Programmable HOTAS Systems
Why they are beneficial and what different products offer

by Joe Keefe

Introduction

When the first joysticks were developed for early home PC flight sims, they were simple devices that offered only an X and Y axis to control roll and pitch. As technology developed, manufacturers included Z-axis wheels, levers, or sliders on their joysticks, which controlled the throttle. Separate pedals were also available to daisy-chain to the joystick's gameport connector, reporting an R axis to applications and controlling the rudder. The realization of true hands-on throttle and stick (HOTAS) flight controls for simulations was to become a reality.

And that was it; 4 axes and 4 buttons were the most that the gameport connection standard could support. Simulations titles were hard-coded to read roll, pitch, throttle, and rudder inputs from the X, Y, Z, and R axes, respectively. If you enabled joystick control in a title, this is what you got, with little to no exception. Buttons were slightly less fixed than axes, with devices such as the *Suncom Talon F-15 HOTAS* permitting the user to program the controller's buttons to send keyboard keystrokes.

As the USB standard developed and as simulation titles became more versatile, simulations began supporting user-customizable controller input and input from multiple controllers. For users who prefer to use joysticks, throttles, and rudders from different manufacturers, and/or for users who construct their own input devices, this is very important. Even simulation users who only use a single-source HOTAS can still run into older titles coded with early DirectX routines; this can lead to throttle and rudder control being assigned to incorrect axes on many controllers.

Today the vast majority of sims support user-customizable multiple controller input. For the sims that don't, HOTAS functionality that allows a user to make his or her HOTAS work in a particular application is a very desirable feature. General programmability is also of importance, with additional features such as ergonomics coming into play as well.

Today we'll take a look at the high-end offerings from the four active HOTAS manufacturers, and we'll discuss their programming capabilities and why these features are useful in certain situations found in simulations. Some of these products are older, with planned improvements

already announced. Some are newer, with software that is still developing. Thus, this article is a snapshot in time that describes the current best that HOTAS manufacturers have to offer. In the interest of fairness the products are presented in alphabetical order.

HOTAS Systems Overview

This article discusses software. However, software exists to make hardware do a certain job, so a brief hardware overview of the HOTAS systems is necessary.

- *CH Fighterstick* and *CH Pro Throttle*
- *Logitech Flight System G940*
- *Thrustmaster HOTAS Cougar*
- *Thrustmaster HOTAS Warthog*
- *Saitek X-52 Pro Flight*
- *Saitek X-65F Pro Flight*

CH Fighterstick and CH Pro Throttle
Joystick and Throttle sold separately
Manufacturer: CH Products
SimHQ Review
Street Price: $200 USD for both items

The *CH Fighterstick* is modeled and styled after the real F-16's joystick, although the throttle is not based on anything real. Of the HOTAS systems evaluated, the *CH Pro Throttle* is the only throttle that slides in a horizontal plane instead of rotating about an axis. The throttle has no detents. The CH equipment is constructed of high-quality plastic of the type used in commercial aircraft. Note that the CH configuration presented in this article does not include a rudder controller. *CH Pro Pedals* are available as a separate component if the user chooses to purchase them, for about $100; these have independent toe brakes as well as the main rudder axis, and are fully programmable using CH software. Generally the *CH Fighterstick* is regarded as having a very light force required for full stick displacement.

CH Fighterstick axes:

1. Stick left/right
2. Stick back/forwards
3. Base wheel

CH Pro Throttle axes:

4. Throttle
5. Microstick left/right
6. Microstick up/down

Logitech Flight System G940
Joystick, Throttle and Pedals
Manufacturer: Logitech
SimHQ Review
Street Price: $285 USD

The *Logitech Flight System G940* is the newest HOTAS available to simulation enthusiasts. It is also the world's first commercially-available force feedback HOTAS, plus it has dual throttles with fixed idle and afterburner detents.

Flight System G940 Joystick axes:

1. Stick left/right
2. Stick back/forwards
3. Ministick (hat) left/right
4. Ministick (hat) up/down
5. Trim 1
6. Trim 2
7. Trim 3

Flight System G940 Throttle axes:

8. Right throttle
9. Left throttle
10. Rotary 1
11. Rotary 2

Flight System G940 Rudder axes:

12. Left toe brake
13. Right toe brake
14. Rudder

Saitek X-52 Pro Flight
Joystick and Throttle
Manufacturer: Madcatz / Saitek
SimHQ Review
Street Price: $140 USD

The *Saitek X-52 Pro Flight* is often referred to as "alien-looking" because of its odd shape and myriad multi-colored lights. When visually compared to the other three HOTAS systems it definitely stands out, but whether that's good or bad is up to the individual. Certainly the *X-52 Pro Force* offers a number of hardware features the other HOTAS systems do not; a throttle indicator that transitions from green to red as the throttle is moved from 0% to 100% travel, an MFD that can display application-specific information, adjustable lighting intensity, an adjustable joystick grip, and a "safety cover" over the FIRE button are just some of these features. The *X-52 Pro Flight's* joystick includes a twisting axis for rudder control. Saitek also makes pedals in the $100 price range. The throttle has a microstick that controls the mouse, but this device cannot be used to control other axes. The throttle has fixed idle and afterburner detents.

The *X-52 Pro Flight* was formerly known as the

X-52 Pro; Saitek rebranded it with the birth of their "Pro Flight" line of equipment. As far as we know this is a name change only, and the features and quality of the product have not changed.

X-52 Pro Flight joystick axes:

1. Stick left/right
2. Stick back/forwards
3. Twist

X-52 Pro Flight throttle axes:

4. Throttle
5. Rotary 1
6. Rotary 2
7. Precision Slider

Saitek X-65F Pro Flight
Joystick and Throttle
Manufacturer: Madcatz / Saitek
SimHQ Preview
MSRP: $399 USD

The *X-65F Pro Flight* is modeled roughly after the real F-16's joystick, although the split throttle is not based on any real plane. The joystick of this HOTAS, including the twist rudder, is force-sensing; this means that the load placed upon the stick, not the displacement of the stick, is translated to controller input. This is a brand-new HOTAS system from Saitek, with a SimHQ review coming soon. The capabilities of the *X-65F Pro Flight* will not be discussed in detail in this article.

X-65F Pro Flight joystick axes (force-sensing):

1. Stick left/right
2. Stick back/forwards
3. Twist

X-65F Pro Flight throttle axes (displacement):

4. Right throttle
5. Left throttle
6. Rotary 1
7. Rotary 2

Thrustmaster HOTAS Cougar
Joystick and Throttle
Manufacturer: Thrustmaster / Guillemot
Street Price: $200 USD

The *HOTAS Cougar* is a replica F-16 joystick and throttle, cast out of metal and labeled appropriately. In its stock configuration it has a very heavy force required for full stick displacement, although there are a number of third-party mods available for the *HOTAS Cougar's* gimbals. The *HOTAS Cougar* throttle has idle and afterburner detents that are user-adjustable The *HOTAS Cougar* also has the unique ability for connection of gameport rudder pedals.

HOTAS Cougar Joystick axes:

1. Stick left/right
2. Stick back/forwards

HOTAS Cougar Throttle axes:

3. Throttle
4. Range rotary
5. Antenna rotary
6. Microstick left/right
7. Microstick up/down

Available *HOTAS Cougar* Rudder axes:

8. Left toebrake
9. Right toebrake
10. Rudder

Thrustmaster HOTAS Warthog
Joystick and Throttle (and Pedals?)
Manufacturer: Thrustmaster / Guillemot
MSRP: TBD

The *HOTAS Warthog* is an upcoming product from Thrustmaster. Although little is known about the *HOTAS Warthog*, teaser images and other information from Thrustmaster have indicated that it will use hall sensors for the joystick, have dual throttles, and feature a number of ancillary switches on the throttle base. The capabilities of the *HOTAS Warthog* will not be discussed in detail in this article.

Simple HOTAS Programming

The mainstay of the programmable HOTAS is the user's ability to say *"I want this controller button to send this keystroke or series of keystrokes to my sim."* All of the evaluated HOTAS systems can do this, although they all go about it in slightly different ways using custom software.

All of the HOTAS systems also have three-mode capability, where a toggle or cycle switch is used to place the HOTAS in a certain mode, and the remaining buttons can be programmed to perform different functions in different modes. They also all can utilize a "shift" button, allowing at least 6 commands per button if desired.

CH Fighterstick and CH Pro Throttle

CH Products devices are programmed through software called Control Manager, the latest version of which is v4.51. CH Control Manager is an integrated driver / software set used for all CH programmability and configuration options.

At its simplest, programming the *CH Fighterstick* and *CH Pro Throttle* through Control Manger involves defining commands in a command file, which allows those commands to be referenced in descriptive text instead of actual keystrokes. The user then selects these commands from a list and assigns one or more to each button, based on the mode and shift state. Additional programming control is available through a text-based scripting language called CMS (Control Manager Scripting), allowing access to CH devices' more powerful programming options.

A cycle switch on the joystick or throttle can cycle through three modes. An option also exists to use CMS and have four modes. Programming for each mode is accessed via tabs in Control Manager for each joystick button, allowing the user to click through these quickly to fully understand the overall HOTAS programming.

CH Control Manager button assignment.

Logitech Flight System G940

The *Flight System G940* is programmed through the Logitech Gaming Software (LGS), the latest version which is v5.08. Logitech Gaming Software is used to program all Logitech joysticks and wheels. Programming options in the Logitech Gaming Software are graphically-based only, meaning there is no advanced text-based editor. The user can program simple commands and macros to each button and can assign the shift button if desired.

Each *Flight System G940* device (joystick, throttle, rudder pedals) gets its own screen in the Logitech Gaming Software, requiring the user to switch devices on-screen in order to complete the programming of all of them. Additionally, the user must toggle the mode of the device that he or she wishes to program, which makes it difficult to see the programming of a certain button across modes.

Unlike any of the other HOTAS programming applications, the Logitech Gaming Software will not start if there are no Logitech controllers connected. This makes it impossible to work on a HOTAS profile when you are away from your HOTAS. Ultimately, v5.08 of the Logitech Gaming Software is only a small modification of older versions of the program that were developed to support much simpler controllers (i.e.

wheels and single-mode joysticks). Adapting this program for use with the *Flight System G940* introduces a number of limitations. Logitech will hopefully continue to develop their LGS software with more refined features, so perhaps newer versions will feature more refined and developed capabilities.
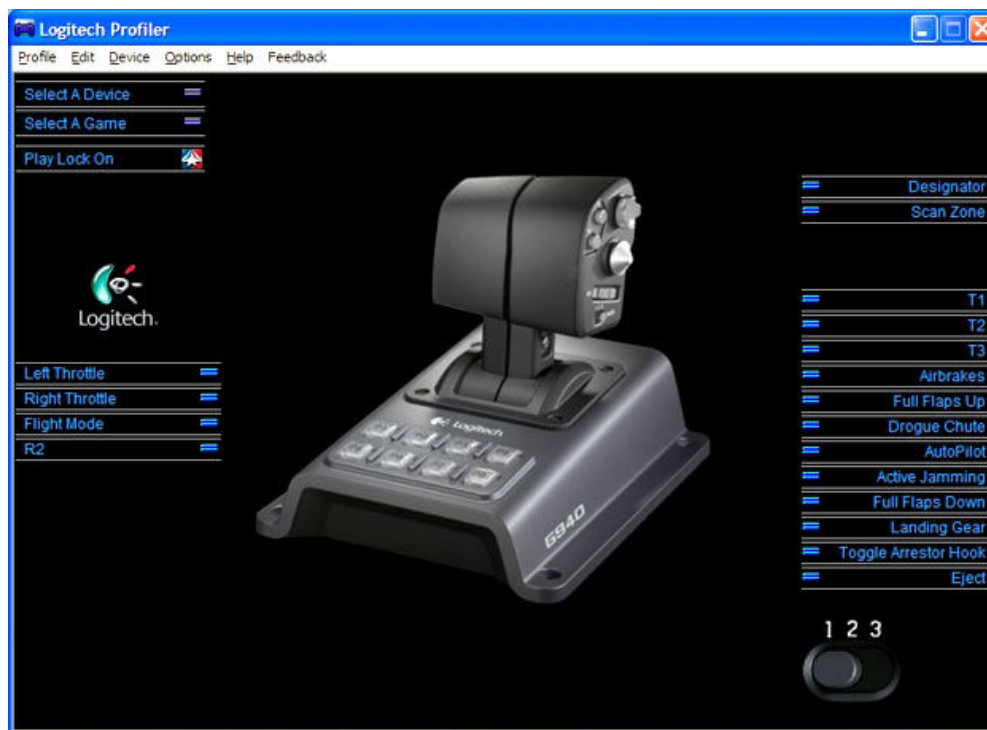

Logitech Gaming Software.

Saitek X-52 Pro Flight

The *X-52 Pro Flight* is programmed via Saitek SST (Saitek Smart Technology) software, the latest version of which is 6.6.6.9. This is a graphically-based editor similar to the Logitech Gaming Software. The SST software has a "product view" where you can see one of the HOTAS modes plus a picture of the HOTAS where the selected button or switch is highlighted. The SST also has a "grid view" where you can see all three modes plus their respective shift states at once.

SST software is the only programming software of those evaluated that applies a command programmed in unshifted Mode 1 to the other five modes. Although this at times might not be desired, it is a quick and simple matter to delete this programming, and overall it is a significant time saver when building a profile from scratch.
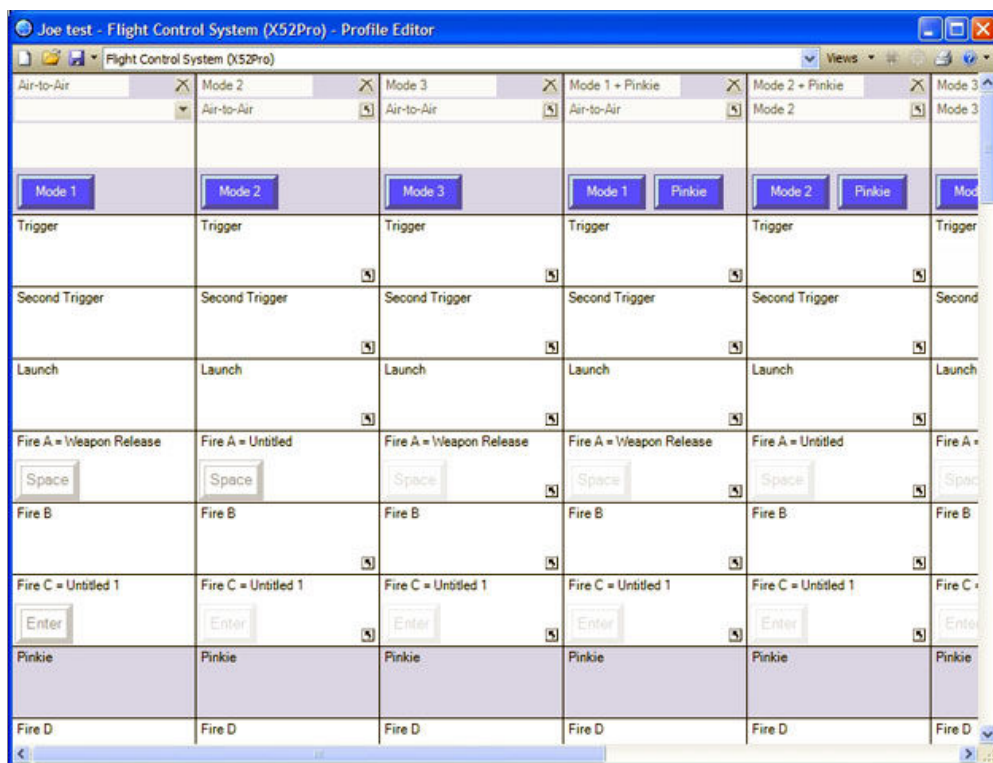
Saitek X-52 Pro Flight Profile Editor.

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

The *HOTAS Cougar* is primarily programmed through an application called Foxy, the latest version of which is 4.0. At its core, Foxy is a powerful text editor that guides a user through programming the *HOTAS Cougar*. The *Cougar* is the only HOTAS that uses completely

text-based programming. Users who understand and grasp computer code appreciate this fact, because the entire joystick profile is present on a single screen and can be viewed without having to click between different tabs or windows. However, text-based joystick programming can be daunting and/or confusing to others. Foxy is integrated with a number of other applications that can help to ease the complexity of text-based joystick profiles, such as simple keymapper utilities and mouse programming utilities.

Very similar to the CH Products command file, Foxy uses a macro file in which game commands are referenced in descriptive text instead of actual keystrokes. Then the joystick profile is created by using the macros defined in the macro file. Foxy color-codes and auto-indents the profile for ease of reading.
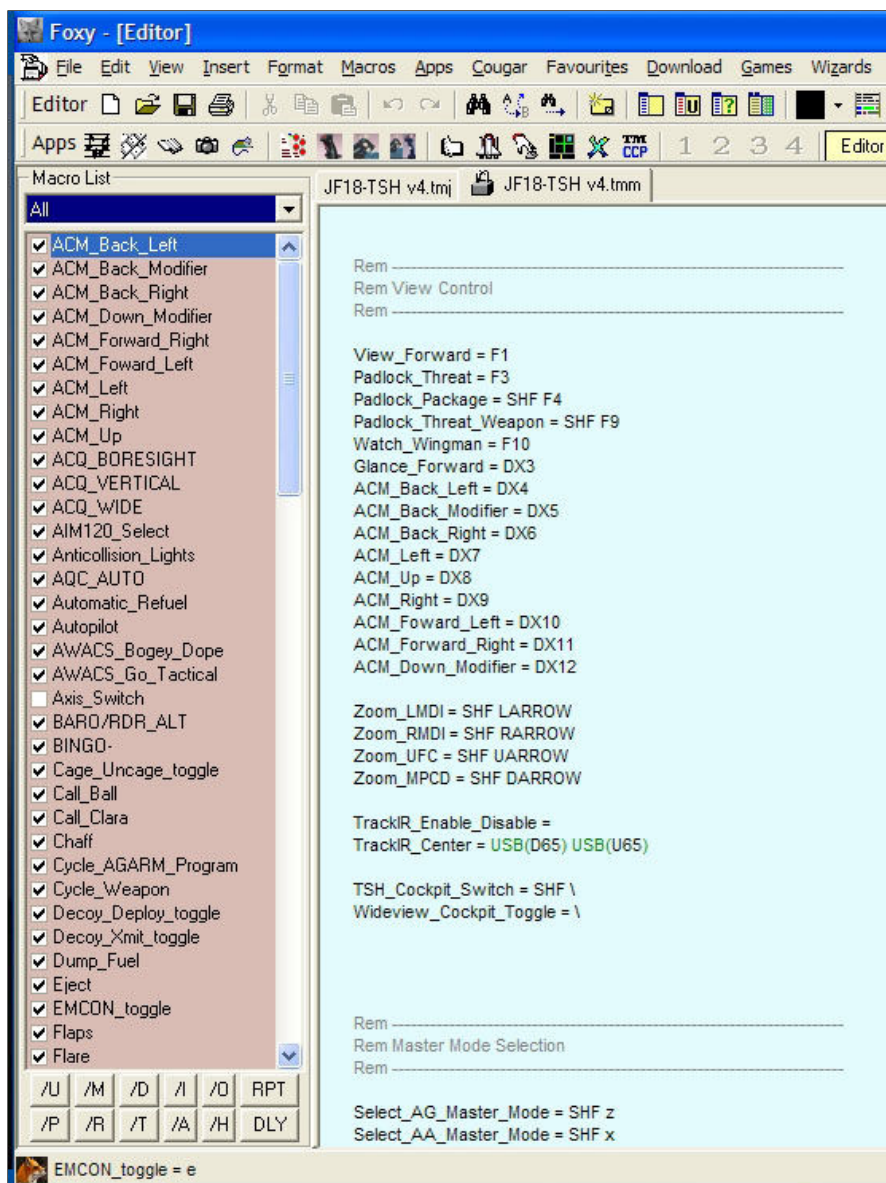
Foxy for the *HOTAS Cougar*.

Foxy uses slash modifiers to enable multi-mode and shifted programming. For example, /U, /M, and /D stand for the up, middle, and down positions of the three-way mode switch. /I and /O stand for shift-button-in and shift-button-out shift states. One of the things text-based programming allows is detailed user commenting; descriptive text can be used to explain complicated programming so that other users of the same profile can understand the programming more readily. Text-based programming really is a different way of going about things, and it's definitely not for everyone.

Thrustmaster HOTAS Warthog

Thrustmaster has announced there will be a new programming software for the *HOTAS Warthog*, but at this time no further information is available.

Axis Response Manipulation

Proper control over HOTAS axes allows the user to adjust the HOTAS response to the sim pilot's liking. Control over axis elements such as deadzones and linearity is critical to proper HOTAS response.

CH Fighterstick and CH Pro Throttle

CH Fighterstick and *CH Pro Throttle* axis "gain" (linearity), center deadzone, and "sensitivity" (percentage of full electrical response) can be set via simple Control Manager controls. Centerpoint offsets and edge deadzones require the use of CMS scripting. CMS scripting can also be used to manipulate any axis response on-the-fly.

Logitech Flight System G940

The *Flight System G940* user has control over the "sensitivity" (linearity), center deadzone, and "range" of the *Flight System G940* axes. Anything less than 100% range compresses 100% of the electrical axis response into less than 100% of the physical axis travel. Since the centerpoint of this compression is not adjustable, the compressions is always centered at the axis midpoint, making it less than ideal if one wishes to use it for manipulation of the throttle response. There is no provision for coordinating the throttle's response with the throttle detent positions, making the detents as troublesome as they are useful. None of the *Flight System G940* axis manipulations can be performed on-the-fly.
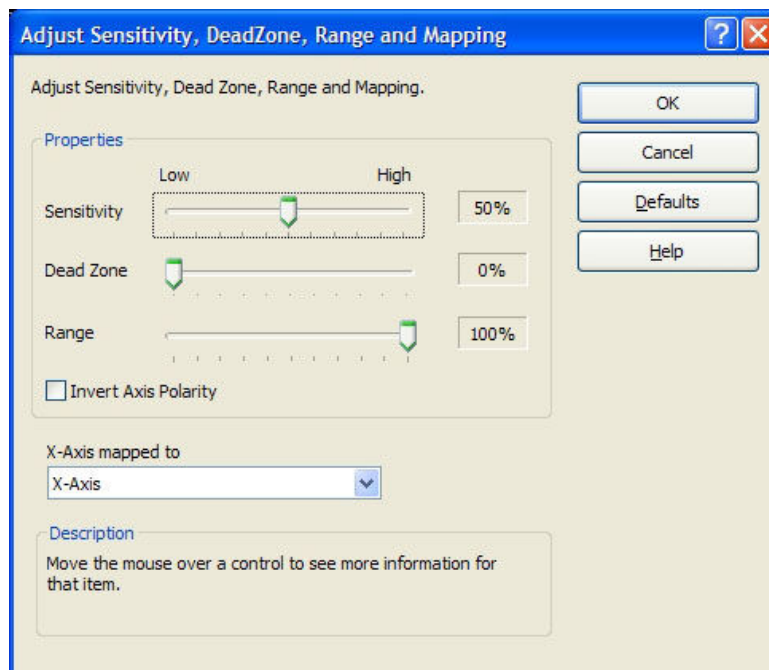
Flight System G940 axis properties.

Saitek X-52 Pro Flight

All *X-52 Pro Flight* axes have adjustable deadbands. These can be adjusted around the center as well as the bottom and top of the axes. Linearity and physical-vs.-electrical response cannot be adjusted.

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

The *HOTAS Cougar* allows shaping of all elements of any HOTAS axis through simple graphical controls. The center deadzone can be adjusted, as can the upper and lower deadzones (independently of each other). The axis response can be offset from zero if desired, and

the axis "curve" (linearity) can be offset from precisely linear (either from center or from the bottom) as well. All of these manipulations can be stored in a HOTAS profile or can be modified on-the-fly through proper Foxy programming. The ability also exists for the throttle's electrical response to be compressed into less than 100% of the throttle axis' physical travel, and a handy utility exists to facilitate this process. Offsetting and compressing the throttle range, so that it responds from the idle detent to the full power position, leaves the travel below the idle detent non-responsive and available for programming of wheel brakes or speed brakes. Without this electrical compression, response in low-power situations (such as landing) can result in the user constantly having to bump the throttle above and below the idle detent, which can be very annoying.
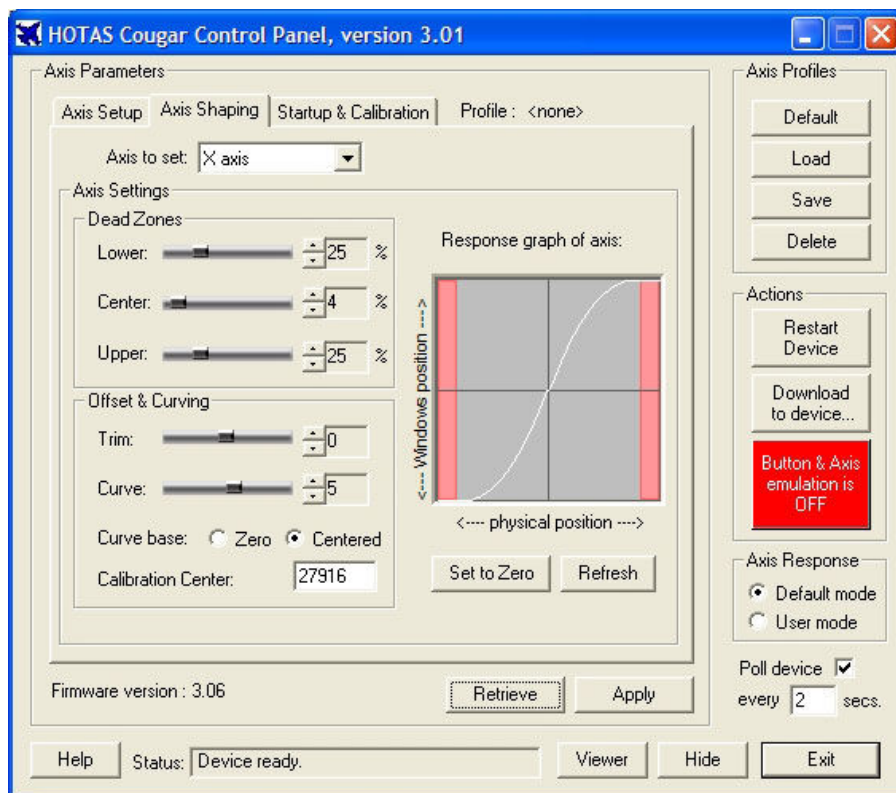
*HOTAS Cougar* Control Panel.

Thrustmaster HOTAS Warthog

Information not currently available.

HOTAS Connectivity and Axis Reporting

DirectX can see a maximum of eight axes per controller. As a result, it is very important that controllers with more than eight axes have a feasible system for managing this limit.

CH Fighterstick and CH Pro Throttle

Each CH Products controller connects via its own USB cable, and CH devices are programmed using the Control Manager software. Control Manager allows each device to be reported as its own controller, or allows the user to create one or more virtual controllers that use some or all of the axes present in the physical controllers. Since there a number of other CH devices compatible with Control Manager (e.g. *CH Pro Pedals*, *CH Throttle Quadrant*, *CH Eclipse Yoke, CH MFP*) this system makes a great deal of sense and is very powerful and versatile. Control Manager allows any physical controller axis to be assigned to any virtual controller axis, meaning sims that have stubborn control configurations can be worked around painlessly.
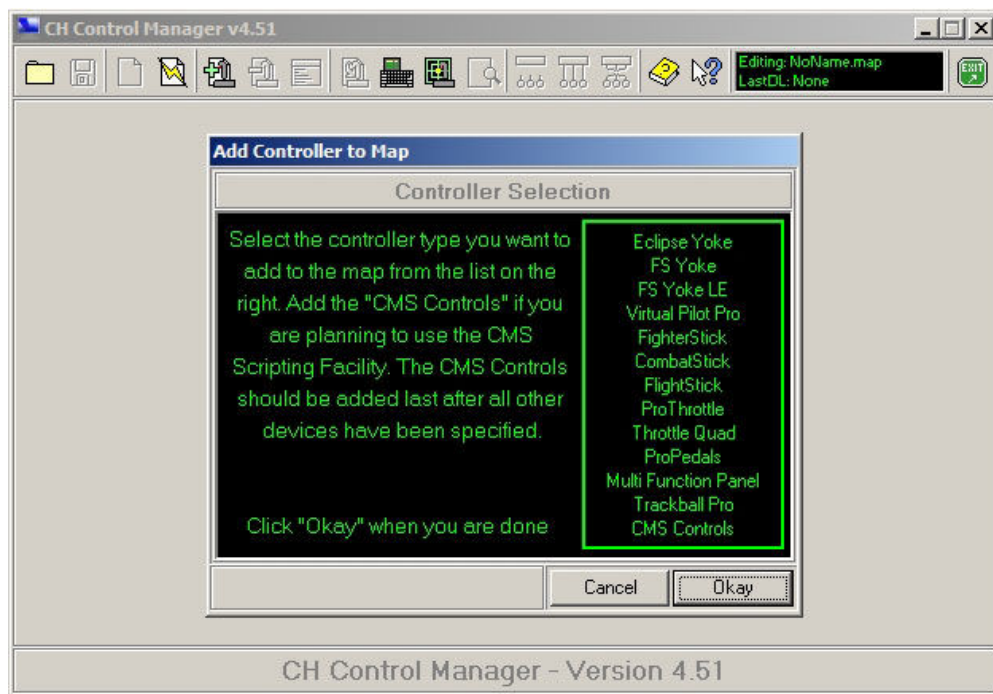
Controllers additions in CH Control Manager.

Axis programming in CH Control Manager.

Logitech Flight System G940

The G940 throttle and pedals connect to the stick base via proprietary pinned connectors, and a single USB connection is made from the stick base. However, three separate controllers are reported via this single USB connection so that all 14 axes can be seen by DirectX. This effectively means that titles that support only a single controller are not compatible with the G940, which is unfortunate. Logitech has stated that they are considering implementing an "arcade mode" to combine controller axes, although when and even if this software feature might see the light of day is unknown.

Saitek X-52 Pro Flight

The *X-52 Pro Flight* stick connects to the throttle via a PS/2 cable, and a single USB connection is made from the throttle base. Since the

X-52 Pro Flight only has seven axes, this method is satisfactory. It should be noted, however, that Saitek's separate rudder pedals report as a second controller and thus do not integrate with the *X-52 Pro Flight* for applications that do not support multiple controllers.

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

The *HOTAS Cougar* throttle and any optional pedals connect to the stick base via 15-pin serial-type connectors. A single USB connection is made from the stick base. This presents all of the *HOTAS Cougar's* axes and buttons as coming from a single controller, which is good for some older sims. However the *HOTAS Cougar* has 10 axes while DirectX only sees eight. The *HOTAS Cougar* Control Panel, the *HOTAS Cougar's* configuration software, allows the user to select which of the 10 physical axes will report as the eight DirectX axes, and in what order. The remaining two axes can only be used as digital axes and will not report analogue values.
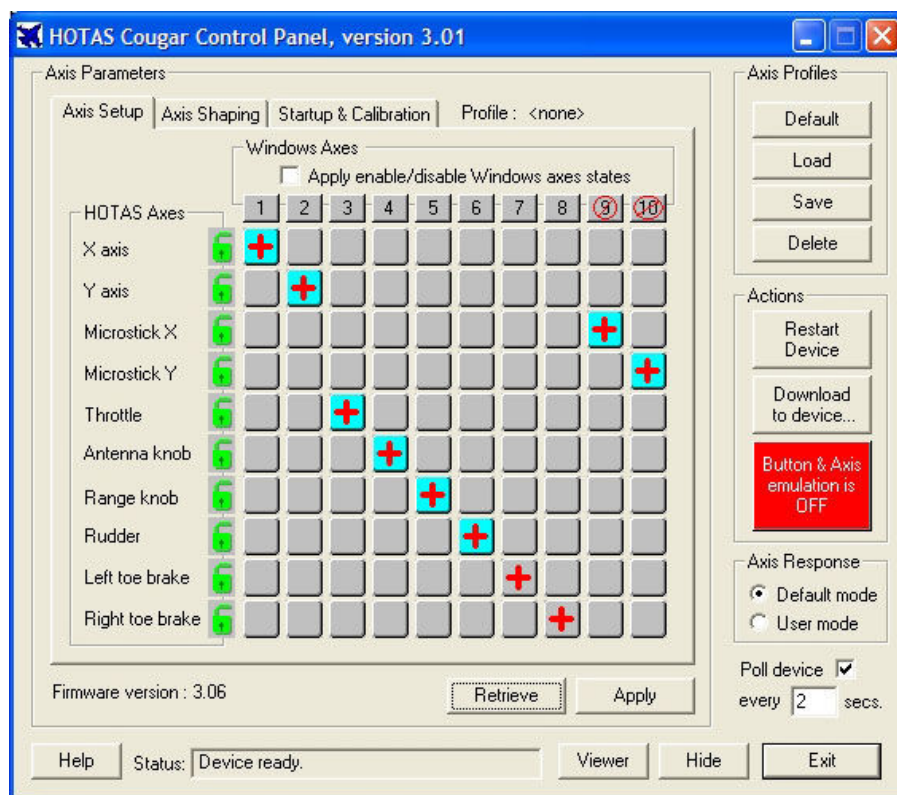
HOTAS Cougar control panel.

Thrustmaster HOTAS Warthog

Information not currently available.

Axis Swapping

Axis swapping is the solution to a title with single controller support where the wrong physical axes are controlling aircraft input. For example, due to older DirectX coding, the precision slider of the *X-52 Pro Flight* or the Range rotary of the *HOTAS Cougar* controls the collective in the "SAR" series of helicopter sims (e.g. Vietnam MedEvac). Since the application software has no provision for changing this, maximum enjoyment of these sorts of titles rests with the programmable controller software. On-the-fly axis swapping can be useful for titles with multiple vehicle types, e.g. a title where one might want to drive a land-based vehicle using the joystick's Y axis for braking and accelerating, but then would want the X and Y axes to control an aircraft while the throttle axis control's the aircraft's power setting.

CH Fighterstick / CH Pro Throttle

Since any physical axis on any CH controller can be assigned to any virtual axis on any virtual controller, most CH setups technically never require axis swapping; the user is able to get it right in the first place. However, axes on CH controllers can also be swapped on-the-fly if desired, with proper CMS programming.

Logitech Flight System G940

Axes on individual controllers can be swapped to other axes on the same controller. This can only be done outside of a sim using the

Logitech Gaming Software. On-the-fly axis swapping with the *Flight System G940* is not possible, nor is swapping an axis from one controller to another (e.g. from joystick to throttle).

Saitek X-52 Pro Flight

Unfortunately none of the *X-52 Pro Flight's* true axes can be swapped. Only the up/down and left/right actions of the mini-mouse controller can be swapped.

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

Any axis can be swapped to any other axis at any time. Outside of a sim this can be done using the previously-shown *HOTAS Cougar* Control Panel. It can also be done with a statement programmed in Foxy, either when the profile is loaded or on-the-fly.

Thrustmaster HOTAS Warthog

Information not currently available.

Logic and Math

The ability of a HOTAS controller to use logic and math allows if / then programming that can increase the utility of the HOTAS.

CH Fighterstick and CH Pro Throttle

All logical and math statements for CH equipment are made in the CMS language. The CH HOTAS is the only HOTAS on the market can do math, which increases its logical capabilities a great deal. For example, math gives the CH equipment the ability to "virtualize" analogue, differential wheel brakes when a sim only accepts a single digital braking command, through the use of fancy programming.

Mathematical statements also allow so-called digital axis programming (programming one or more digital keystrokes in certain bands of an analogue axis, usually a rotary) for CH equipment, as well as the ability to program a controller button to do different things when it is held down for different amounts of time.

Logitech Flight System G940

The *Flight System G940* does not have logical capabilities that allow for the advanced programming techniques discussed above, although there are provisions in the Logitech Gaming Software for programming simple digital axis control (called "zones").

Saitek X-52 Pro Flight

The *X-52 Pro Flight* does not have logical capabilities that allow for the advanced programming techniques discussed above, although there are provisions in SST for programming simple digital axis control (called "bands").

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

The *HOTAS Cougar* cannot do math, although it can calculate other logical functions. It uses something called logical flags to do so; these are turned on and off according to the joystick programming and can themselves send keystroke commands. There is a limit of 48 logical flags per *HOTAS Cougar* profile. Logical programming on the *HOTAS Cougar* is not very intuitive, but with some studying of the manual it can come to make sense. There is a logical flag viewer utility to help the user understand what is happening and what state logical flags are in.

Foxy logical programming.

Foxy logical flag viewer.

Testing and Documentation

Proper testing utilities allow a user to determine if he or she has programmed the HOTAS as desired. Proper documentation allows a user to learn about all of the HOTAS programming capabilities and use them wisely.

CH Fighterstick and CH Pro Throttle

Control Manager includes a key tester that displays all keyboard keypresses, including "invisible" keypresses (e.g. ESC, F1, Print Screen, etc.). The device test screen can be used to test DirectX button presses and axis responses. This is a complete and simple test suite that should suit all needs.

Control Manager documentation is primarily provided through the well-written help file. Although the help file does not cover all aspects of the program, it does provide useful CMS scripting examples and uses plain English to teach the user how Control Manager works and what it can do.

Good orientation and training basics for the CH Products Control Manager software is available in the "Control Manager for Dummies" pdf reference by Ken "531 Ghost" King. You can download it from here (8MB).

Logitech Flight System G940

The *Flight System G940* help is minuscule, and what little there is is through the Logitech Gaming Software's help system that is written generically for all Logitech controllers, and not for the *Flight System G940's* specific capabilities. There is no key-testing utility; Logitech recommends using Notepad, but most "invisible" keystrokes don't show up in Notepad.
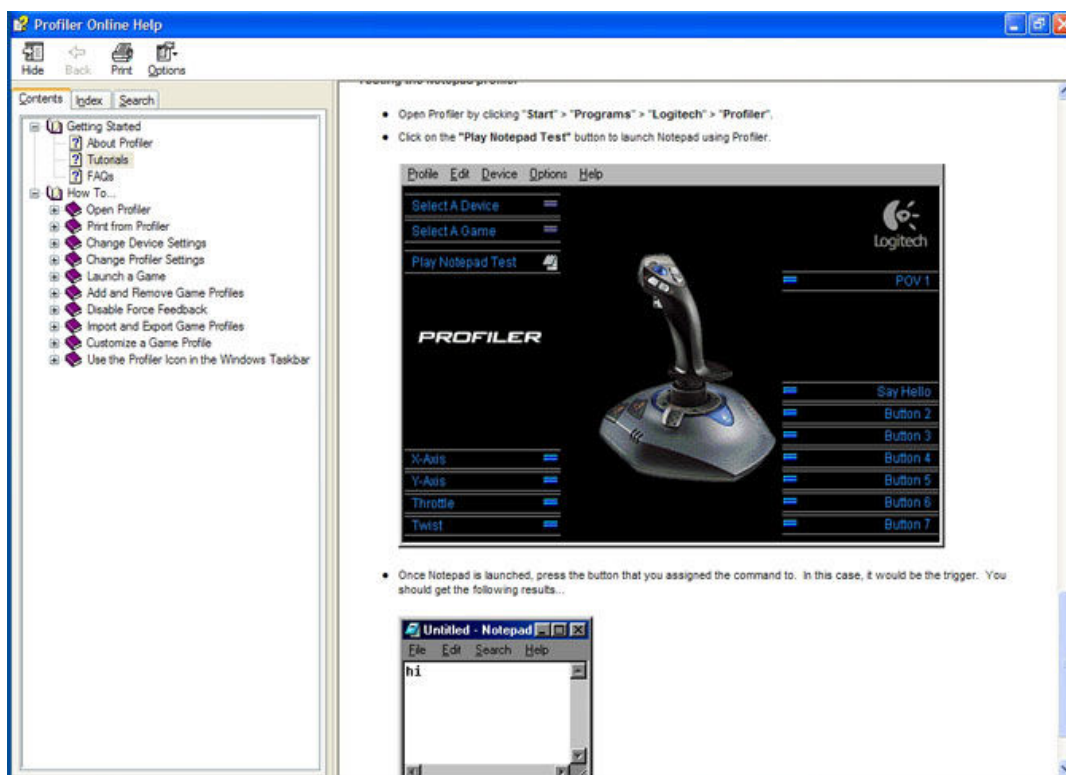
Flight System G940 Help System.

Saitek X-52 Pro Flight

Downloadable PDFs and HTML help files written to the hard drive at installation provide clear programming instructions. A profile tester is included in the SST software.

Saitek X-65F Pro Flight

Information not currently available.

Thrustmaster HOTAS Cougar

The *HOTAS Cougar* has similar help and documentation features as CH Products. Useful tutorials are provided by means of heavily commented controller profiles.
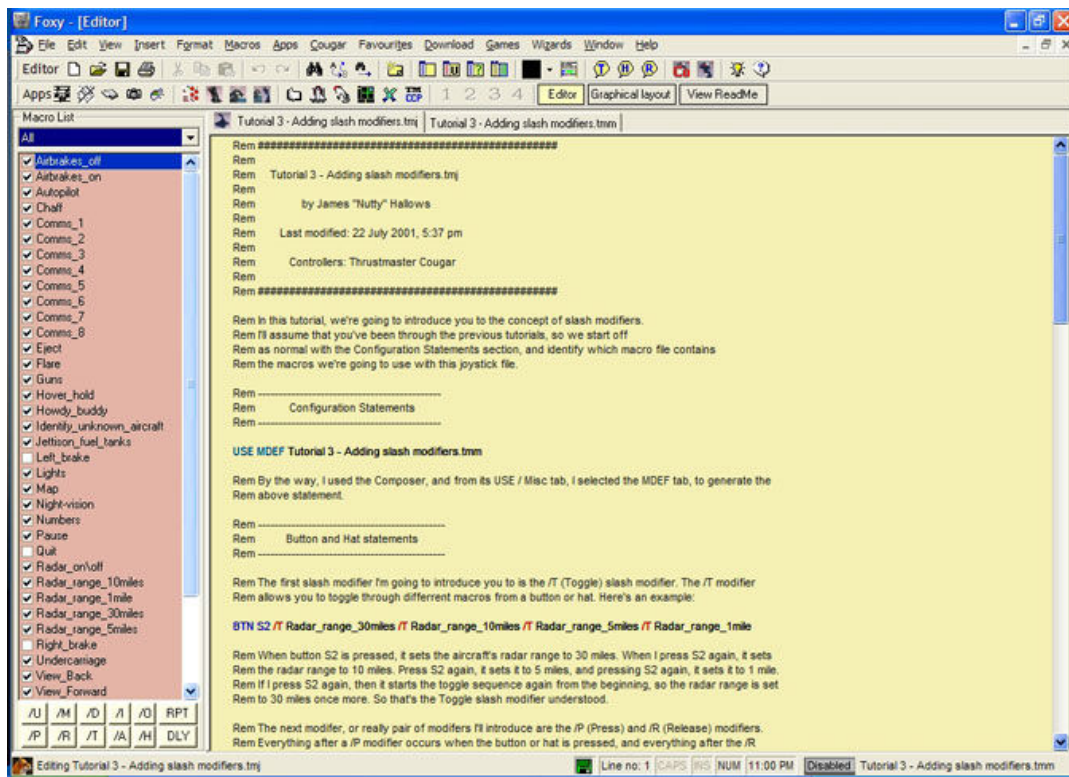
Foxy's Tutorial 3 - Adding Slash Modifiers.

Thrustmaster HOTAS Warthog

Information not currently available.

Conclusion

It is clear that there is no one HOTAS that has software that makes it overtly more capable that any other. However, the available products sort themselves into two categories. The *CH Fighterstick* and *CH Pro Throttle* and the *Thrustmaster HOTAS Cougar* are HOTAS systems with powerful programming capabilities that allow the user to do almost anything one might wish, either before starting up a sim or once the action has begun.

In contrast, software for the *Logitech Flight System G940* and the *Saitek X-52 Pro Flight* generally lack many of the more advanced features of the other two manufacturers, and once a sim is started the axis properties of these controllers by-and-large cannot be modified. The *Logitech Flight System G940* is further hampered by software that was designed for simpler controllers and has been adapted just enough for use on a multi-axis, multi-mode HOTAS. The fact that the *Logitech Flight System G940* reports as three separate devices, with no existing method of combining axes into a custom single controller, is also a big blow to users of older or less-featured titles.

However, programming capabilities are only one part of the whole story. Hardware capabilities play a big part in HOTAS preference, and in this realm each product from the four manufacturers is rather different.

CH Products has a sliding (not rotating) throttle and their HOTAS components can be purchased as individual items.

The *Thrustmaster HOTAS Cougar* accepts gameport rudders, has adjustable throttle detents, and is metal. Arguably, its internal construction is not as durable as the CH Products HOTAS based on the *CH Fighterstick* and *CH Pro Throttle*.

The *Logitech Flight System G940* has force feedback and dual throttles.

The *X-52 Pro Flight* has a display in the throttle base, an adjustable grip, lighted buttons, and sells for significantly less than any of the other products.

The two newest offerings about to hit the market, the *Saitek X-65F Pro Flight* and the *Thrustmaster HOTAS Warthog* will undoubtably change the flight sim controllers world again.

If you've ever wondered how the major HOTAS programmability options stack up, now you know. There is no HOTAS with everything, nor do we even all agree on what the perfect HOTAS would be (mine would be a force feedback, all-metal, split-throttle, 18-axis, adjustable grip, adjustable tension device with swappable sticks and a hybrid of the Foxy / Control Manager interface — in other words, elements of the

HOTAS systems discussed here plus some features that *none* of them have).

For now, flight simulation enthusiasts are lucky to have multiple manufacturers producing quality HOTAS devices for our entertainment enjoyment, with new products on the horizon.

Author's System Specs

- Intel Core 2 Duo @ 2.53 GHz
- NVIDIA 8800 GTS 640MB
- 4GB DDR2 RAM
- Windows XP SP3