

TOMAHAWK[®]

HELICOPTER FLIGHT SIMULATION

LOADING

Cassette Type LOAD "" and press ENTER.

Disk From POWER UP or RESET insert disk and press ENTER. From + 3 BASIC insert disk and type LOAD "" and press ENTER.

Disk version

When the program has loaded, you are prompted for a softlock security code. The code is found by looking up the number on the screen in the left hand column of the table and entering the number in the right hand column using keys 0-9 and ENTER. The game is now ready for playing.

Cassette version

This program is protected by Lenslok. Please read these instructions carefully. Lenslok is a plastic lens which is folded and placed against the television in order to read a security code. Lenslok is extremely easy to use, and to help you get familiar with its use, the program contains a tutor mode.

1. When the program has loaded, a large "H" appears on the screen. Use the symbol shift and space keys to adjust the H until it is about the same width as the lens holder before it is folded. When the H is the correct size press the "T" key if you wish to practice the Lenslok procedure in tutor mode or the "Enter" key for game entry.
2. Now fold the lens holder into a U shape with the words on the holder "this side out" on the outside.
3. Hold the lens at arms length in front of the screen with the feet of the lens holder firmly against the screen and "top" at the top.
4. Close one eye, align the centre line of the lens with the vertical line on the screen. Holding your head at least 1 ft away from the screen with your eyes level with the lens, the letters "O" and "K" should appear. If you cannot see the letters clearly, the letter size can be adjusted slightly using the symbol shift and space keys. Keep the holder in the same position and press the "enter" key when OK can be clearly seen.
5. The two character security code, consisting of a combination of numbers, small or capital letters, has now appeared on the screen. Read the two characters using Lenslok and enter them on the keyboard. In tutor mode it will tell you if the code was correct and in game entry mode the protected program will run.
6. If, however, you make a mistake (WRONG) or you are too slow (TIME-OUT), press any key for the next security code. In game entry mode three attempts are allowed before it is necessary to reload the program.

3D real-world display:

Features include landing pads, buildings, trees, transmission pylons, mountains, enemy tanks, field guns and helicopters. Ground texture is visible when flying below 500 feet to enhance the sensation of speed. It is possible, with practice, to fly between trees and mountain peaks.

MENU OPTIONS

MISSION 1 - FLYING TRAINING - Used for helicopter familiarisation and developing ground attack skills. Enemy ground forces will not return fire. Each sector contains 8 enemy targets, either field guns or tanks, giving a total of 1024 possible targets across the complete map. Proceed to an adjacent sector after destroying all targets in your present sector, either by flying directly or landing at a pad and using the joystick (method described later under MAP). Refuel and reload with ammunition as necessary.

MISSION 2 - COMBAT - This is a short mission involving the invasion of four allied sectors by enemy ground forces. By selecting the map mode, you will see the sectors in question, flashing to indicate the presence of hostile forces. Your mission is to liberate the four sectors by destroying the ground targets, each sector taking typically 10 minutes to clear. After destroying all targets the mission is completed by landing at the nearest helicopter pad and closing the throttle.

MISSION 3 - COMBAT - Surrounded totally by enemy territory, your mission is to liberate the entire map from enemy occupation. Each hostile sector becomes allied as the ground targets are cleared, thus allowing you to land and reload with weapons etc.

MISSION 4 - COMBAT - A strategic battle for occupation of the entire map. Your task is to support allied ground forces in their battle along the front line. As each sector is cleared of enemy ground forces, the front line will progress to the right until you have cleared a complete row. Likewise, if the enemy succeeds in destroying your ground forces, the sector will become hostile territory and the front line will progress to the left. Once a row is completely liberated or occupied, it is out of the game.

n.b. in all COMBAT missions the enemy will fire back! The simplest approach is to use the laser-guided missiles to destroy the enemy as soon as possible, but points scored will be lower than using rockets or guns.

In the heat of the battle, care must be taken to avoid landing in enemy territory if you are damaged or need to reload or refuel. Check for enemy occupation before landing by inspecting the map.

DAY OR NIGHT - Daytime: horizon visible. Nighttime: no horizon, computer-enhanced infrared imaging (Pilots' Night Vision System.)

CLEAR OR CLOUDY - option for overcast sky with selectable cloudbase for instrument flying.

CLOUDBASE - selectable from 50 ft to 5000 ft.

CROSSWINDS & TURBULENCE - for the experienced pilot! Variable crosswind & turbulence effects.

PILOT RATING - TRAINEE
SQUADRON
INSTRUCTOR
ACE

The pilot rating is equivalent to difficulty level and varies potency of enemy. With each increase in pilot rating, the enemy's accuracy doubles!

KEYBOARD or JOYSTICK

SOUND ON or OFF (IBM only)

INSTRUMENTS

TADS

Target Acquisition & Designation System -

Used to identify and track tanks, field guns and helicopters, allied or enemy includes range readout in feet when target is less than 10,000 feet away.

VDU - Visual Display Unit

Speed, in knots, displayed in reverse video when flying backwards.

Altitude, feet

VSI - Vertical Speed, ft/sec (arrow UP = climb, arrow DOWN = descent)

TIME - Time to reach target.

RANGE - auto-ranging navigation computer

ARTIFICIAL HORIZON

Shows attitude of helicopter relative to the ground. For example, if the helicopter rolls right, then the artificial horizon will roll to the left and vice versa.

DOPPLER NAVIGATION/COMPASS - Readout of Heading, Bearing & Track.

Heading: direction in which the helicopter is pointing.

Track: flight path direction.

Bearing: heading required to point at objective.

Note: a helicopter can be pointing in one direction (Heading) but moving in a different direction (Track) e.g. sideways! Match the heading to the target bearing to intercept target. The flashing dot indicates relative bearing of target.

This instrument can operate in four different modes that help you to navigate or find hostile targets. The modes are:

Air to air (symbol):	enemy helicopter interception
Ground (T):	ground target tracking
Beacon (B):	beacon navigation
Helipad (H):	landing pad guidance

Flashing symbol warns of approaching enemy helicopter.

CONTROLS

THROTTLE - key W to open throttle
key S to close throttle

Controls engine/turbine rpm. Normally set to fully open unless practising engine-off landings. Assisted in flight by computerised autothrottle control.

COLLECTIVE LEVER - key Q increases lift
key A decreases lift

This is basically a vertical lift control used for take-off to the hover, and forward thrust control in straight & level flight.

CYCLIC CONTROL

joystick forward (cursor key ↑) tilts nose down

joystick back (cursor key ↓) tilts nose up

joystick right (cursor key →) to roll right

joystick left (cursor key ←) to roll left

RUDDER - key X to yaw right
key Z to yaw left

DOPPLER MODE

Change between air-to-air, ground attack, beacon and helipad modes by pressing the mode change key (see control card).

8 beacons (0 to 7)

4 landing pads per sector (0 to 3)

8 enemy targets per sector (0 to 7)

1 enemy helicopter

WEAPON SYSTEMS & TARGET ATTACK

See control card for weapon selection. The helicopter must be airborne to fire its weapons.

The gun & rockets are manual tracking only i.e. the target must be in the sights when the weapon is launched or for the TADS to operate. The missile system locks on to any hostile target passing through the sights & lock-on is depicted by a Solid Square. Tracking is automatic if the target remains on screen.

GUN - vert/horiz sights - range 2000 ft 1200 rounds 30mm ammunition, 750 rounds/min.

ROCKET - diagonal sights - range 4000 ft 38 unguided rockets (19 each side).

MISSILES - square sights-range 3.1 mis 8 Hellfire missiles - laser guided, auto-tracking

FIRE BUTTON - SPACE BAR or 'fire button on joystick.

The time for a weapon to reach a target will depend on how far the target is away. It is possible to locate and destroy enemy targets in both map mode and in cloud.

During combat, enemy fire is indicated by flak. The screen will flash if the helicopter is hit

Damage to helicopter systems is indicated on the failure status panel and structural damage is shown by the Doppler helicopter symbol.

A third structural hit is fatal! The chances of being hit by the enemy are decreased by swerving during the attack. You have a total of 3 helicopters per mission. Study the mission report for crash evaluation and performance report.

If an enemy helicopter is approaching, a warning symbol will be flashed on the Doppler instrument if you are not in air-to-air combat mode. You are advised to select air-to-air combat mode and destroy the enemy helicopter before he gets too close!

Scoring Scheme

Target

Weapon Used	Field gun	Tank	Helicopter
Gun	20	-	100
Rockets	10	20	50
Missiles	5	10	25

Points Scored

It is not possible to destroy a tank with the chain gun. Destruction of allied forces will result in total loss of score. Although it is much easier to hit a target with a missile, fewer points will be scored. The enemy will begin to fire back at a range between 4000 and 5000 feet, making it much more dangerous to use guns (range 2000 ft!) but the points scored will be higher.

MAP

Use key M to select map or to return to normal display. Your helicopter is shown by the flashing symbol with a tail. Enemy helicopters are shown without a tailplane. Beacons 0 to 7 are used for navigation purposes.

By selecting MAP mode when sitting on any allied pad, the helicopter may be moved to another allied sector by using cursor keys or joystick. This feature eliminates the need for lengthy straight and level flight to visit each sector.

When training (Mission 1), all sectors are allied and any landing pad may be used for refuelling, rearming or repairs. All sectors contain enemy tanks and field guns for target practice.

In combat missions, the map is divided into Allied and Enemy territory. A flashing sector indicates the presence of enemy forces in allied territory or allied forces in enemy territory. Note the colour code of allied territory before you take off - you will be captured if you touchdown behind enemy lines!

The destruction of all enemy forces in a hostile sector will result in the sector becoming allied. Likewise, if all allied forces in a sector are destroyed, the sector becomes hostile.

The map is designed to "wrap around" at the edges i.e. when flying off the map, the helicopter will reappear at the opposite edge.

COMPLETION OF MISSION

A mission is completed when all enemy ground forces have been destroyed and you have returned safely to a landing pad. After touchdown, close the throttle to bring the turbine and rotor rpm to zero. A complimentary mission report will follow.

PILOT'S NOTES

Helicopters are naturally unstable and difficult to fly without autostabilisation. The Apache is fitted with Digital Automatic Stabilisation Equipment (DASE) making it far easier to fly than most modern helicopters.

Take-off procedure:

- 1 Ensure that collective indicator is at minimum.
- 2 Select full throttle - key W - hold pressed until throttle indicator at maximum.
- 3 Wait for turbine rpm & rotor rpm to reach 100%.
- 4 Increase collective pitch by pressing key Q until lift-off occurs. VSI indicates vertical speed in ft/sec.
- 5 Reduce collective (key A) to achieve hover i.e. VSI - 0. The helicopter is now hovering above the helipad.
- 6 Turning on the spot is accomplished by applying left or right rudder (Z or X).

Transition to forward flight from hover

- 1 Increase collective (key Q) to between 80% to 100% Torque. Reduce collective (key A) if overtorque warning sounds.
- 2 Tilt nose of helicopter downwards (key t or joystick forward) to between 15 and 30 degrees.
- 3 Speed will be seen to increase. Autostabilisers will slowly raise the nose of the helicopter to a level attitude.
- 4 Reduce collective (key A) to adjust for VSI = 0 ft/sec i.e. not climbing or descending. The helicopter will now be cruising at a steady forward speed. The Apache is a very agile helicopter. From a stable hover, it can reach 100 kts in approx. 6 seconds by pulling 100% torque and tilting the nose downwards to approx. 30 deg.

Straight & Level Flight

Forward speed is related primarily to the torque setting & hence the collective lever setting, assuming the helicopter is not autorotating (explained later). Typical speed/torque settings are as follows:

Torque	Speed
44%	60 kts
60%	119 kts
75%	147 kts
100%	159 kts

These values will vary slightly with altitude and changes in helicopter weight resulting from fuel consumption and weapon release. The Apache is fitted with a computer-controlled stabilator which enables the helicopter to cruise at any speed with the fuselage level.

Turning Flight

Providing that the forward speed is greater than 60 kts, turning is achieved by simply banking left or right. Some vertical lift will be lost when banking and the helicopter will begin to descend. This may be counteracted by increasing the collective setting. The helicopter will tend to slow down in a turn unless the pilot dives to sacrifice height to maintain speed.

At speeds under 60 kts, the helicopter will tend to "drift" into the turn, shown by the sideslip ball at the bottom of the artificial horizon. Turns may be assisted by applying the rudder, but this will reduce forward speed.

Fluctuations in rotor rpm occur during a turn because of g force effects. The autothrottle will adjust the turbine rpm accordingly to keep the rotor rpm at approximately 100%.

Slowing down & returning to the hover

- 1 Gently raise the nose of the helicopter by pulling back on the joystick (key 1). The aircraft will begin to slow down and also climb. Maintain the nose-up attitude by repeatedly pulling back on joystick (gently!).
- 2 Reduce the rate of climb by reducing collective (key A) to keep VSI to approximately zero. As the forward speed drops below 60 kts, increase collective (key Q) to counteract sink rate. Allow nose of helicopter to return to level flight as speed approaches zero.

- 3 Adjust collective as required to achieve a VSI of zero. The helicopter should now be in a stable hover.
- 4 The helicopter will also slow down when turning, providing that it is not in a dive. Banking repeatedly left and right is another common method of slowing down.
- 5 Providing that the forward speed is less than 60 knots, the pilot may apply rudder to increase sideslip (sideways drift). The helicopter will slow down dramatically as a result of the large drag forces generated.

Landing

The helicopter may be landed from the hover (vertical descent) or at forward speeds of less than 60 kts.

- (a) From hover: Lower the collective lever to maintain a steady rate of descent. Maximum VSI at touchdown = 12 ft/s. Ground cushion effect will be experienced below 30 ft, resulting in reduction of the descent rate.
- (b) Rolling touchdown: With a forward speed of less than 60 kts, gently lower the collective lever to begin descent. Max VSI at touchdown - 12 ft/s. After touchdown, the helicopter will slow down and eventually stop. Steer on the ground by using rudder control.

Taxiing on ground

The helicopter may be taxied on the ground, up to a maximum speed of 60 kts, providing that the engine/rotor rpm are at 100%. Assuming that the helicopter is stationary, raise the collective lever to produce about 20% torque. Pushing forward on the joystick will accelerate the aircraft, and likewise pulling back will decelerate and eventually stop. Steer by using the rudder.

Refuelling/Rearming/Repairs

By landing or taxiing onto a helipad (not an enemy one!) the aircraft may refuel, reload with weapons, and be repaired. Once on the pad, close the throttle to bring turbine & rotor rpm to zero. The helicopter will be serviced and prepared for the next take-off immediately.

Backward & Sideways Flight

Starting from the hover, the helicopter may be flown backwards by raising the collective lever and raising the nose to approximately 10 deg. The speed readout will turn white to denote backward flight. Keep the nose of the helicopter pitched up to sustain speed. Likewise, the helicopter may be flown sideways by rolling left or right and raising the collective lever. The speed readout does not show sideways speed and the pilot must watch the sideslip indicator below the artificial horizon in order to monitor sideways drift.

Torque Turn

This manoeuvre allows the pilot to perform a 180 deg turn with a dramatic climb & simultaneous turn. With a forward speed of 100 kts or more, pull the nose of the aircraft up to approx 70 deg pitch. Hold this nose-up attitude until the speed drops to approx 60 kts. Release joystick & apply rudder until heading has changed by approx 160 deg. Release rudder, adjust roll to zero if necessary and accelerate with nose down attitude. During this manoeuvre, the helicopter will roll, pitch & yaw simultaneously, pulling out on a reciprocal heading.

Aerobatics

The Apache may be flown safely within the following limits:

Pitch	±	90 deg
Roll	±	110 deg

Control response may become unpredictable outside these limits i.e. loops & rolls are NOT recommended!

Autorotation

Autorotation is equivalent to the helicopter "gliding" through the air and is used when the pilot wishes to descend rapidly or after engine failure. During autorotation, the rotor blades are being driven by airflow through the rotor disc as the helicopter descends. This reduces the power required from the engines and the engine RPM is automatically reduced to maintain 100% rotor

speed and the "split" between turbine rpm & rotor rpm can be seen on the bar scales. Autorotation is best performed at approximately 60 kts. and above 500 ft. Entry into autorotation is made by gently lowering the collective lever:

(a) Engines active

As the descent rate builds up, the automatic throttle control will be seen to reduce the turbine rpm. Any fluctuations in rotor rpm will be compensated automatically by the autothrottle. As the altitude falls to below 200 feet, the pilot should begin to pull the collective lever up to reduce the rate of descent, accompanied by raising the nose of the helicopter if he wishes to slow down. With practice, the pilot will co-ordinate increasing the collective and adjusting the pitch angle in order to slow down to the hover just a few feet above the ground.

(b) Engine-off landings

In the event of failure of both engines or if the pilot deliberately closes the throttle in flight, engine rpm will reduce to zero. The pilot must respond quickly by lowering the collective lever before the rotor blades slow down too much. Rotor rpm is controlled during the descent by careful adjustment of the collective lever. Keeping the helicopter level and the speed between 50 & 60 kts, raise the collective lever just before touchdown to bring the rate of descent to below 12 ft/sec.

Warnings-limits worth noting!

1. The maximum permissible speed of Apache is 197 kts. in a dive. If the speed should rise above this, the pilot will get an audible warning. If he continues to increase his speed, the helicopter will shed a rotor blade at 210kts, resulting in catastrophic loss of control!
2. If the pilot demands too much power from the engines (overtorque), the engine temperature will rise and an audible warning will occur. If this warning is ignored, the engines will overheat and eventually fail. It is possible to hover and fly on one engine but flying time is limited if both engines have failed!

Features of TOMAHAWK:

- o Spectacular 3D real world display
- o Fully aerobatic (within limitations of real helicopter)
- o Ground attack & air-to-air interception
- o Over 7000 ground features
- o Day/night vision systems
- o Cloudy conditions, crosswinds & turbulence
- o Doppler navigation & target tracking system
- o Laser guided missiles, plus rockets & 30mm chain gun
- o Selection of training and combat missions
- o Pilot ratings - Trainee to Ace



Acknowledgements

Digital Integration would like to thank McDonnell Douglas Helicopters for their technical assistance during the design of TOMAHAWK. We would also like to thank the many pilots who kindly assisted in the testing and evaluation of this product.

All information stated herein is accurate to the best of our knowledge. Although considerable effort has been given to achieving a realistic simulation, approximations have been made due to the limitations of the computer and certain technical data not being available to the public.