. Armor plate is installed in the cockpit area for protection of the pilot during combat.

AIRPLANE DIMENSIONS

The following dimensions apply to the airplane:

Wing span.....37 feet
Length.....32 feet 2 inches
Height (three-point attitude).....13 feet 8 inches

AIRPLANE GROSS WEIGHT

The normal gross weight of the airplane with no external load is approximately 9000 pounds. The gross weight can be as high as 12,300 pounds when external armament and fuel are carried.

ARMAMENT

The airplane is armed with six forward-firing .50-caliber machine guns, three mounted in each wing.

ENGINE

The airplane is powered with a Packard-built Rolls Royce V-1650-3, -7 or -9A series engine rated at 1490 horsepower (Military Power) and has a two-stage, two-speed supercharger. The 12-cylinder, liquid-cooled engine drives a four-bladed constant-speed propeller and is equipped with an injection-type carburetor and an automatic manifold pressure regulator. An aneroid-actuated switch automatically controls the supercharger blower speed shift.

ENGINE CONTROLS

THROTTLE

The throttle, located on the left longeron, is mechanically linked to the manifold pressure regulator. The throttle in-

corporates a gate that allows a maximum of 61 in. Hg manifold pressure up to critical altitude. When the throttle is moved past the gate, breaking the light locking wire, a manifold pressure of as much as 67 in. Hg is possible for War Emergency Power. To set the throttle on P51 Mustang Flight Simulator use keys 1-6 where 1=idle, 2=descent throttle, 3=cruise throttle, 4=climb throttle, 5=full throttle, and 6=War Emergency Power. The "" key turns the engine off.

STARTER SYSTEM

The starter system consists of an electric direct-cranking starter, a starter switch, and a booster coil. To aid the magnetos when rpm is low during cranking, a booster coil intensifies the spark of the right magneto, which fires the intake spark plug of each cylinder.

PROPELLER

The airplane is equipped with an 11-foot 2-inch diameter, four-bladed, constant-speed, Hamilton Standard Hydromatic propeller of the nonfeathering type. A propeller governor mechanically controlled from the cockpit admits engine oil to the propeller dome for pitch changes necessary to maintain a constant engine speed. Engine oil pressure is used to aid the centrifugal twisting moment of the blades toward low pitch (increase rpm), and boosted engine oil pressure through the governor moves the blades toward high pitch (decrease rpm).

FUEL SYSTEM

The fuel system consists of two self-sealing wing tanks of 90 US. gallons (usable fuel) each and one fuselage self-sealing tank of 85 US. gallons. Filling the fuselage tank to the 85-gallon capacity may cause an aft CG condition beyond limits; therefore, the fuselage fuel tank is placarded for 65 US. gallons maximum and should never be filled above this quantity. Each of the main fuel tanks has its own gravity-fed submerged-type booster pump receiving power from the electrical system of the airplane. These pumps supplement the engine-driven fuel pump and will handle the fuel needs of the engine at all altitudes if the engine-driven fuel pump fails. If the booster pumps fail, the engine-driven fuel pump will supply fuel only up to approximately 8500 feet.

FLIGHT CONTROL SYSTEM

The ailerons, elevators, and rudder are conventionally operated through push-pull rods and dual cables by a control stick and rudder pedals. Trim tabs on each of the primary surfaces are operable from the cockpit by a cable system. A reverse boost rudder tab is installed on most airplanes. On late airplanes and on some airplanes modified in service, a 20-pound bobweight has been added to the elevator control system to improve the flight characteristics.

Normal Procedures

FLIGHT RESTRICTIONS

Detailed airplane and engine limitations are listed under Operation Limitations.

ENTRANCE

The cockpit can be entered from either side of the airplane. However, a spring-loaded flush handhold is provided below the canopy frame on the left side of the fuselage. A marked reinforced section of the wing fillet is used as a step during entry.



Caution

Do not use trailing edge of wing flap or extreme edge of fillet as a step, as damage will result to these units.

ON ENTERING COCKPIT: INTERIOR CHECK

1. Fasten safety belt and shoulder harness. Check operation of shoulder-harness lock.
2. Adjust seat level to obtain full travel of rudder pedals in extreme position.
3. Adjust rudder pedals for proper leg length to obtain full brake control. Press foot against lever on inner side of each pedal.
4. Check controls for free and proper movement, watching control surfaces for correct response.
5. Wing flap setting full up.
6. Check fuel quantity gage.



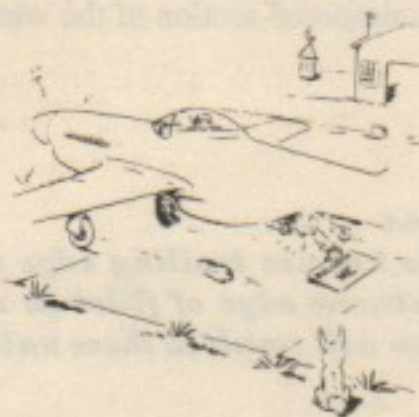
Caution

Do not exceed 40 in. Hg during ground run-up without having tail tied down, because of the possibility of airplane nosing over.

TAXING

Use the following procedure during taxiing:

1. Steer a zigzag course to obtain an unobstructed view.
2. Taxi with stick slightly aft of neutral to prevent excessive loads on tail wheel.
3. Use brakes as little as possible, to prevent overheating.
4. Upon reaching take-off position, stop airplane at right angles to runway so that approaching airplanes may be seen.



Caution

Taxi cautiously to avoid damage from objects which the tires or propeller might pick up and throw against the radiator air outlet flaps.

BEFORE TAKE-OFF

Before take-off, check safety belt fastened and shoulder harness unlocked; then check:

1. Primary Controls:
Check surface controls for free movement.
2. Instruments and Switches:
All instrument readings in desired ranges.
All switches and controls at desired positions.
3. Flaps:
Flaps set for take-off (UP for normal take-off).

CLIMB:

1. Allow airspeed to build up to 170 mph for normal climb.
2. Make sure Flaps and Gear are up.

FLIGHT CHARACTERISTICS

DESCENT

Descent may be carried out at any safe speed down to the recommended margin of about 25 percent above stalling speed. Lowering either the flaps or landing gear, or both, greatly increases the gliding angle and the rate of descent.

Be sure to check speed before lowering flaps or gear as possible damage will result at too high a speed.

NORMAL LANDING

For a normal landing, plan your approach so that you are over the edge of the field at 120 mph. Use a continuous back pressure on the stick to obtain a tail-low attitude for actual touchdown. Because of the wide landing gear and locked tail wheel, landing roll characteristics are excellent on this airplane. Minimize use of brakes during ground roll. At completion of landing roll, clear runway as soon as possible.

MINIMUM-RUN LANDING

Minimum-run landings may be accomplished in either of two ways. If no obstacle is present, lower flaps fully and make a flat power-on approach. Hold airspeed to lowest possible safe limit. When in position, close throttle completely. For a minimum-run landing over an obstacle, lower flaps fully and close throttle completely when sure of clearing obstacle.

GO-AROUND

If a go-around is necessary use the following procedure:

1. Open throttle.
2. Maintain wings level and nose straight.
3. Landing gear handle UP.
4. Raise flaps when at least 200 feet above ground.

Emergency Procedures

ENGINE FAILURE DURING FLIGHT

If the engine fails during flight, the airplane may be abandoned, ditched, or brought in for a dead-stick landing. To land with the engine dead, follow these instructions:

1. Lower nose at once so that airspeed does not drop below stalling speed. Keep IAS well above stalling speed.
2. Choose an area for landing. Judge your turns carefully and plan to land into wind.
3. If a long runway is available and time and altitude are sufficient to properly plan an approach: landing gear handle DN. If landing under any other condition, keep gear up; you stand less chance of injury by making a belly landing.
4. Wing flap lever approximately "30 degrees," saving last 20 degrees of flap to overcome possible mistakes in judgment. Lower flaps fully when proper landing is ensured.
5. Land into wind, changing direction only as necessary to miss obstructions.
6. After landing, get out of airplane as quickly as possible and remain outside.

MAXIMUM GLIDE

Maximum glide distance in event of a dead engine may be attained by gliding at an airspeed of 175 mph with gear and flaps up.



Note

There is no fire-extinguishing system on this airplane.

DITCHING

The airplane should be ditched only as last resort. If it is impossible to maintain sufficient altitude for bail-out, ditch according to the following procedure:

1. Check gear up and flaps one-half down.
2. Land into wind with one wing about 20 degrees low, and maintain enough speed above stall to keep rudder control. As low wing hits water, kick hard inside rudder to spin airplane around on surface to prevent severe diving and quick deceleration. As soon as airplane comes to rest, get out immediately. (In this simulation, any ditching results in pilot death.)

BAIL-OUT

Before bail-out, reduce airspeed as much as possible and trim to slightly nose-down attitude. Head for an uninhabited area and press the "\n" key.

Operation Limitations

AIRSPEED LIMITATIONS

The white square on the airspeed indicator marks the maximum permissible airspeed. Do not exceed the following wing flap setting airspeed restrictions:

ANGLE DOWN (degrees) / MPH

10/400 20/275 3/225 40/180 50/165

COMPRESSIBILITY EFFECTS

At high diving speeds, there is a danger of the airplane being affected by compressibility as the airplane speed approaches the speed of sound. Compressibility effects are indicated by instability of the airplane, uncontrollable rolling or pitching, stiffness of controls, or combinations of these effects. A nose-heaviness will be noticed and will become more severe as speed increases.

PROHIBITED MANEUVERS

No intentional power-on spins or snap rolls are permitted, as it is impossible to do a good snap roll and most attempts end up in a power spin.

No intentional power-off spins are permitted below 12,000 feet.

Inverted flying must be limited to 10 seconds because of loss of oil pressure and failure of the scavenge pumps to operate in an inverted position. (The simulation does not enforce this restriction.)

ACCELERATION LIMITATIONS

The airplane is limited to a maximum positive load factor of 8 G and a maximum negative load factor of 4 G. Remember that when you pull the maximum G, the wings of your airplane must support eight times their normal load. This means that during a maximum G pull-out the wings of the airplane (at design gross weight) are supporting eight times 8000 pounds or a total of approximately 64,000 pounds (the maximum that the wings can safely support). Therefore, when your airplane weighs more than 8000 pounds, the maximum G that you can safely apply can be determined by dividing 64,000 by the new gross weight. The maximum load factors we have been talking about apply only to straight pull-outs. Rolling pull-outs are a different story, however, since they impose considerably more stress upon the airplane. The maximum allowable load factor in a rolling pull-out is two-thirds the maximum G for a straight pull-out.

Flight Characteristics

GENERAL

The airplane is stable at all normal loadings.

STALLS

The airplane has a comparatively mild stall. The airplane doesn't whip at the stall, but rolls rather slowly and has very little tendency to drop into a spin. When you release the stick and rudder, the nose drops sharply and the airplane recovers from the stall almost instantly.

FLIGHT CONTROL EFFECTIVENESS

AILERON CONTROL

This airplane has sealed-balance ailerons. A fabric diaphragm seals the space between the leading edge of the aileron and the aft side of the wing spar, and tends to lighten the stick forces. At normal speeds, control is positive.

ELEVATOR CONTROL

At normal speeds, elevator control is very good and stick pressure is light. As speed increases in a dive and pull-out is attempted, you must use caution so as not to over control and pull up too fast; otherwise, undue stress or even failure may result.

RUDDER CONTROL

Because of the reverse-boost rudder tab and dorsal fin, the airplane has very good directional stability, with a directional change requiring definite pressure on the rudder pedal in proportion to the amount of yaw desired.

LEVEL-FLIGHT CHARACTERISTICS

LEVEL-FLIGHT STABILITY

Level-flight stability is good, with normal control pressure required for desired effect.

LOW SPEED

At low speed, the controls tend to become slightly mushy but control is still good.

CRUISE SPEED

Controls are positive at this speed, and control stick forces are normal.

MANEUVERABILITY

Control response for this airplane is very good, with unusually light stick pressures required to perform maneuvers.

CAUTION: Avoid rapid movement of the elevators in dives and maneuvers at speeds above 350 mph IAS or .7 Mach, particularly at aft CG positions, to prevent rapid uncontrolled increase in G-loads.

DIVES AND ACCELERATED FLIGHT

At high diving speeds, there is danger of the airplane being affected by compressibility-a phenomenon likely to be encountered when speed approaches the speed of sound. Compressibility may be indicated by instability of the airplane, uncontrollable rolling or pitching, stiffness of controls, or a combination of these effects. The longitudinal

characteristics remain normal until the speed of the airplane reaches approximately 72 to 74 percent of the speed of sound. At this speed, the airplane may become slightly nose-heavy because of the compressibility. Inasmuch as further increases in speed may result in more severe nose-heaviness, diving speed should be limited at this point and recovery started immediately after the change in longitudinal trim is evident.

WARNING: The anti-G suit should be used with a constant 6 G pull-out.

DIVE RECOVERY

If diving speed limits are exceeded, compressibility effects will be experienced. Reduce power and pull up very gradually, taking care not to exceed 4 G except in emergencies. If pull-out above 4 G is necessary, as G increases, relax pull force on stick. The elevator trim tab is not normally required to aid recovery. In the event it is necessary, use with extreme care and feed in gradually.



Warning

Be very careful in pull-outs, since the stick forces are relatively light, and an abrupt pull-out may cause structural failure.

WARNING: Care should be taken in pull-outs above 4G, as the stick forces are relatively light, and an abrupt pull-out may cause rapid uncontrolled increase in G.

Systems Operation. It is often asked what the consequences will be if the 5-minute limit at Take-off Power is exceeded. Another frequent inquiry is how long a period must be allowed after the specified time limit has elapsed until Take-off Power can again be used. These questions are difficult to answer, since the time limit specified does not mean that engine damage will occur if the limit is exceeded. Instead, the limit means that the total operating time at high power should be kept to a reasonable minimum in the interest of prolonging engine life.

It is generally accepted that high-power operation of an engine results in increased wear and necessitates more fre-

quent overhaul than low-power operation. However, it is apparent that a certain percentage of operating time must be at full power. The engine manufacturer allows for this in qualification tests in which much of the running is done at Take-off Power to prove ability to withstand the resulting loads. It is established in these runs that the engine will handle sustained high power without damage. Nevertheless, it is still the aim of the manufacturer and to the best interest of the pilot to keep within reasonable values the amount of high-power time accumulated in the field. The most satisfactory method for accomplishing this is to establish time limits that will keep pilots constantly aware of the desire to hold high-power periods to the shortest period that the flight plan will allow, so that the total accumulated time and resulting wear can be kept to a minimum. How the time at high power is accumulated is of secondary importance; i.e., it is no worse from the standpoint of engine wear to operate at Take-off Power for one hour straight than it is to operate in twelve 5-minute stretches, provided engine temperatures and pressures are within limits. In fact, the former procedure may even be preferable, as it eliminates temperature cycles which also promote engine wear. Thus, if flight conditions occasionally require exceeding time limits, this should not cause concern so long as constant effort is made to *keep the over-all time at Take-off Power to the minimum practicable.*

WAR EMERGENCY POWER

During emergencies in a combat zone, it is sometimes necessary to get the absolute maximum manifold pressure at which the engine may be operated within reasonable safety limits. This extra power is available when the throttle is pushed beyond a gate on the throttle quadrant (select key "6").

CAUTION:

Keep War Emergency Power use to below 5 minutes per mission or engine failure may result.

Section VI - Notes from the Author

Isn't everyone in love with the P51 Mustang aircraft? P51 Mustang Flight Simulator is the program I've wanted to do for a long time. Way back when I wrote Fokker Triplane Flight Simulator (back in 1985, it seems longer ago than that) I originally was going to make it a P51. But I knew I could not do the aircraft justice if it was to be my first flight simulator program. So I picked another interesting aircraft, the Fokker Triplane. I think there is also something less intimidating about the Triplane, not only from a flying point of view, but somehow that transfers over to a programming point of view. The Triplane flew a lot slower, had fixed gear and no flaps, had hardly any cockpit gauges (in the actual aircraft), and had a greatly reduced range (when compared with the Mustang). Of course, the range of the Mustang, when fitted with external fuel tanks, was one of the important factors in the European theatre. Before the Mustang, no allied fighters could escort bombers all the way to their targets, deep inside Germany, and the bombers were taking a real beating. Reichmarshal Goering remarked after the war that the day he saw Mustangs over Berlin was the day he decided that Germany had lost World War II. The P51 Mustang is widely accepted as the best all around fighter of WWII. It also saw service in various Air Services around the world into the late fifties and even into the sixties.

Of the 9603 P51D's that were built, it's estimated that a scant 200 may still be flying or flyable. You owe it to yourself to see this great American aircraft in person. You may be surprised to find the the airport near you has a Mustang parked in one of its hangars, there are Mustangs based in something approaching half of the 50 states. And just about any major air show or fly-in across the country will have a least one Mustang on display. One organization dedicated to preserving in flying condition all combat aircraft from World War II is the Confederate Air Force, based in Harlingen, Texas. They fly Mustangs, as well as other WWII aircraft to many air shows. Champlin Fighter Museum, in Mesa, Arizona, has a Mustang on display as well as assorted flying memorabilia. Also, Chino California seems to be a hot bed of sorts for Mustang activity. There is a company there, Unlimited Aircraft Limited, that restores and sells Mustangs, and I'd guess there are probably 10 Mustangs at Chino at any given time. (Although I have not made the trip myself, and I cannot say exactly what can be seen there.) I personally know of at least three Mustangs based in Northern California, and one in Reno, Nevada. There are several in Florida, Texas, and Wisconsin. And, of course, you can see a Mustang at the National Air and Space Museum. And the National Air Race Championships at Stead, near Reno, usually have 4 or 5 Mustangs show up for the races.

The Mustang is one incredible flying machine. And that sound! Anyone who has been near a Mustang, with those 12 big cylinders snarling away, must have fallen under its spell.

I was recently chatting with an acquaintance who owns and flies a P51 Mustang. Besides the obvious, that he's having the time of his life, he had an interesting comment. He said that while he's flying, he doesn't hear the aircraft like we would on the ground. He jokingly said that the flying experience would be perfect if he had a mike outside the aircraft and could pipe the sound back into his car. His term for the sound inside the cockpit was, "it sounds like a big Mack truck".

Originally, the Mustang was a single seat aircraft, with 85 gallon fuel tank behind the pilot. This fuel tank is no longer legal in the aircraft, so most (all?) Mustangs have a second seat installed behind the pilot seat. That's right, Mustangs are now two seaters, able to carry passengers!

The writing of P51 Mustang Flight Simulator went pretty smoothly, although it took a very long time. I began by reworking the 3D routines used in my other programs, and rewriting the flight algorithms. As I worked on P51, features would kind of force themselves into the program. It's kind of a rotten feeling to add one new detail, and realize that you probably should now add two or three other things, just to keep the level of the program even. What I mean by that is you can't have fine detail at one point, and totally ignore detail at another. You have to keep the same level throughout, so having a neat idea about one item can add a couple of weeks work, creating things that the original idea didn't envision. It's the kind of thing that keeps a programmer up all night.

For example, I decided it would be neat to be able to parachute out of the aircraft. Okay, that's a fine idea. What does it involve. You need a routine to control the movement of the body out of the aircraft. You have to slow the fall down when the chute opens, and you have to return to your aircraft after you land. Pretty simple. Okay, maybe the chute doesn't always open, and maybe there are different landing messages. Okay, no problem. It would also be fun to look around on the way down. Oops, now you gotta add the chute being visible if you look up. Wait a minute, what if you are using a different camera angle? Now you also need a pilot object. Well, you should also allow the other aircraft's pilot to bail out, better add that feature. You can use some of the same routines, if you wrote them generically. Now you must also add some A.I. for when the other guy bails out. Wait a minute, how will this effect the "Replay" feature? None of this stuff will work with Replay, better rewrite that. Oh yeah, there's also the two player feature, do things still work with that?

You can see how a minor addition can sometimes balloon into major work. Of course, the later in the program cycle you add a feature, the more it can balloon and effect other parts of the program. If you knew everything you wanted to do before you started, you could think it all out before hand, and the programming would go a lot smoother and quicker. But it never works out that way (at least not for me). Even if I were to attempt to rewrite Mustang exactly the same way, I'm sure that I would want to add new things before I finished. For me, that's the nature of programming. Add a component and try it out. Does it work, does it add to the whole, does it "fit"? I sometimes feel as if I'm chipping away at a huge slab of granite, trying to find the statue inside. I know exactly what it looks like, and I know it's in there, but I can't just make one big swing and bam, there it is. I have to chip away, piece by piece, chip by chip. It's great fun.

Well, enough about me, I hope you enjoy P51 Mustang Flight Simulator. And I look forward to hearing from you about the good and bad things you find.

Donald A. Hill, Jr.-1988

Here's a list of source material.

Books:

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The Fighter Movie, P&C Productions
Warbird Checkout No. 5, Historic Aviation

Book and Tape Catalogs:

Historic Aviation, 3850 Coronation Road, Eagan Minnesota, 55122
The Cockpit, 33-00 47th Avenue, Long Island City, New York 11101
Publishers Central Bureau, 1 Champion Avenue, Avenel, New Jersey 07001
Zenith Aviation Books, P.O. Box 1, Osceola, Wisconsin 54020

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