HUD Gauge in the simulator

A MSFS 2024 native hang gliding experience

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The Hang Gliding Files

The hang gliding files is a project of the NextWave Mobile Apps company. We are building tools, aircraft, models, whatever is necessary to fly hang gliders in the MSFS 2024 flight simulator.

Be as realistic as we possibly can.

But we also must leverage and bend to the environment that we are trying to do that in. This simulator gives us a great simulated Earth with complete geography, photogrammetry, weather and physics engine. It lets us explore this world as an

Avatar. That Avatar happens to be an aircraft and all our interactions with this environment is as if we were this avatar. That makes it a flying simulator (as opposed to say a fishing simulator).

But a hang glider (flex wing types especially) does not fly or operate like any other aircraft other than they move the air and use aerodynamic physics to "fly"

The HUD – what is it

The HUD represents everything that the pilot can experience in the sim that does not require instrumentation. That is ambient information like temperature, humidity, in/out of clouds, precipitation, ground surface type, ability to tow from current location.

It also controls the physical nature of foot launch flight and tow flight. It does this by controlling the physics engine in the sim to allow the glider to be moved and positioned on the ground without a motor as well as foot launch from ground locations.

It controls the tow launch sequence of connecting to a tow line, release from the tow line and calling for a new tow.

It controls some in-air flying operations that are unique to weight-shift controlled aircraft. This includes the changing of the center of gravity with pilot movements, the changes in pilot positions in flight, the control of system states; Ground, Tow, Flying in a state engine. The results of these states drive: Animations, sounds, voice sounds, and internal state controls such as launch state, landing state, crash/damage state, launch method type, and others.

Other physics features are the ability flair the glider when in ground effect (stop flying safely), automatic detection of launch position change (going prone), the automatic detection of landing approach (pilot going upright position), and automatic near landing state (gear out/feet down).

The physics engine will also make the glider stable in flight. A hang glider (without a pilot changing CG) will always remain stable in pitch, yaw and somewhat in roll without any additional input. This is a feature of elements of the wing itself: Flexible wing changes to airflow, changes in billow, fixed tips, sprogs, and luff lines the control pitch up moments, what will take it out of this stability is the pilot moving. If the pilot does not move (joystick centered), the glider will tend to return to straight and level flight, all on its own. Other aircraft can only do this using autopilot features (electronic). In hang gliders, it is structural. Even in a dive, the glider will force the nose to pitch up and the pilot must overcome this. In roll, the glider will attempt to return to straight and level, fighting the pilot in forcing a roll and then trying to undo roll once in a turn. The severity of these types of corrections are part of the flight model of each glider and the physics engine needs to account for this. This interaction between pilot, wing, and wind is what makes this type of aviation a sport and not just point to point flying. You should get tired while flying a hang glider. It is a physical act.

It will automatically transport the glider to any location on Earth. It reads local variables that define where it should be. These can be set by any external application that can set them such as our EFB application: The Widget or our desktop PC app: THGF.

This C++ WASM gauge that has very little visual interfaces but controls a great deal of the physics and interactions, cameras, state engines, animations, sounds, and communication between applications used to create the entire hang glider infrastructure.

Pilots only need to understand the User Interface components to fully use the features in this gauge.

Visual Components

Pilots only need to understand the User Interface components to fully use the features in this gauge.

This gauge visually interacts with the pilot by providing the pilot with some control or buttons that are located on the control bar frame of the hang glider. On hang gliders that have cockpits, these function will appear elsewhere.

The buttons or controls can be accessed using the mouse or the freelook mechanism of selection and activation.

Control Bar display

This is a display of visually ambient information that a pilot could get just by physically existing in the sim. Temperature, wind direction, ground speed, surface type, ability to tow, in- cloud density.

| **When flying** | **On the ground** |

This control can be turned on or off. There are no other interactions. Interaction with this control is done either using a mouse (on a PC) or using the FREE LOOK feature to look at the control and then activate it (on a PC or CONSOLE).

Control Bar buttons

There are 8 control buttons located across the base bar that can be used to trigger events when highlighted and selected. The definitions of what events occur with each button are subject to change. This document describes the latest factory settings.

This is an example of button 3:

Each button can be toggled (*on/off states*). There are no other interactions. Interaction with this control is done either using a mouse (on a PC) or using the FREE LOOK feature to look at the control and then activate it (on a PC or CONSOLE).

Button #'s start with 1 on the far right going to 8 on the far left.

Button 1

Located on the control bar - right side

Not Used

Button 2

Pitch Axis Inversion

This will reverse the current Y-axis orientation of your current controller input for pitch.
This is to allow each pilot to set how they are most comfortable with this interaction

Button 3

Exit Glider

This will put you into Avatar mode (out of the glider) if you are on the ground. It has no effect while in the air.

Button 4

Not Used

Button 5

Request a tow

This will send an event to the sim to re-start a new tow.

This will always be a winch tow.

Button 6

Release Tow

This will release your glider from the tow line at any time.

Button 7

Toggle seeing POI markers

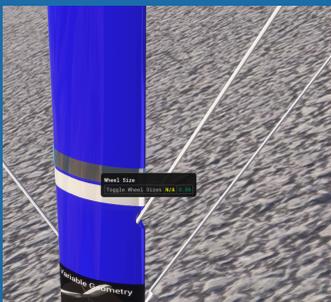**This will turn POI markers on or off.**

Button 8

Toggle to next POI

This will move to the next available POI

Down tube buttons

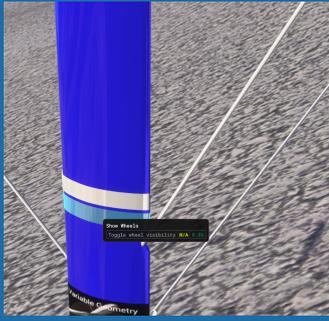There are 2 function buttons on either side down tubes that can be assigned functions

Downtube button 1

Wheel size

This button will toggle wheel size(s) if available for the model you are flying.

Downtube button 2

Wheels Visible

This button will toggle wheel visibility if available for the model you are flying.

Downtube button 3

Toggle Airport Labels

This button will toggle airport POI indicators if allowed by your sim configuration

Downtube button 4

**Toggle Aircraft Labels**

This button will toggle aircraft information indicators if allowed by your sim configuration

VG system

The VG system is based on FLAPS settings for a glider. It allows the pilot to change flight configuration parameters by changing the actual glider planform in flight. This is done by clicking on the VG rope. It can also be manipulated using controls mapped to flaps.
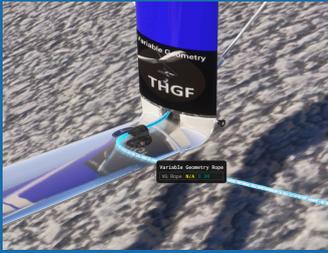
VG Rope

This will cycle thru the VG set points

Wind Indicator

The wind indicator is located on your front flying wires. It will indicate both ambient wind direction and ambient wind velocity. You can turn this feature on or off.

Wind Indicator Toggle

This will toggle the visibility of the tell-tail

WASM Component

Behind the HUD is a C++ WASM service that controls all the physical and data management tools used by all gliders. C++ is fast and efficient and should have no effect on your computer's performance or your FPS rates.

Ground Handling

On major element that the WASM handles is the recognition that the glider is on the ground and how it overrides controls normally used for aerodynamic controls to be used for ground movement controls.

See the complete documentation on Ground Handling to get all the details.

Camera Handling

When flying we manipulate the simulator camera system(s) to simulate the First Person view of the moving pilot.

The pilot will move for weight shift control (forward, backward, side to side, twisting) and this means that the camera point of view must change with the moving pilot.

The pilot also changes "poses". On the ground he can be in set down, pickup, walking and launching pose position. In the air, the pilot will either be prone or upright position.

All of these change the pilots point of view and therefore the CAMERA point of view too. This is also kept in sync with the pilot animation sequences.

However, MSFS 2024 requires that the camera mode is in COCKPIT/INSTRUMENT mode to be able to interact with buttons, varios, instruments. This module provides the controller events that switch between First Person mode and Instrument modes at any time.

See the complete documentation on Flying to get all the details.

Tow Handling

All of our gliders can be towed normally within the simulator. The simulator provides the tools to start tows, release tows and call for new tows. We bind these functions to controller buttons for you. We also track your state of tow as you go through different state transitions during a tow so that we can manage pilot pose positions and pilot and tow equipment animations.

See the complete documentation on Towing to get all the details.

Launch/Landing recognition

The simulator itself does not recognize that gliders are airborne or that a flight has ended unless they both occur on a runway. We almost never do that, so the WASM gauge tracks the start and stop of flight and creates a log record that can be examined later.

End of flight state recognition

How a flight ends is important.

You can have a good landing, a bad landing that causes damage, or you may even crash. This is normally done by landing on your feet, and your feet can only take so much speed (forward) or vertically (down), and almost none goes sideways. You can ignore that you crash into landings, but we do not. This is a difficult skill to learn and if you can't find safe places to land, then that affects your in-flight decision making. Having no fear of impacting with the ground may make you a super-pilot, but where is the fun in that?

Physical ability recognition - *FUTURE*

Hang gliding is a physical sport. You should be affected by the flight itself and what happens during the flight. You should get tired. You should get cold or hypoxic if you fly too high, too long.

We have not yet identified how we can simulate this, but we do think it is important.

Perhaps reducing the effectiveness of the controls over time?

Perhaps variometer issues/battery in extended cold environments?

In-Flight Physics

Normally, any aircraft model in MSFS 2024 will define flight characteristics by the definitions found in the flight model configuration. Each aircraft is a little different from all other aircraft and the simulator physics engine works from these parameters to simulate the flying style and outcomes for any model. Great!

However, Flex-wing hang gliders have aerodynamic characteristics not found in any other aircraft. Therefore, they cannot be modelled in the standard way. We override the following physical characteristics:

Neutral Stability - *autopilot*

Flex-wing hang gliders are trimmed in one position. Neutral. They are engineered to automatically recover from a dive condition (speed) and will return to trim speed. A stall will also return the glider to trim speed. Roll conditions will return to level flight because the flexible wing changes shape dynamically in roll and will return the glider to level flight.

In flight, this must be simulated by putting the joystick in the "neutral" position (no input). The glider in the simulator should then try to find trim, all on its own, all the time.

When a pilot shifts his weight (moves the controller), he modifies the center of gravity of the entire aircraft significantly as he/she probably outweighs the entire empty weight of the aircraft by at least 2:1.

This takes the glider out of trim and the glider pitches or rolls in the direction of the pilot's movement. It does not do this based on aerodynamic forces (like ailerons, rudders or elevators). It does it because it becomes unbalanced. The glider will then aerodynamically attempt to return to trim unless the pilot holds his position off neutral. This takes effort as the glider will fight to get to trim. If hang gliders were not this auto-stable aerodynamically, they would be uncontrollable in any scenario outside straight and level flight. And that was true in the early days of hang gliding! Very dangerous.

Given that, we trick the simulator to "fly" by telling it we have ailerons, rudder, flaps, spoilers, and elevator. But that trickery only gets us so far. We have no ability to modify the aircraft CG, nor do I think it would respond correctly even if it did. We then must "add" in some physics that manipulate pitch and roll to add the stability elements back in. (standard aircraft are not neutrally stable. They go where you point them. They go how they are trimmed. They change their aerodynamics by modifying the flying surfaces and changing the center of pressure. If this pressure center is not dead center in all directions (aerodynamically), the craft will turn, dive, or do whatever it must to try and equalize the difference. Straight and level is never this. This is why they need to have trim mechanism and autopilots.

Hang gliders do not.

Turn stability

As hang glider progressed, the safety of having stable aircraft made it harder (physically) to fly in unstable conditions. These conditions require a lot of turns, pitch control, etc. as opposed to ridge soaring that loves stable flight. Gliders can now be tuned to be more unstable in both pitch and roll. These gliders require more pilot skill to remain safe to fly. The more stable gliders are more suitable for easy flying and/or learning to fly.

We model these tunings based on glider configuration settings. This can reduce the pitch response (allows flying fast easier) and make turn stability more (harder to start the roll, easy to maintain in roll) or less (easy to start a turn, harder to get out of one).

Variable planform geometry

The VG system is meant to be an in-flight mechanism to control this tuning. It also affects the lift/drag coefficient associated with the glider as the wing flattens in full VG (less lift, less drag) but greatly reduced pitch stability. When VG off, the glider has its best sink rate (more lift, more drag at speed) but roll tuning is eased as well.

All these physics responses have to be coded to happen as the base simulator has no mechanisms to modify flight characteristics in this way. Airplanes simply do not do this.

Ability to Flair

All aircraft flair on landing. It is the transition between flying and not flying and on most aircraft, this occurs right at stall speed so that aircraft stops flying as the wheels hit the ground. It does not take much pitch change to make this happen and is well within the normal control movements. Nothing special.

But hang gliders need to land on your feet. Your running speed is WAY slower than stall speed, even on a hang glider. We need to stop the glider from flying at or near ZERO ground speed for a safe landing. A good landing requires no more than 1 or 2 steps. More than that will most likely result in damages to either the glider and/or the pilot.

To do this correctly, the pilot changes his/her position to be upright (more drag) before landing, but more importantly, moves their hands up higher on the down tubes in the control frame. This increases pitch control leverage (weight shift moving backwards) and reduces roll leverage (weight shift left/right). Because of this, you do not go into this position until you are near to the ground and well onto final of your approach pattern. You then have so much pitch authority that you can pitch the glider to have the nose point straight up by a simple push! Instant zero forward motion. Also, zero lift. Timing is everything.

This is built into this physics engine. You do not have to do anything special except time your flair correctly.

Wheels

To mitigate the skill of foot landing, many gliders have wheels. The existence of wheel will make faster speed landings safer for both pilot and glider (somewhat). Most are there for insurance and not necessarily for landing on. Some gliders will have big wheels, and these wheels can be landed on like other aircraft (not foot landed). This is completely controlled by the glider model you are flying.

The physics engine takes wheel type and size into account when calculating safe landings.

Communications with other applications

The HUD WASM gauge interacts with other applications by using L: Var values that it both reads and writes to. The values of these variables are read and managed by the WASM gauge as a way other applications can communicate with it and how it communicates information to other applications. Any 3rd party application or even you, can modify these values and have the WASM gauge interact and react to them.

EFB Widget

This application controls selection of flying sites. This includes a database of sites and UI tools to find and search in the database for sites.

This application can make the glider teleport to a known location using this C++ WASM gauge.

See the complete documentation on EFG Widget to get all the details.

Variometer/flight computer

This gauge controls the instrumentation used during flight and is self-contained in displaying flight information it gets from the simulator.

However, state changes like launching, landing, pilot poses and other information from the State Machine are transmitted to the variometer via this WASM gauge.

Also, this WASM gauge shares files with this gauge via a common sandbox work directory called

WORK. This directory belongs to parent package that all WASM gauges belong to. This is the glider category package.

See the complete documentation on Variometer/Flight computer to get all the details.

PC Desktop Applications

We supply PC desktop applications that are not bound by the sandbox rules mandated by the simulator for all applications that run inside the simulator. These application can read/write files created by the WASM gauges or read by the WASM gauges or the EFB applications.

See the complete documentation on THGF Desktop application to get all the details.

Teleportation

We need to have the ability to move the glider to virtually any place on Planet Earth. We have some defined flying sites. More get created all the time. We provide you with the ability to create new sites (The Desktop app), find them inside the sim (The EFB Widget) and the HUD WASM will teleport the glider to any defined location defined in the L: VAR variables set by either app or any 3rd party app or even just manually typing them into the SDK tools.

The C++ WASM will read the variables and use them to put a glider on the ground in that location in a state that can be controlled.

State Machine

The HUD WASM also serves as a state machine for each glider.

It manages and maintains what state the glider, pilot, configuration are in at any point in time. It saves state changes in the L: VAR variables.

The simulator uses these L: VAR variables to do things automatically within the simulator, sound effects, and all animations.

Messages

The HUD can send message notifications from the state machine. These may be seen as messages within the variometer instrument or any other listener.

Voice Sounds

We have configured some voice states that allow you to hear when some state changes occur. These are typically things that a pilot might say when these transitions occur.

Example: "Launching!" indicates that the physics engine will respond as though you will launch next.

Other Sounds

Other incidental sounds occur as state machine changes occur. These are transmitted to the simulator as L:VAR values that sound configurations are using to initiate simulator sounds.

Example: Walking on the ground using ground handling physics makes walking sounds.

Animations

Most simulator animations that occur are the result of a state change made by the physics engine and that are then acted upon in the glider models. The models do not know where or what caused the state change, only that they must animate to be in that state.

Example: prone flying state to upright flying state is a transition that would trigger an animation.

Appendix A: Work directory

The simulator sandbox allows the C++ WASM (apps) to read and write from only 1 directory:

In this directory you will find all settings, configurations etc. that you have set for this type of glider. It applies to all make and models of this type of glider. Different categories of gliders such as rigid wings, etc. **will have different work directory paths**.

This is the only directory that WASM Gauge can read from as well. That is why any task files used by the variometer/flight computer are put here as well.

Flight logs and IGC flight recording can also be found here.

\work

This is an example of a typical path:

C:\Users**<USER NAME>**\AppData\Roaming\Microsoft Flight Simulator 2024\WASM\MSFS2024**<PACKAGE NAME>**\work

<USER NAME> is your username on your PC

<PACKAGE NAME> is the name of the glider category package you are flying

Typical package names:

- **thgf-single-surface:** all single surface type gliders
- **thgf-intermediate:** all double surface type gliders with king posts
- **thgf-topless:** all double surface type gliders without king posts
- **thgf-spoilers:** all rigid wing type gliders that use spoiler control
- **thgf-rigid:** all rigid wing type gliders that use 3-axis control

File types in the work directory

XCSoar task files (.tsk)

The variometer can see and use any *.tsk (XCSoar task format) files found in this directory. Drop any file of this type here to be able to use it inside the simulator

IGC flight logs (.igc)

The variometer will automatically or manually create these flight export files after flights. Look here to find the track logs of your recent files.

Variometer Settings

All your personal settings for variometer configurations and preferences are saved in files in this directory. They can be manually edited if necessary.

- Data_config_settings: data page definitions

- Map_view_settings: moving map page settings

- Vario_settings

- Tone_settings

- Control_bar_settings

- Xcsoar_settings

Future

The future? The future isn't here yet! Well, it is. We can't wait to see what is next.

How to help

Join our Patreon and help us continue this journey. Patreon is where you will find all of our 2025 products and services. For MSFS 2020 type products you can find them on flightsim.to

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