

# Preface

## ***Welcome Aboard your Piper PA28-Warrior (Navigator)***



The purpose of this Flightgear aircraft is to provide you with a selection of resources relevant to aerial navigation. Throughout the documentation we will just refer to it as - [the Navigator](#).

Next to links to online text, audio and hands on video resources you will also find a collection of hands on navigation practise flights.

These practise flights assume a comfortable level of flying your aircraft with or without auto pilot and a basic knowledge of aviation.

No consideration has been given to real world aspects such as communication with ATC, nor restrictions of other nature or multiplayer environment.

All of the practise flights can be performed offline provided one has access to pen, paper, ruler, copies of charts , etc.

You may need to download additional scenery from Terrasync, alternatively Terragit, as the flights more or less span around the globe.

Furthermore it is assumed that you are familiar with putting together a flightplan, how to calculate ETA and fuel consumption

The instructional material is by no means to be used for real world aviation and no guarantee of completeness or correctness can be given, the sole purpose being to provide examples of instrument usage within the context of the flight simulator.

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For information on GPS/Waypoint navigation you need to search elsewhere as at present for small crafts there is no fully functional model available at the time of writing. For ATC vectoring look at the ATC topics like FGCOM, ATC etc.

Online links and references are valid at the time of writing, however should a link be broken you may find the relevant info by means of your favourite search engine. If you don't happen to have a dual monitor setup or experience internet connection problems you might wish to print what is important to you as a fall back position. We certainly recommend to have at least hardcopies of the practise flights handy.

To commence your journey we would recommend a leisurely read of Charles Wood's comprehensive yet easy to read **Flight Simulator Navigation**, [www.navfltsm.addr.com](http://www.navfltsm.addr.com) or the downloadable pdf at [www.anaspides.net/documents/flight\\_simulator\\_documents/Instrument%20course.pdf](http://www.anaspides.net/documents/flight_simulator_documents/Instrument%20course.pdf)

The practical side of it leans heavily on Microsoft FS, however most of the practise flights work in FG as well.

For instrument related info and usage here is another comprehensive online FG manual [www.emmerich-j.de/HB/EN/RNAV](http://www.emmerich-j.de/HB/EN/RNAV)

You also find topics like pilotage and dead reckoning in there or you may wish to check out [www.experimentalaircraft.info/flight-planning/pilotage-dead-reckoning.php](http://www.experimentalaircraft.info/flight-planning/pilotage-dead-reckoning.php)

The FG Navigator is based on David Megginson's original Piper Cherokee Warrior II (1979 model). For relevant details such as technical specification or info on how to fly look up Help and consult the online Wikis. If completely new to the world of aviation you may wish to start with Chapter 8 of the official Flightgear manual titled **A Basic Flight Simulator Tutorial** using the default aircraft a Cessna.

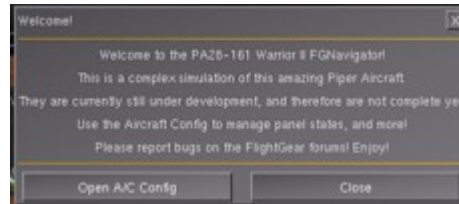
The focus of the Navigator however purely rests on navigational aspects and practical guidance of how to do it.

Topics like flightplanning, ATC comms, pertinent rules and regulations as such form no part of this package.

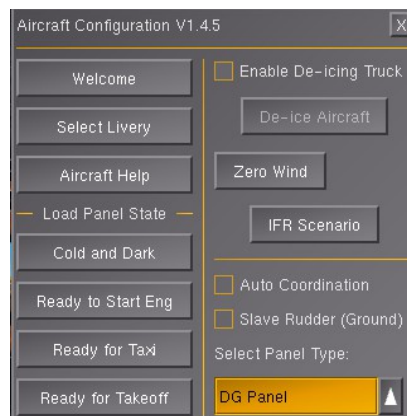
Enjoy your journey and enjoy the world of Flightgear as much as we do.

## Getting Started

After having nominated your Navigator and generic start-up parameters in your FG Launcher be it QT, FGRUN, FFGO or other, the PA28-Warrior will open with a Welcome Message



Once you select **AC Config** the Configuration dialog will prompt you for your startup preference



First up you need to choose your preferred panel, that is you have a choice between two sets of instrumentation, a panel featuring a standard Digital Gyro (DG) and two VOR s or alternatively a panel featuring a HSI with VOR1 integrated and VOR2 to the right.

(You can switch between panels any time on the ground or in the air by selecting the Warrior menu option, Aircraft Config or by way pressing the letter **w**).

Next you can decide on your desired panel state:

### **Cold and Dark**

*as the name implies you will need to start up in accordance to the startup checklist found in the aircraft Help screen.*

### **Ready to Start Engine**

Avionics, Battery, Alternator are on, all you need to do is fire up the engine using the primer and magnetos and the starter after having set Mixture to full and throttle to 20%.

***Ready to Taxi***

Use this mode to proceed from a parking position to the assigned runway or for practising movement on the ground. You start with park brake set and the engine idling at about 1050 rpm, enough to start moving once the brake is released.

***Ready for Take Off***

pretty self explanatory, normal take-off roll or ref up prior to releasing the brake with or without flaps depending runway length....

**IMPORTANT**

Once you select a panel state, a warning message will appear prompting you to wait until configuration is completed, just wait and do not touch keyboard or mouse or joystick.

Prior to choosing the panel state you also have the option to invoke auto coordination and or slaving the rudder on the ground.

***De-Ice***

This option allows you to de ice your aircraft in wintry, frosty conditions prior to take off.

***Zero Wind***

Unrealistic scenario, however useful for the novice to practise patterns, approaches and flying DME arcs. Checked will turn off any wind, uncheck will revert back to normal wind patterns. Watch the HUD for wind status.

***IFR Scenario***

Will switch between fair weather and CAT II minimum conditions with poor visibility and strong crosswind.

Can be combined with Zero Wind to avoid getting blown off the runway.

***Auto Coordination***

invokes automatic co ordination of rudder and ailerons. (An alternative to FG standard auto co-ordination, use one or the other, not combined!)

***Slave Rudder on ground***

solely serves the purpose of checking if controls work as part of check-list.

## Panel Configurations

First up, your cockpit:



### Instrumentation:

- Nav1 Nav2 Switch
- ELT (Emergency Locator Switch)
- Altimeter
- Radio Altimeter
- ASI (Airspeed Indicator)
- VSI (Vertical Speed Indicator)
- Tacho (RPM)
- AI (Attitude Indicator)
- TC (Turn Coordinator)
- Autopilot (Custom KAP140)
- RMI Config Switch (toggle VOR Needle on/off)
- RMI (Radio Magnetic Indicator for ADF NDB)

- DG HSI Switch
- DG or HSI (Digital Gyro or Horizontal Situation Indicator – KCS55)
- ILS Marker Beacon
- HobbsMeter
- VOR 1
- VOR 2
- GS in Range Light /manual toggle Landing Light
- Stall Warning Light
- Master Light Button (red)
- Flaps Status Light) blue
- Nav 1 Radio
- Nav 2 Radio
- DME (Distance Measuring Equipment)
- ADF (Automatic direction Finder)
- HSI Slave Switch
- KMA20 Audio Panel
- Other gauges below the main panel include GPS, Fuelgauge, EGT, Ampmeter, Lightswitches, Clock, AOA, OAT, Flaplever and other. For general information refer to [http://wiki.flightgear.org/Avionics\\_and\\_instruments](http://wiki.flightgear.org/Avionics_and_instruments) , and for more specific info on navigation instrument usage we recommend the reading of [www.emmerich-j.de/HB/EN/RNAV](http://www.emmerich-j.de/HB/EN/RNAV)

**TIPS:**

- knobs work in both directions using scroll or left mousebutton
- mouse buttons on knobs advance or regress one degree or unit at a time
- mouse wheel depending on instrument between 3 and ten degrees
- to match the Compass with HI/DG heading look at the tooltips

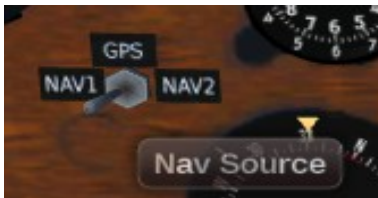


## **Instrumentation continued**

### about your Navigation Instruments

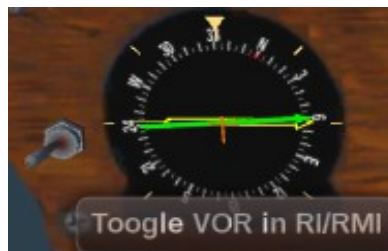
#### *Panel Switches:*

##### **Nav1-GPS-Nav2 Switch**



This switch will toggle the Nav radio source for the Autopilot, GPS, the RMI VOR needle and the DME. The switch is synchronised with the ITAF mode selection.

##### **RMI+/-VOR Switch**



This switch will toggle a green VOR needle on or off. Once displayed the VOR needle nav source is determined by the settings of the Nav1-GPS-Nav2 switch.

The instrument it self is a combination of the Bendix King KI228 and KI229 which often is coupled with the KR87 ADF receiver.

## DG Panel



The panel displays the standard Digital Gyro plus Vor1 (Nav) and Vor2 (Nav1)

The **HSI panel** by contrast



displays the Horizontal Situation Indicator (HSI) incorporating VOR1 (Slave Mode) and the Vor 2 unit at the right hand side. The blind spot above may see the later installation of another instrument.

## The Toggle Sound Hotspot



Clicking the microphone allows you to turn all sounds on or off. If left muted on closing down a session at the next startup sound will be enabled again.

Clicking the earphone will only be necessary once starting the aircraft in midair.

Hotspots in general are used to make an object clickable for some action to occur. If you want to see what is clickable on any aircraft within Flightgear simply press <CTRL> C (toggle)





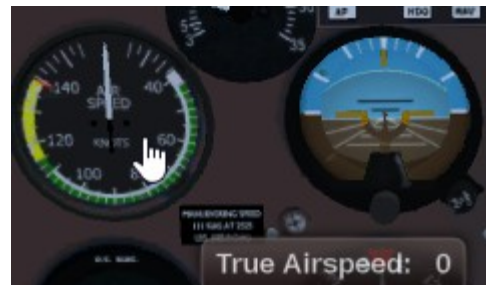
## Hotspots & Digital Readouts(Tooltips)

Most of the hotspots are used to display instrument related properties such as speeds, rpm, radials, bearings etc. A select few however will invoke some action such as opening a dialog, turning knobs, pushing buttons and so forth.

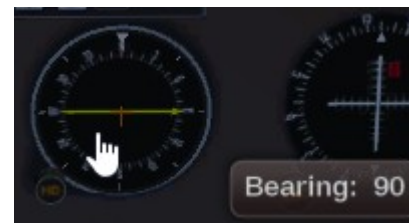
*Hotspots for displaying static or dynamic information are:*



[http://www.angelflightne.org/images/Docs/the\\_almeter.pdf](http://www.angelflightne.org/images/Docs/the_almeter.pdf)

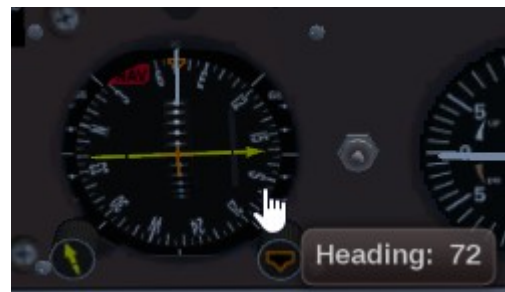


The ASI - air speed indicators needle shows IAS, whereas the tool tip on the face shows TAS





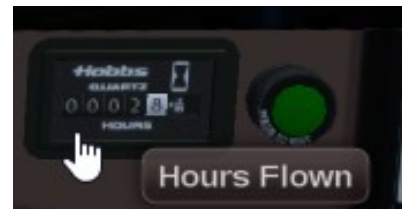
Lags in update, can use standard Hud as an alternative



Heading bug = current heading, Knob + or -



The blue light will be lit when flaps are not retracted.



The Hobbs displays total accumulated flying time based on when the wheels are not on the ground.

**Actions** can be invoked by means of using the menu, shortcut (hotkeys) or alternatively hotspots

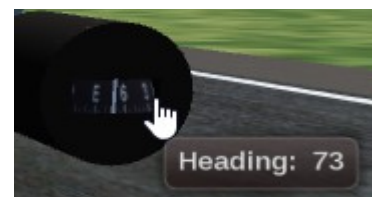
Hotspots for displaying static or dynamic information are:



Resets the current view to default after moving around with the mouse or changes to zoom level



If the stopwatch gets into the way use the timer of



Use the readout for adjustment of DG and or HSI

the ADF instead for timing legs, procedure turns..



Opens the Radio Settings dialog



Opens the FG internal GPS Dialog



Switches DG/HSI panels



Manual toggle of Landing Light

*In addition clicking the altimeter will pop up the QNH dialog.*

## HUD – Head up Display

Realistically GA crafts don't come equipped with HUDS, but because the Navigator was designed also taking the needs of the visually and hearing impaired into consideration we have included a set of Huds that can be easily turned on or off as desired.

At times given the size of monitors instruments may be hard to read, on other occasions a view may be zoomed to a degree hiding a specific instrument like for example the DME.

As such important data is displayed in the HUD which also allows to fly the aircraft from the outside.



Pressing the letter **h** will toggle between colours as at times the outside may be too bright or too dark. **H** will also turn it on or off.

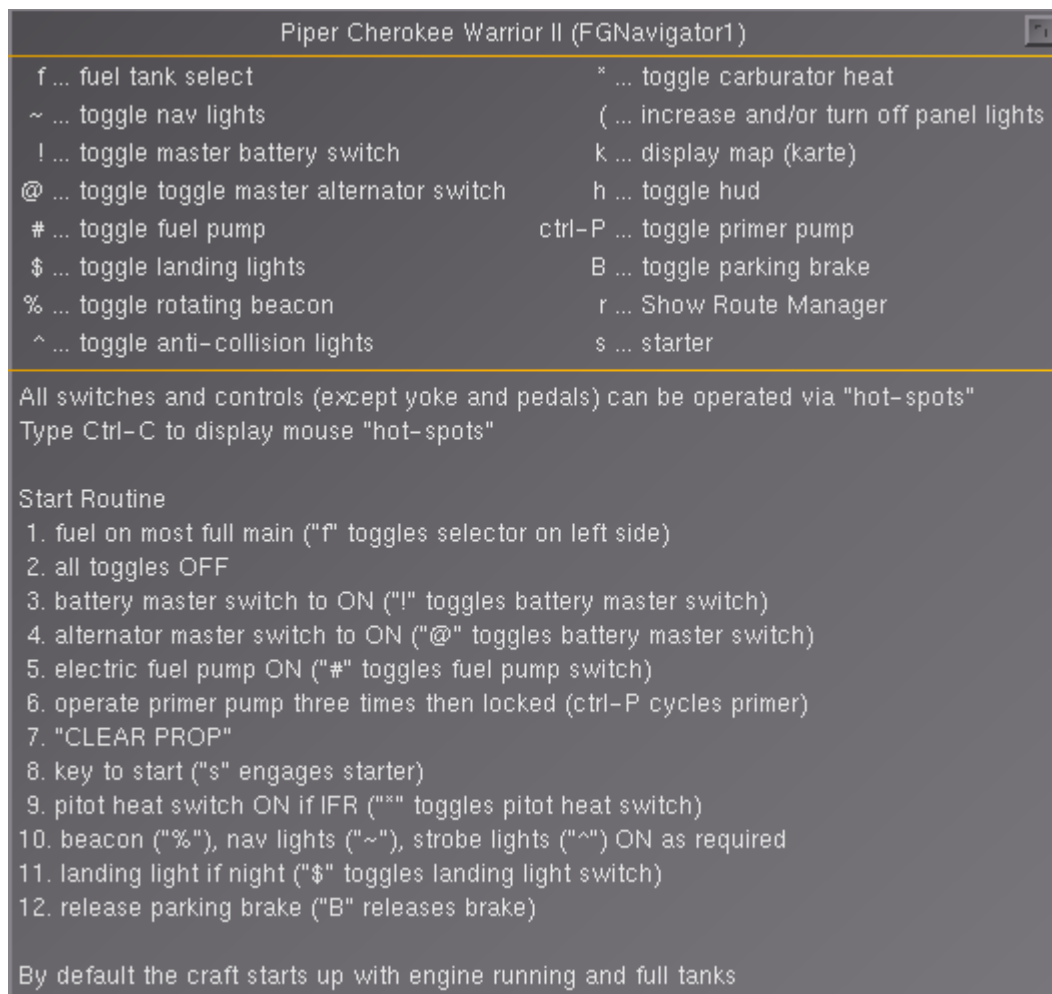
Pressing **Shift I** will toggle between the three HUD versions

## Keyboard

The standard Flightgear keys apply in addition to the aircraft specific shortcut keys. These are listed in the Help Menu or can be looked at by pressing ?

Most of the custom key bindings are identical with the original Piper Cherokee Warrior. So for instance

- h calls up the Hud toggle
- \* toggles Carburator Heat
- k opens the map dialog
- r opens the Route Manager Dialog



Nb, working the throttle from the keyboard can be a little slow, clicking the Lever will increase the RPMS by 25%, clicking the VSI will decrease the throttle by 25% while clicking the Hobbs will give you full throttle.



## Auto Pilot(s)

The Navigator comes equipped with an auto pilot namely a modified version of the Bendix King KAP140.

Whilst the unit looks the same as the standard version, its core functionality has been modified and extended by the seamless integration of the more sophisticated IT\_Autoflight (ITAF) Autopilot developed by Joshua Davidson.

This means the Hybrid now supports waypoint navigation via Route Manager/GPS including VNAV capability resulting in two NAV modes, one to follow the Route Manager and one for the original VOR Lock mode.

The auto pilot can be activated from either the panel embedded KAP140 unit as shown below



or alternatively from the ITAF dialog



which provides both more functionality and a much friendlier interface. By default the dialog will open at the bottom left corner thus not obscuring the pilots view.

To display the ITAF press F11 or click the face of the Kap140 or choose the menu.



## KAP140

If not already familiar with the operation of the generic KAP140, the following link will take you to a Wiki explaining its basic modus operandi. It is vital to be familiar with the equipment, its shortcomings in particular, as otherwise you might be in for some rather nasty surprises.

[http://wiki.flightgear.org/Bendix/King\\_KAP140\\_Autopilot](http://wiki.flightgear.org/Bendix/King_KAP140_Autopilot)

Prior to examining the extended functionality the interface of the ITAF provides, a brief recap of the various modes:

**AP** turns the auto pilot on with ROL and VS modes activated, that is wings level and current pitch maintained be it level, ascent or descent.

### WARNING

Pressing AP again will turn the autopilot off, however not immediately. It will flash for a little while prior to receeding control to the pilot.

Due to that delay in release the auto pilot should not be used at take off and turned off well before touch down.

**HDG** the AP will follow the direction of the heading bug of either the digital gyro or the HSI

### CAUTION

The Autopilot will always turn the shortest way to the left or right. A turn must not exceed 180 degrees or the autopilot will suddenly turn in the opposite direction midturn because the other side now has less degrees to turn to.

In order to turn more than 180 degrees you need to break up the turn into phases like the first turn to 120 and just before there turn another 90.

**VS** the AP will ascend or descend continuously at the fpm rate specified using the UP/DN buttons. (Increments/Decrements are in 100ft lots)

One problem with VS may occur just after takeoff, when the AP senses the required VS based on pitch, air pressure and other parameters and sets your VS at 1500fpm or more. Your low powered engine can not sustain that and you will stall.

**ALT** activates the altitude control. Pressing ALT will stop the plane from its current climb or descend by levelling out provided no desired altitude has been preset.

If a wanted (preset) altitude has been set and armed, ALT will automatically activate with at first the plane slightly overshooting the target and levelling out on target.

### Subtleties

If the armed preset altitude differs from the current altitude you are going to climb or descend based on the +/-fpm (UP/DN) settings.

preset/armed 6000	current 3000	+600fpm	result altitude hold in 5 minutes
preset/armed 4000	current 4200	+500fpm	result climb until out of fuel
preset/armed 5000	current 3000	-300fpm	result crash in 10 minutes

Clicking ALT again will cancel altitude hold whereas pressing (UP/DN) will take you back into VS mode.

### Note:

To set the desired altitude using KAP140 use the wheel to increment/decrement setting by 100ft lots, using ITAF you simply nominate the wanted altitude in the ALT: box and then press the ARM button.

**NAV** switches from ROL or HDG mode to follow the course set in "NAV1" or "NAV2". The AP will then attempt to intercept the radial set in the OBS and track it following the VOR CDI. The intercept angle however should be less than 60 degrees.

If the Nav Source Switch is set to GPS/Route Manager Nav mode will fly the route as defined in the Route Manager.

**APR** arms the approach mode and activates the ILS/GS-Approach once the Nav receiver senses the Glide-slope in range.

**REV** switches to LOC Back Course mode (refer to the ILS topic)

### Note:

Other FG aircrafts come with their own KAP140 Version, original or modified, so if you fly another aircraft with a KAP140 check the documentation, if there is no doco.....

## Flight Settings Reference Tables

[illegible]

## Add your specific scenarios

[illegible]

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## How To s...

### Command Lines

It is assumed you had at least a glance at the official manual and or are somewhat familiar with the concept of command lines. If not it may be useful to read up on the topic (either use the pdf found in the Flightgear Docs folder or the html version found in the Help menu.

A freshly installed FG version will come in plain vanilla i.e. You pick an aircraft, your departing airport, select a runway and off you go.

Depending on your version FG opens up with either FGRun or QT Launcher, both providing you with the option to specify command line options.

Sooner or later you may wish or need to change your settings, maybe just change the weather, use the moving map or turn other features or general options on or off.

Therefore we need to know what's available. A good start are the Command Line WIKIS

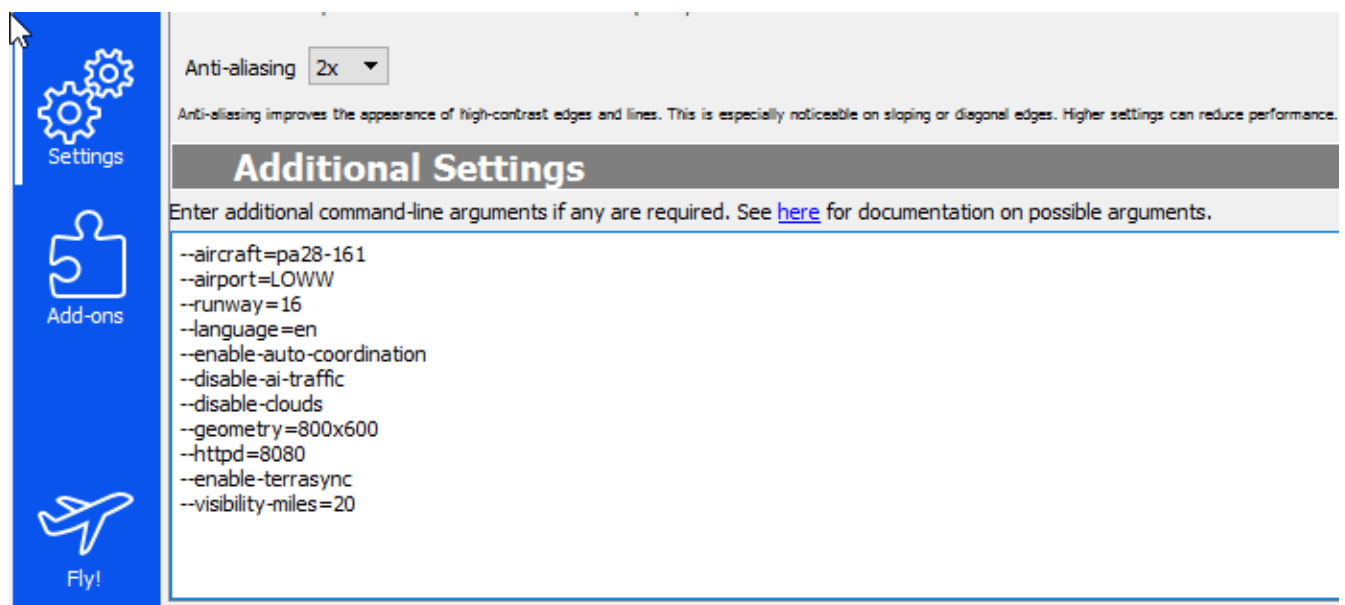
[http://wiki.flightgear.org/Command\\_line](http://wiki.flightgear.org/Command_line) Windows/Linux

[http://wiki.flightgear.org/Command\\_line\\_options](http://wiki.flightgear.org/Command_line_options)

Most of them are self explanatory and in order to use them you need to be in a Launcher like QT Launcher or other depending on your Operating System and Flightgear Version.

Alternatively you can also specify them directly using a command prompt or embed them in some sort of text-file ending with the extension .bat (a Windows Batch File)

This is an example of one of the QT Launchers:



--aircraft=WarriorII-160  
you want to fly the PA28-Warrior

--airport=LOWW  
Vienna is your desired departure

--runway=16  
this is your favourite runway

--language=en  
your OS is Spanish but you really would like FG in English

--enable-auto-coordination  
synchronises ailerons & rudder

--disable-ai-traffic  
relevant only for multi player

--disable-clouds  
in case you are a good weather pilot

--geometry=800x600  
your systems recommended or best screen resolution

--httpd=8080  
internet port for online moving map, some documentation shown in a browser,...

--visibility-miles=20  
how far you want to be able to see

That s an awful lot of typing and you need to do it again and again and to make matters worse if you accidentally close the dialog rather than fly, all the settings go to nirwana....

You can type one line at a time as shown above, but you can also put it all in a single line if you wish:

### Additional Settings

Enter additional command-line arguments if any are required. See [here](#) for documentation on possible arguments.

```
--aircraft=pa28-161 --airport=LOWW --runway=16 --language=es --enable-auto-coordination --disable-ai-traffic --disable-clouds --geometry=800x600  
--httpd=8080  
--visibility-miles=20
```

```
--altitude=3500 --heading=330 --vc=85 --nav1=160:108.5.3 --dme=nav1
```

## Batch Files

Your FGNavigator1 contains a folder named QuickStarts which contains a number of quick start options WINDOWS10 batch files. Extract that folder on to your desktop and you are on the runway or starting in the air with just two or three clicks completely bypassing the FG Launcher.

More detail can be found under the menu option Practise Approaches.

About these batch files - USE AT YOUR OWN RISK

Batch files are basically just containers of a list of command lines. Once the file is executed it simply feeds the commands to Flightgear like the Launcher does.

Batch files can also prompt for input amongst other things. Yet they are just plain text files you create or modify with a text or word processor and Save with a .bat extension

First of all the included batch files are designed to run on Windows10. Older Windows Versions use a slightly different syntax and as such the above mentioned files may not run.

If that's the case use your search engine to look up creating or modifying batch files.

The author of this document is not familiar with Apple or Ubuntu, KDE or other operating systems but rest assured there is plenty of info out there how to automate startup of FG with something similar to DOS/Windows batch-files.

Here an example of a batch file:

```
set /p ac=Aircraft:
```

```
set /p ap=Airport:
```

```
"C:\FlightGear 2017.2.1\bin\fgfs.exe" --fg-root="C:\FlightGear 2017.2.1\data" ^
```

```
--aircraft=%ac% ^
```

```
--airport=%ap% ^
```

```
--dme=nav1 ^
```

```
--timeofday=morning ^
```

```
--enable-auto-coordination ^
```

```
--disable-terrasync ^
```

```
--enable-freeze ^
```

```
--enable-fullscreen
```



line 1 and 2 will act as storage for user input for craft and airport by the means of prompts displayed by line 4 and 5.

**IMPORTANT!** *Line 3 tells the batch file where on the PC it can find the Flightgear Installation. If you have an older version you need to change the 2017.2.1 bit to whatever your version is and possibly change the path as well.*

--disable-terrasync

If enabled FG in the background downloads scenery as you fly or synchronises data in the background gobbling up system resource like memory....

--enable-fullscreen FG will open in full screen mode at default resolution unless otherwise specified.

Note – if you use windows you might prefer to set the geometry property to ie 800x600, no fullscreen and maximise the window after startup, this way you do not lose the taskbar.

Generally its a good idea to back up whatever customisations you put into place.

## PIPER CHEROKEE WARRIOR II PERFORMANCE DATA

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The Piper Cherokee Warrior II is a four-seat, fixed-gear aircraft with performance is very similar to that of the Cessna 172n and 172p, which share the same 160 hp Lycoming O-320 engine. Next to the Cessna 172, the Warrior is probably the most common trainer at flight schools as well as a popular entry-level aircraft for new owners and for rental pilots at FBO's.

Like the 172, the Warrior is a very easy plane to fly: its stall is gentle, and its responsiveness to control inputs is slow (making it harder to overcontrol, an especially useful trait for new IFR pilots).

There are a few important differences from the 172p aside from the low wings:

- it does not glide quite as well, so the flare is shorter (don't let the speed decay too much) and there's a slightly higher stall speed
- it is a little gentler in the stall and a little more stable in turbulence

Here are the numbers from the Piper POH:

### Speeds

-----

Vne (never exceed): 160 KIAS  
Vno (max. cruise): 126 KIAS  
Vfe (max. flaps): 103 KIAS  
Va (maneuvering): 111 KIAS (2440 lb) - 88 KIAS (1531 lb)  
Vs (clean stall): 50 KIAS  
Vso (flaps stall): 44 KIAS  
Vglide (best glide): 73 KIAS  
Vx (best climb angle): 63 KIAS  
Vy (best climb rate): 79 KIAS  
Enroute climb: 87 KIAS  
Approach (no flaps): 70 KIAS  
Approach (full flaps): 63 KIAS  
Cruise (75%, 8000 ft): 124 KTAS (107 KIAS)  
Cruise (55%, 8000 ft): 103 KTAS (89 KIAS)

### Power

-----

Take off: full  
Climb: full  
75% power at 8,000 ft: 2665 rpm  
75% power at 4,000 ft: 2570 rpm  
75% power at sea level: 2480 rpm  
55% power at 12,000 ft: 2470 rpm  
55% power at 8,000 ft: 2375 rpm  
55% power at 4,000 ft: 2285 rpm  
55% power at sea level: 2195 rpm

### Fuel

----

Total fuel: 50 gal US  
Usable fuel: 48 gal US  
Grade: 100LL/100 (Avgas)  
GPH (75%, 8000 ft): 10.0 gph ROP, 8.8 gph LOP/WOT  
GPH (55%, 8000 ft): 7.0 gph ROP, 5.5 gph LOP/WOT

## FG Wikis

[http://wiki.flightgear.org/Main\\_Page](http://wiki.flightgear.org/Main_Page)

[http://wiki.flightgear.org/Frequently\\_asked\\_questions](http://wiki.flightgear.org/Frequently_asked_questions)

[http://wiki.flightgear.org/Command\\_line](http://wiki.flightgear.org/Command_line)

[https://www.faa.gov/regulations\\_policies/handbooks\\_manuals/](https://www.faa.gov/regulations_policies/handbooks_manuals/)

<http://wiki.flightgear.org/Weather>

[http://wiki.flightgear.org/Howto:Fly\\_a\\_circuit\\_pattern](http://wiki.flightgear.org/Howto:Fly_a_circuit_pattern)

[http://wiki.flightgear.org/Understanding\\_navigation](http://wiki.flightgear.org/Understanding_navigation)

[http://wiki.flightgear.org/List\\_of\\_abbreviations](http://wiki.flightgear.org/List_of_abbreviations)

[https://en.wikipedia.org/wiki/List\\_of\\_aviation,\\_aerospace\\_and\\_aeronautical\\_abbreviations](https://en.wikipedia.org/wiki/List_of_aviation,_aerospace_and_aeronautical_abbreviations)