Black Square

VELOCITY XL

OPERATIONS MANUAL

For Microsoft Flight Simulator

Published By:

Just Flight™

Black Square

"Virtual Aircraft. Real Engineering."

Velocity XL User Guide

Please note that Microsoft Flight Simulator must be correctly installed on your PC prior to the installation and use of this Velocity XL aircraft simulation.

Contents

Introduction

The Velocity is a family of homebuilt, high performance, composite construction, single engine aircraft. Notably, the Velocity has canard style airfoils, rather than a conventional main wing for lift, and counteracting tail surfaces for control and stability. The most advantageous feature of the canard design is its resistance to deep stalls and spins. On a canard aircraft, the forward wing is designed to stall prior to the main wing, thereby pitching the aircraft down, and restoring lift to the main wing. Nearly 1,000 proud Velocity owners have assembled and fabricated parts to complete the aircraft of their dreams in a process that takes around 2,000 hours of work. The builder is rewarded with one of the highest performance piston singles on the market, and an aircraft that meets their exact specifications.

The original Velocity was designed by Danny Maher, and debuted at the 1986 Sun-N-Fun Aerospace Expo in Lakeland Florida, USA. The modern Velocity models are the result of several redesigns by the current owners, Scott and Duane Swing.

Black Square's Velocity XL is modeled after a top-end Velocity build, with an upgraded 400hp Continental TSIO-550, fitted with dual turbochargers, giving the aircraft a critical altitude of 24,000 feet, and a cruising speed over 400 mph. With a range of over 1,600 miles and single engine efficiency, the Velocity is a real contender when compared with small turboprop business aircraft that operate at 5-10 times the cost.

For more information on this product's capabilities and a list of all included equipment, see the operating manual at www.JustFlight.com.

Aircraft Specifications

Length Overall	20'
Height	7' 9"
Wheel Base	110"
Track Width	80"
Wingspan	34'
Canard Span	188"
Main Wing Area	132.5 Sq Ft
Canard Wing Area	22.8 Sq Ft
Total Wing Area	155.3 Sq Ft
Fuel Capacity	92 US Gallons (87 Usable)
Oil Capacity	8 US Quarts
Design Load Factors	+9/-7 G's
Tested Airframe Load	6 G's
Cabin W/L/H	47.5" x 94" x 43.5"
Seating	5
Wing Loading at Gross	20 psf
Engine	400 hp Continental TSIO-550 EXP w/ Twin Turbochargers
Propeller	4-Blade MT Constant Speed, Hydraulically Actuated

Aircraft Performance

Takeoff Distance	1,200 ft
Landing Distance	1,500 ft
Range	1,600 nm
Rate of Climb	2,400 ft/min
Critical Altitude	24,000 ft
Service Ceiling	25,000 ft
Empty Weight	1,900 lbs
Max Gross Weight	3,000 lbs
Useful Load	1,100 lbs

V-Speeds

Vr	75 kts	(Rotation Speed)
Vs	68 kts	(Stalling Speed)
Vx	80 kts	(Best Angle of Climb Speed)
Vy	130 kts	(Best Rate of Climb Speed)
Va	125 kts	(Maneuvering Speed)
Vg	90 kts	(Best Glide Speed)
Vno	200 kts	(Maximum Normal Operating Speed)
Vne	220 kts	(Do Not Exceed Speed)
Vle	110 kts	(Maximum Landing Gear Extension Speed)
Vlo	120 kts	(Maximum Landing Gear Operating Speed)

Engine Limitations

Manifold Pressure	32 inHg max.
Propeller RPM	2,700 RPM max.
Oil Pressure	116 PSI max, 25 PSI @ idle
Oil Temperature	250 °F max, 220 °F desired
EGT Temperature	1,650 °F max, 1,600 °F continuous
CHT Temperature	460 °F max, 435 °F continuous
TIT Temperature	1,750 °F max, 1,700 °F continuous

Paint Schemes

The Velocity XL comes with six paint schemes based on real world aircraft.

N285VL (USA)
N467AK (USA)
N516K (USA)
N750C (USA)
N7075J (USA)
G-IRTI (UK)

A blank (plain white paint scheme) is included for users to easily create their own paint schemes. Since the Velocity is a homebuilt aircraft, there are no standard paint schemes, so the possibilities for modders are endless! The “Experimental” placards on the inside of the two cabin doors, required by real-world regulations, can be easily removed in a separate texture if the user prefers for aesthetics.

Feature Overview

Model

- Accurately modeled Velocity TXL-RG, inside and out, created from hundreds of reference photos from Velocity aircraft builders.
- 100% MSFS native animation code for the smoothest animations and cockpit interactions using either legacy or new cockpit interaction modes
- 4096x4096 (4K) textures are used to produce the highest possible texture clarity
- PBR (Physically Based Rendering) materials with real-time environment reflections for superb quality and realism
- Detailed normal mapping for leather, fabric, plastic, stitches, scratches, carpet, tooling marks, and even embroidered logos, resulting in a texture resolution of 10,000 pixels per square inch (90.0kB)
- Extensive use of new MSFS decal system for nearly vector-graphic quality of labels, arrows, and exterior detail features
- Ground services support (marshaller and fuel truck)
- Full support for MSFS visual icing effects

Cockpit

- Fully featured IFR capable panel with dual G3X Touch (Working Title G3X freeware mod recommended), GTN 750 (requires freeware PMS-50 GTN 750 mod), and GFC500 autopilot controller, all with cross-fill, and synchronized autopilot controls
- Every knob, switch, and button is interactable and implemented, along with its respective electrical circuit
- Lighted standby instruments for worst case scenario failures
- Hideable side-sticks
- Pacarded reference speeds for easy reference while learning the aircraft
- Developed using the latest MSFS standards, including intuitive and easy-to-use controls for rotary knobs, multi-position switches and levers

Systems

Experience the power of one of the world's fastest, highest flying, piston driven light aircraft. From the beginning, Black Square's Velocity XL was designed to deliver the raw excitement of operating a homebuilt, four seat aircraft in the flight levels, traveling at over half the speed of sound. Enjoy features, like…

- Twin, turbo-normalized engine with exhaust vibration and tailpipes that glow accurately with turbine inlet temperature
- Black Square's advanced turbocharger simulation with sound
- Fully realized electrical system with every circuit breaker functioning
- Complete environmental control system with sounds
- Challenging push-prop engine temperature management monitored via custom G3X engine instrumentation
- Unique "two-green" retractable landing gear system, fully implemented gear warning and electric hydraulic system, with backup gear release valve logic
- Hear the ambient noise difference the inflatable door seal system makes to the comfort of your cruise, with door ajar warning
- Dimmable interior lighting with backlit panels, standby instrument lighting, glareshield glow, and cozy cabin dome lighting
- Unusual fuel management system with combining header tank logic
- Working ELT and Hobbs meter to track your flying hours

Sounds

The Velocity XL features a MSFS-native (Wwise) 3D sound package taking full advantage of the new capabilities. Based on the default MSFS Extra 330, the Velocity XL's sound set includes added sounds and custom code to create a fully featured soundscape inside and out to give the feel of the real aircraft's power and construction.

- Rich audio for every switch, button, lever and electrical system
- Detailed physics-based effects on engine and wind noise
- Accurately positioned 3D sound sources (best enjoyed in VR!)
- Crash and scraping effects for composite airframe
- Authentic retractable gear sounds and whistle

Flight Dynamics

The Velocity XL features realistic and accurate flight dynamics, designed to work with MSFS's new aerodynamics simulation. The aerodynamics take advantage of new canard aerodynamics options that have only recently become available in MSFS. Users can expect the docile stall and spin-resistant characteristics of real canard aircraft with this addon.

Installation, Updates & Support

Installation

You can install this aircraft as often as you like on the same computer system:

1. Click on the 'Account' tab on the Just Flight website.
2. Log in to your account.
3. Select the 'Your Orders' button.
4. A list of your purchases will appear and you can then download the software you require.
5. Run the downloaded installation application and follow the on-screen instructions

If you already have an earlier version of this software installed, the installation application will detect this and update your existing software to the new version without you needing to uninstall it first.

Installing the PMS GTN 750

1. Go to the following link, and click download for the **FREE GTN 750 Mod.** https://pms50.com/msfs/downloads/gtn750-basic/
2. Move the "pms50-instrument-gtn750" archive (zipped folder) from your browser's download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting "Extract All".
3. Drag the resulting "pms50-instrument-gtn750" folder into your Microsoft Flight Simulator Community Folder.

   If you don't know how to locate your MSFS Community Folder, you should be able to find it in one of the following locations, based on the service you used to purchase the simulator.

   For the Windows Store install:

   C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightSimulator_8wekyb3d8bbwe\LocalCache\Packages\

For the Steam install:

C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightDashboard_8wekyb3d8bbwe\LocalCache\Packages\

Important: Windows 10 by default hides the "AppData" folder, so you will have to go to "View" in the menu of File Explorer, and select "Hidden items" so as to see it.

For the Custom install:

If you used a custom location for your Flight Simulator installation, then proceed there.

For example, you may have set:
E:\Steam\steamapps\common\MicrosoftFlightSimulator\Community

Installing the Working Title G3X Touch

1. Go to the following link, and click the "Download Latest Version" button.
   https://www.workingtitle.aero/packages/g3x/
2. Move the "workingtitle-gx" archive (zipped folder) from your browser's download location (downloads folder by default) to your desktop, and extract (unzip) the archive by right clicking, and selecting "Extract All".
3. Drag the resulting "workingtitle-gx" folder into your Microsoft Flight Simulator Community Folder.
   If you don't know how to locate your MSFS Community Folder, please refer to the above section for instructions on locating the folder.

TDS GTNxi 750 Integration

This product supports the TDS GTNxi 750 as of version 1.1. This aircraft's GTN 750 unit will automatically detect a valid TDS GTNxi installation and license key, and automatically switch between using the PMS GTN 750 and the TDS GTNxi 750 without any required action by the user.

LIMITATIONS:

MSFS native GPS units and native flight planners will not cross-fill from the GTNxi. This could also be seen as an advantage, allowing simultaneous flight plan loading.

NOTE: These are limitations of MSFS and not this aircraft, nor the TDS GTNxi. If and when these issues are resolved, a coordinated effort from the developers of these products will be launched to remove these limitations as soon as possible.

Accessing the Aircraft

To access the aircraft:

1. Click on ‘World Map’.
2. Open the aircraft selection menu by clicking on the aircraft thumbnail in the top left.
3. Use the search feature or scroll through the available aircraft to find the ‘Velocity XL’.
4. After selecting the aircraft, use the ‘Liveries’ menu to choose your livery.

Uninstalling

To uninstall this product from your system, use one of the Windows App management features:

Control Panel -> Programs and Features
or
Settings -> Apps -> Apps & features

Select the product you want to uninstall, choose the ‘Uninstall’ option and follow the on-screen instructions.

Uninstalling or deleting this product in any other way may cause problems when using this product in the future or with your Windows set-up.

Updates and Technical Support

For technical support (in English) please visit the Support pages on the Just Flight website. As a Just Flight customer, you can get free technical support for any Just Flight or Just Trains product.

If an update becomes available for this aircraft, we will post details on the Support page and we will also send a notification email about the update to all buyers who are currently subscribed to Just Flight emails.

Regular News

To get all the latest news about Just Flight products, special offers and projects in development, subscribe to our regular emails.

We can assure you that none of your details will ever be sold or passed on to any third party and you can, of course, unsubscribe from this service at any time.

You can also keep up to date with Just Flight via Facebook and Twitter.

System Guide

Flight Controls

Being a canard aircraft with twin tip-sails, the Velocity may seem unusual to many pilots, but its flight characteristics and controls are mostly conventional. All single engine Velocities have traditional ailerons, two rudders, a single elevator on the canard, and no flaps. These control surfaces are controlled in the conventional way, with rudder pedals (also equipped with toe brakes), and side-sticks. This Velocity is equipped with electrically actuated elevator and rudder trim, which can be controlled by a HAT switch on either side-stick, or rocker switches on the center console. One notable feature regarding the Velocity's rudders is that they only actuate in the outboard direction, meaning that only one rudder is ever in motion at a time. This results in slightly asymmetric yaw during rudder application, which may be noticeable to the pilot. Side-sticks can be hidden in this simulation by clicking on the dust covers at their bases.

Landing Gear

The Velocity features a tricycle landing gear configuration, where the two main gear struts are permanently connected in a scissor-like mechanism within the aft fuselage. This unusual configuration results in a single landing gear actuation and indication for the main gear, thus reducing the number of green lights present on the panel from three to two. The main landing gear struts are of fiberglass-resin construction with a molded cover that retracts completely and rests flush with the underside of the wing for optimal airflow. The main gear is outfitted with Matco 6-inch wheel hubs and integrated disk brakes, with 6.00 x 6 tires, while the nose gear is outfitted with a castering 5.00 x 5 castering wheel. The landing gear is actuated by an electrically driven hydraulic pump contained within the nose wheel well. Nose gear doors are closed passively with cam followers. This aircraft is equipped with a gear warning system which will flash a red annunciator light with an accompanying buzzer on the landing gear panel when under approximately 1,000 ft AGL, and the throttle retarded.

Fuel System

This Velocity XL build is equipped with two upgraded wing fuel tanks with 46 US Gallon each, totaling 92 US Gallons. Fuel flow can be turned on or off to each tank by red valve handles marked “L” and “R” on the center console, in front of the throttle quadrant. Fuel balance is maintained manually by actuation of these valves. When both valves are open, fuel will gravity feed into a 4 Gallon header tank located behind the aft cabin bulkhead, and will be used at similar rates from both tanks, though variations may occur depending on flight conditions.

Exterior Lights

This Velocity is equipped with an LED landing light in the nose, LED navigation lights, and high intensity LED strobe lights. NOTE: In some regional areas, an additional red rotating beacon light may be required by regulations, which is not present on this aircraft. All exterior lighting is controlled via the rocker switches on the overhead switch panel.

Interior Lights

Interior cabin and panel integral lighting are controlled by potentiometers with integrated power switches on the lower right main panel. A diffuse green glareshield light is located under the glareshield to illuminate the panel during non-night-vision-critical operations. Standby instruments and standby compass integrated lighting are controlled via the “INSR. LIGHTS” dimmer, and should be set for nighttime operation, should an emergency occur. Integral panel backlighting and illuminated switch lighting is controlled via the “PANEL LIGHTS” dimmer. Cabin reading lights for passengers, and map lights for crew are controlled via a “MAP LIGHTS” master switch on the overhead switch panel, and are dimmed via the “OVHD LIGHTS” dimming knob.

Emergency Gear Extension

This Velocity is equipped with an emergency gear extension system, should the electric hydraulic pump become inoperative. To manually extend the landing gear, the red valve handle on the pilot's side of the center console should be moved into the open position, and then the landing gear switch placed in the extended position to release the gear from its uplocks. The gear should rapidly gravity-fall into position and lock, providing two green indications while the gear warning light flashes. This can be tested by simply pulling the landing gear pump circuit breaker on the landing gear panel. To retract the landing gear, return the red valve handle to the closed position, and place the landing gear switch in the retracted position. If the red handle is left in the open position, the gear will retract, but the landing gear pump will continue running, and the gear may have trouble locking in the up position.

NOTE: The gear warning light will continue to flash when the landing gear has been deployed manually via the emergency extension valve, but the warning horn will be silenced.

Environmental Control System

This aircraft is equipped with a simulated environmental control system, allowing the user to learn the essentials of passenger comfort while operating this aircraft. Cabin temperature is calculated distinctly from outside air temperature. Since the walls of the aircraft are insulated, it will take time for the cabin temperature of the aircraft to equalize with the outside air temperature. The cabin will also heat itself beyond the outside air temperature during warm sunny conditions, and slowly equalize with the outside air temperature after sunset. Without the need for any aircraft power, the cabin temperature can be equalized with the outside air temperature by opening either cabin door, or with ram air cooling, so long as the airspeed of the aircraft is great enough. Cabin temperature can also be equalized with the use of the electric vent blower centrifugal fan. The rate at which temperature equalization, active heating, or active cooling can be achieved can be increased by increasing the vent blower fan speed, or the air conditioning blower speed as appropriate. Be aware that the electric ventilation systems increase the load required from the current power source substantially, and therefore should be used predominantly while under power.

All heating and cooling is controlled via the climate control panel on the central pedestal. The system must be on and powered to control the vent fan or mixing valve to provide heating or cooling control. When adjusting the fan speed with the two leftmost buttons on the climate control panel, 1, 2, 3, or OFF will be shown momentarily on the LCD display to indicate which fan speed is selected. Similarly, the desired cabin temperature will be shown briefly when using the rightmost two buttons to adjust the desired cabin temperature. The unit can be turned on and off with the on and off buttons. Pressing the defrost button will direct airflow towards the windscreen, set fan speed to maximum, and the desired temperature to maximum. The defroster can be used to melt light windshield icing. Pressing the auto button will set the desired temperature to 75°F (24°C), and continuously adjust the fan speed to achieve the desired temperature quickly. Pressing the OAT button will show the outside air temperature on the LCD display for a few seconds.

To heat the aircraft, set the desired temperature on the climate control panel, and ensure the engine is running. Set the fan speed as desired.

To cool the aircraft, set the desired temperature on the climate control panel, and turn on the air conditioning master switch. To increase the rate of cooling, turn the air conditioning blower speed knob clockwise. The engine must be running at a minimum of about 1,200 RPM for the air conditioning compressor to run.

All of these climate control functions have sounds associated with them to help provide a sense of their functioning.

Avionics

This Velocity build makes use of two IFR-capable Garmin G3X Touch integrated flight displays, straddling a single Garmin GTN 750 touch screen GPS. Below the GTN750 is a Garmin GFC-500 autopilot controller. Users will find cross-filling is enabled between the GTN 750 and the G3X units, meaning that flight plans may be entered on any unit, and they will appear on the others. The three axis autopilot may be controlled either through the GFC-500, or via the G3X touch screen interface. The same goes for the transponder, and audio controls.

Screen brightness will be automatically controlled to suit ambient lighting conditions by default. Should the user desire manual control over screen brightness, an option to do so is provided in the G3X setup menu.

The dual G3X units are configured with an automatic reversionary mode, should one unit fail. This can be demonstrated by pulling the circuit breaker for the co-pilot's side unit.

If you have not done so already, see the Installation, Updates & Support section of this manual for instructions on installing the required FREEWARE GTN 750 mod, and the highly recommended FREEWARE G3X Touch mod.

Door Seal System

This Velocity is equipped with inflatable door seals, controlled via the door seal panel on the copilot's subpanel. The presence of door seals in this aircraft does not indicate that the aircraft is pressurized, rather the seals are to reduce interior wind noise at high indicated airspeeds. This feature is modeled in this aircraft, and wind noise will be reduced by roughly half when the door seals are inflated. The door seals may be inflated via the electric pneumatic pump any time after engine start by placing the mode switch in the inflate position, and placing the power switch in the on position. To deflate after landing, the mode switch may be moved to the deflate position. Any time one of the cabin doors is open, the red "door open" light will illuminate, and pressure will be dumped from the door seal system.

Overhead Panel

An overhead panel contains rocker switches for most primary functions of the aircraft, as well as two reading lights for the flight crew. All switches are togglable, except for the “Engine Start” switch, which is momentary. The switches are internally illuminated for operation at night.

Standby Instrumentation

Conventional standby instrumentation with integrated lighting is provided as a backup on the pilot's side-panel. This panel also incorporates a memory tool for important aircraft operating limitations and speeds. For further information on operating limitations, see the "Aircraft Specifications" section of this manual.

Circuit Breakers

A circuit breaker panel is located under the armrest on the center console between the two front seats. Breakers may be pulled or pushed to disable electrical circuits within the aircraft. There are also several system-specific breakers located on the main panel of the aircraft. All the corresponding electrical circuits are modeled. The status of the electrical system may be monitored via the indications on the right side of the secondary G3X touch screen displays. In an emergency situation, such as the detection of smoke, acrid burning smells, loss of engine, or alternator failure, all non-essential electrical systems should be switched off, workload permitting.

Aircraft Handling

High Performance Aircraft

This Velocity XL represents one of the highest possible performance Velocities that money can build, going far beyond what most builders attempt. The result is debatably the fastest single engine piston aircraft on the market, far exceeding what's possible with conventional certified aircraft. Even less ambitious Velocity builds can be a challenge to fly, given the increased takeoff and landing distances required when compared to conventional aircraft due to the Velocity's lack of flaps, and low drag frame. Add an even more powerful engine and retractable landing gear to the mix, and you not only have these inconveniences, but also an aircraft that you must think far ahead of while executing your flight plan, given that it's capable of covering over eight miles every minute, or a mile every seven seconds, with a tailwind. Expect the Velocity to climb like a jet, cruise like a turboprop, and slow down like a sailplane.

Stall Behavior

The Velocity's most compelling design feature is its resistance to stalls and spins. In a canard configured aircraft, rather than having a tail surface that produces a counteracting downward force to the wing's upward force, both forward and main wings produce an upward force. This means that the aircraft does not become uncontrollable at low airspeeds. The forward wing is designed to have a greater angle of attack with respect to the oncoming air, such that it will begin to stall and lose lift prior to the main wing, thus pitching the aircraft down, and regaining speed before the main wing can stall. Since this phenomenon happens smoothly, it is almost unnoticeable to the operator, and results only in an aircraft that behaves mostly the same at all speeds of flight, with the exception of a doubling of the back pressure required to maintain the same flight attitude at the lowest speeds. Since an incipient stall is required for an aircraft to spin, canard aircraft are very "spin resistant", though not impossible to spin. This characteristic can be demonstrated most readily by holding the stick in the full aft position, and varying power alone to effect a climb, descent, or leveling off of the desired rate. Aggravated pitching of the aircraft at low speed may result in what's called a "pitch bucking" behavior, where the canard is allowed to stall more completely than in normal flight, and the aircraft pitches nose down more abruptly until the angle of attack is reduced. The pitch rate should still be far less than one would expect of a conventional aircraft.

Transition Training Notes

The Velocity's "Owner's Flight Manual" offers the following notes on transitioning from more conventional light aircraft to the Velocity's unique airframe:

"There is no such thing as a minimum number of total hours a pilot should have to be qualified for checkout solo in a new aircraft.The best pilot qualification is variety. He should be current in more than one type of airplane.The Velocity is not difficult to fly, but it is DIFFERENT: like a

Yankee is different from a Cessna, or a Cub is different from a Cherokee. A pilot who is used to the differences between a Cessna and a Cub is ready to adapt to the differences in a Velocity.The Velocity has entirely conventional flying qualities. However, its responsiveness is quicker and its landing speed is faster than most light training aircraft. It should not be considered as a training airplane to develop basic flight proficiency.The Velocity ranks with the best tricycle-geared types for ground stability and has none of the ground-looping tendencies of the taildraggers.

Initially some of the pilots checked out by Velocity tended to do the following on their first takeoff: immediately after liftoff, they would level off or descend, then re-establish a normal climb. We have found that this is caused by the unusual visual cue provided by the canard wing. Even though the climb angle is similar to other light planes, the canard wing gives the pilot the impression that he has over-rotated. Since we found this was the cause, we have told pilots the following and have found that the pitch “bobble” no longer occurs: rotate smoothly to liftoff at 75 knots. If you think you have over-rotated, do not overreact; do not shove the stick forward. Hold the liftoff attitude and the airplane will accelerate to 85 knots for climb.

Occasionally, a new Velocity pilot will tend to make a ‘full stall’ landing or flare too high.Tell him that if he has made the approach at the correct speed and pulls power to idle before the flare, he should not spend a lot of time in the flare. Make a complete flare, then fly the airplane down onto the runway with finesse. Once the main wheels make contact, continue to fly the canard and lower the nose when speed allows.”

Turbocharged Operation

Owners of other turbocharged aircraft for Microsoft Flight Simulator will be familiar with the inaccurate need to lean the mixture continuously to maintain proper fuel-air mixture while below critical altitude. THIS IS NOT NECESSARY with the turbocharger simulation in this product. This simulation is also substantially more complex than other turbocharger simulations.

Turbocharger Basics

Unlike car engines, which predominantly operate at near sea-level air pressures, aircraft engines may operate at sea-level pressure, and within the upper atmosphere where atmospheric pressure is less than one third of that at sea level. In a normally aspirated aircraft engine, the mixture control is used to maintain a favorable fuel-air ratio throughout these different altitudes. Unfortunately, as the amount of fuel per cylinder is reduced to match the air pressure, so too is engine performance reduced. A turbocharger uses high velocity exhaust gasses from the engine's combustion to compress the atmospheric air to a higher pressure. In the case of a "turbonormalized" engine, the turbocharger and an absolute pressure controller provide consistent sea-level pressure air to the engine until the aircraft reaches critical altitude.

Critical Altitude

Simply put, the critical altitude of a turbocharged engine is the maximum altitude at which the turbocharger can compress the atmospheric pressure air to sea-level pressures. When the aircraft continues to climb beyond this altitude, manifold pressure will begin to drop, and the mixture must be leaned, just as with a normally aspirated engine. Critical altitude is listed in aircraft handbooks as a single altitude in feet; however, critical altitude as described above, is constantly changing throughout the flight.

The book value for critical altitude applies only in standard atmospheric conditions when pressure altitude is equal to density altitude. Otherwise, the critical altitude is based on density altitude, not pressure altitude, as is commonly thought. Additionally, sea-level pressure intake air can only be maintained at the critical altitude at wide open throttle, when the compressor turbine is operating at maximum rated RPM. If the velocity of exhaust gas air is reduced by pulling back on the throttle when the wastegate is fully closed, the turbocharger will no longer be able to maintain sea-level pressure at the manifold. When the aircraft is operating well beyond critical altitude, fully retarding the throttle may even cause the engine to cease combustion. For similar reasons, operators should be aware of the signs of turbocharger failure when operating at very high density altitudes, as a sudden failure of the turbocharger may present as a complete engine failure. Should the turbocharger fail in-flight, the engine may continue to be operated as a normally aspirated engine, but it is recommended that a landing be made at the nearest suitable airport.

Operation Before & During Takeoff

Operating a turbonormalized engine is remarkably similar to operating a normally aspirated engine, as there is no need to manually control a wastegate, or significant worry about

overboosting the engine. While on the ground, it's unlikely that any difference will be observed in the turbocharged engine. The mixture should still be leaned during ground operations to prevent spark plug fouling, but placed in the full rich position for takeoff. During engine runup, the sound of the turbocharger will likely be heard, and the manifold pressure will reach the 29.6 inHg redline regardless of density altitude, assuming the turbocharger is operational.

Applying takeoff power is the most likely time to inadvertently cause an overboost, as the oil viscosity may still be high, and slow the operation of the wastegate. When advancing the throttle through the last quarter of its movement, be especially careful to apply power slowly while monitoring manifold pressure.

Operation During Climb & Cruise

The most noticeable difference between a normally aspirated engine and a turbocharged one is the lack of need to adjust the mixture setting during climb. Do not reduce throttle or mixture setting during the initial climb phase. As the absolute pressure controller assures sea-level pressure air is supplied to the intake manifold at wide open throttle, there is no need to adjust the fuel-air ratio with the mixture control until critical altitude has been exceeded, or until the throttle is reduced in the cruise phase. When the aircraft climbs through the critical altitude, manifold pressure will begin to drop, and manual mixture control will be required to maintain desired cruise power.

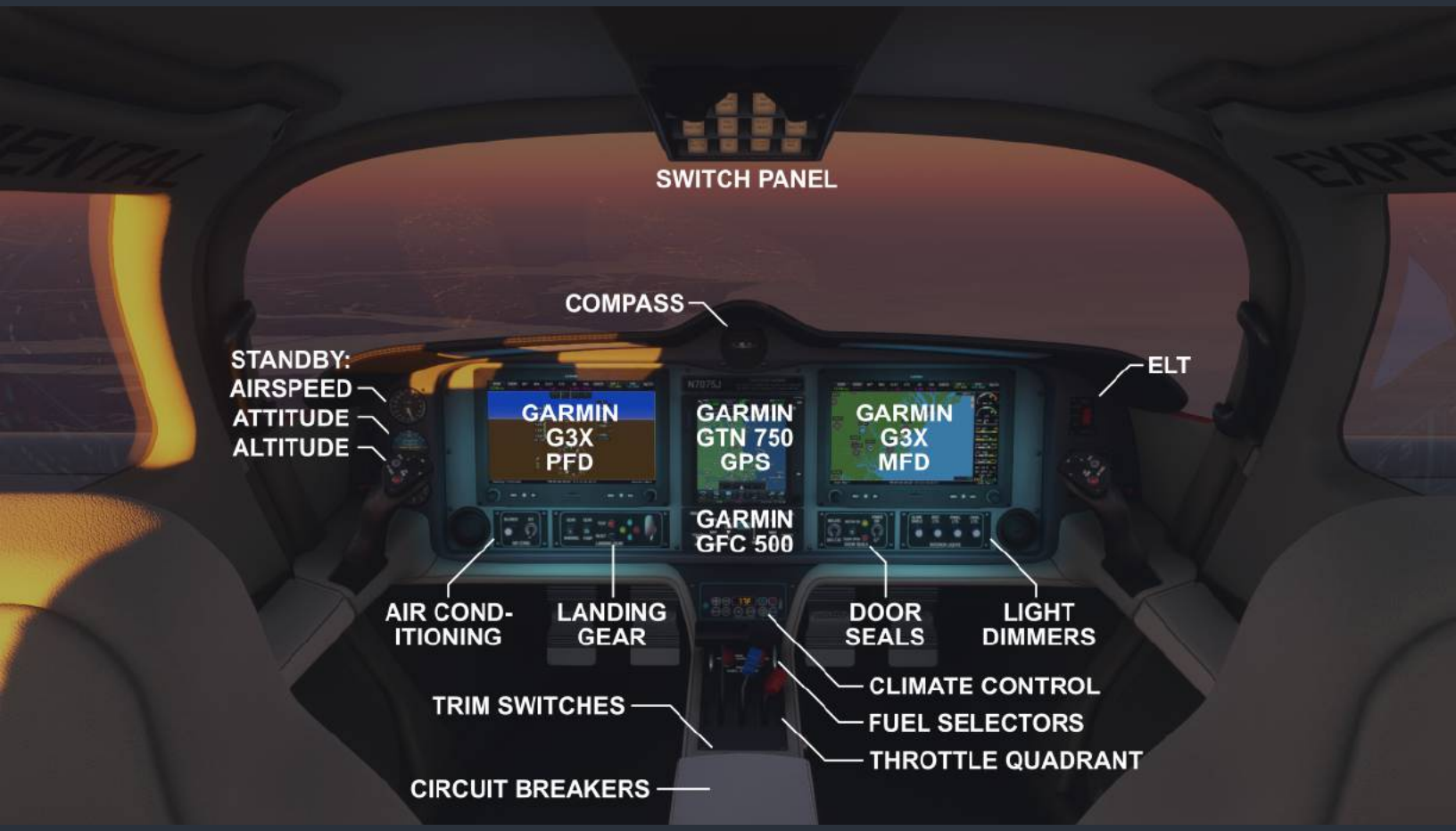
If a reduced throttle setting is desired during cruise, manual control of the mixture setting may also be required. As the critical altitude is only guaranteed at wide open throttle, a reduced throttle setting may reduce turbocharger RPM to the point where the desired manifold pressure can no longer be maintained. For this reason, it is recommended to assess engine performance after every power adjustment when operating at high altitudes.

NOTE: For your convenience while leaning, the friction lock knob located on the right of the center pedestal can be used to increase the fidelity of mixture control adjustments via the mouse wheel. Roll the friction lock clockwise (drag up) to make very fine adjustments to the mixture control.

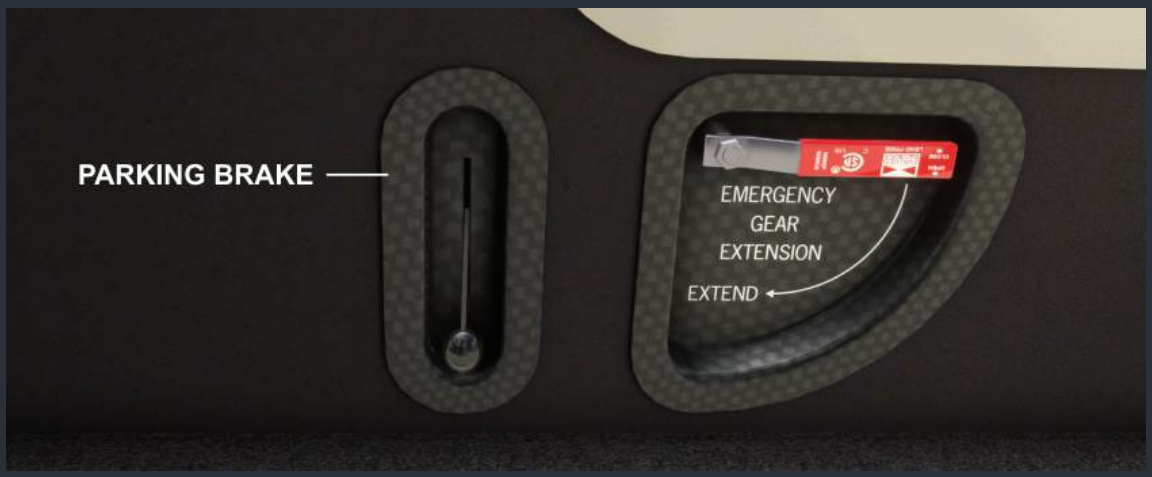
Operation During Landing & Securing

The approach and landing phases are very similar to normally aspirated engines, except that engine performance may be reduced more than would be expected for a given change in throttle setting when operating at higher altitudes. After exiting the runway, be sure to give the turbocharger enough time to cool at turbine idle RPM before stopping the engine. This is more important in colder ambient temperatures to prevent warping of the turbocharger shaft.

Panel Overview



Main Panel



Pilot's Side Center Console

Checklists

Before Engine Start

Parking Brake	On
Emergency Gear Handle	Up
Fuel Selectors	Both On
Mixture	Idle Cut-Off
Propeller Pitch	Full Fine
Throttle	Idle
Circuit Breakers	All In
Air Conditioning	Off
Landing Gear Breakers	In
Landing Gear Handle	Down
Door Seal Breaker	In
Door Seal Mode	Deflate
Door Seal Power	Off
Cockpit Light Dimmers	As Desired
ELT	Armed
Electrical Switches	All Off

Engine Start

Battery Master	On
Strobe Lights	On
Nav Lights	As Required
Cabin Lights	As Required
Avionics	On
Magnetos	On
Fuel Pump	On
Mixture	Rich for 5 sec.
Mixture	Idle Cut-Off
Throttle	Open 1/4in
Fuel Pump	Off
Starter	Engage
Mixture	Advance
Engine Instruments	Monitor
Throttle	1000 RPM
Mixture	Lean for Taxi
Alternator	On
Temps. & Press.	Green
Fuel Quantities	Confirm
Ammeter	Charging
Landing Gear Indicators	Test
Autopilot	Engage
AP Disc.	Test

Before Taxi

Doors	Closed & Latched
Doors Closed	Confirm
Seatbelts & Harnesses	Secure
Seat Adjustments	Secure
Standby Instruments	Set & Check
Flight Instruments	Set & Check
Cabin Lights	Off
Cockpit Light Dimmers	Dim for Taxi
Landing Light	As Required
Parking Brake	Release
Toe-Brakes	Test

Run-Up Checks

Parking Brake	On
Mixture	Full Rich
Throttle	1700 RPM
Temps. & Press.	Green
Magnetos	Cycle
Propeller Pitch	Exercise
Throttle	Close
Temps. & Press.	Green
Throttle	1000 RPM
Mixture	Lean While Holding
Trims	Set T/O
Pitot Heat	As Required
Autopilot	Set

Take-Off

Transponder	Mode-C On
Fuel Pump	On
Landing Light	On
Runway & Final	Clear
Mixture	Full Rich
Propeller Pitch	Full Fine
Throttle	Take-Off Power

Climb

Landing Gear	Up & Locked
Throttle	Max. Continuous
Propeller Pitch	2650 RPM
EGT	Less Than 1650
CHT	Less Than 460
Fuel Pump	Off
Door Seal Mode	Inflate
Door Seal Power	On
Air Conditioning	As Required
Mixture	Lean As Required

Enroute Climb

Throttle	Max. Continuous
Propeller Pitch	2600 RPM
EGT	Less Than 1625
CHT	Less Than 425
Mixture	Lean As Required

Cruise

Throttle	Cruise Power
Propeller Pitch	2450 RPM
EGT	Less Than 1600
CHT	Less Than 400
Mixture	Lean As Required
Landing Light	Off
Fuel Balance	Monitor
Air Conditioning	As Required

Descent

Throttle	Greater Than 20 inHg
Propeller Pitch	Greater than 1700 RPM
EGT	Greater Than 800
CHT	Greater Than 250
Mixture	Enrichen As Required
Throttle	Greater Than 15 inHg
Propeller Pitch	Greater than 2000 RPM
Mixture	Enrichen As Required

Approach

Landing Light	On
Fuel Pump	On
Air Conditioning	Off
Landing Gear	Down Below 120kts

Before Landing

Throttle	15 inHg
Propeller Pitch	Full Fine
Mixture	Full Rich
Magnetos	On
Landing Gear Indicators	Test & Locked
Seatbelts & Harnesses	Secure
Autopilot	Disconnect

Go-Around

Autopilot	Disconnect
Throttle	Take-Off Power
EGT	Less Than 1650
CHT	Less Than 460
Landing Gear	Up Before 110kts

After Landing

Throttle	Idle 1000 RPM
Mixture	Lean for Taxi
Fuel Pump	Off
Pitot Heat	Off
Landing Light	As Required
Door Seal Mode	Deflate for 10 sec.
Door Seal Power	Off

Shutdown & Securing

Landing Light	Off
CHT	Less Than 250
Throttle	Close
Propeller Pitch	Full Fine
Mixture	Idle Cut-Off
Magnetos	Off
Alternator	Off
Strobe Lights	Off
Nav Lights	Off
Cabin Lights	Off
Avionics	Off
Battery Master	Off
Electrical Switches	All Off

Instrument Markings

Manifold Pressure:
- 10-12 inHg (WHITE)
- 20-30 inHg (GREEN)
- 30-32 inHg (YELLOW)
- 32-40 inHg (RED)

Propeller RPM:
- 1200-1800 RPM (WHITE)
- 1800-2600 RPM (GREEN)
- 2600-2700 RPM (YELLOW)
- 2700-2800 RPM (RED)

Fuel Flow:
- 0 GPH (MINIMUM)
- 40 GPH (MAXIMUM)

Oil Pressure:
- 0-25 psi (RED)
- 25-55 psi (YELLOW)
- 55-95 psi (GREEN)
- 95-115 psi (YELLOW)
- 115 psi (RED)

Oil Temperature:
- 0-100 °F (YELLOW)
- 100-245 °F (GREEN)
- 245 °F (RED)

Exhaust Gas Temperature:
- 800-1250 °F (WHITE)
- 1250-1550 °F (GREEN)
- 1550-1650 °F (YELLOW)
- 1650 °F (RED)

Cylinder Head Temperature:
- 250-320 °F (WHITE)
- 320-400 °F (GREEN)
- 400-460 °F (YELLOW)
- 460 °F (RED)

Turbine (Turbocharger) Inlet Temperature:
- 800-1250 °F (WHITE)
- 1250-1550 °F (GREEN)
- 1550-1750 °F (YELLOW)
- 1750 °F (RED)

Fuel Quantity (Left & Right):
- 0-2.5 gal (RED)
- 2.5-12.0 gal (YELLOW)
- 12.0-46.0 gal (GREEN)

More Information on Operation

Black Square aircraft are created by an avid pilot who believes that every switch, knob, and button should be interactable, and the user should be able to follow real world procedures without compromising results from the simulation. This aircraft was designed and tested using real world handbooks and procedures, and leaves little to the imagination in terms of functionality. For the most immersive experience, it's recommended that you seek out manuals, handbooks, checklists, and performance charts from the real aircraft represented in this simulation. Although this aircraft and simulation is not suitable for real world training, and should not be used for such, every effort has been taken to ensure that the simulation will represent the real aircraft until the fringe cases of instrument flying.

Frequently Asked Questions

Why is the GTN 750 GPS screen black?

Make sure you have the PMS GTN 750 mod installed properly in your community folder. The mod can be obtained for free from the following link. Installation instructions are included in the "Installation, Updates & Support" section of this manual.

https://pms50.com/msfs/downloads/gtn750-basic/

Why do my G3X displays not look like the screenshots?

Make sure you have the Working Title G3X Touch mod installed properly in your community folder. The mod can be obtained for free from the following link. Installation instructions are included in the "Installation, Updates & Support" section of this manual.

https://www.workingtitle.aero/packages/g3x/

Why won't the overhead map lights turn on?

The map light intensity is controlled via a dimmer knob on the main panel, but they are turned on and off via a rocker switch on the overhead panel. Make sure the switch is on, and the dimmer knob is turned clockwise.

Why won't the engine start when I follow the checklists?

Standard starting procedure for fuel injected aircraft engines is to engage the starter with the mixture lever at idle/cut-off, and then advance the mixture to start the aircraft. This is reflected in the included checklists with this product, including the in-game checklists. Unfortunately, users with only a mouse for input will not be able to do both actions simultaneously. It is

recommended that the starter command is bound to either a keyboard input, or a joystick/yoke input in order to accomplish both actions simultaneously, and realistically; however, users should be able to set the mixture to full/rich before engaging the starter, since MSFS does not simulate engine flooding.

What if I want to fly with a stock 350 hp TSIO-550?

If you find the performance of the upgraded 400hp TSIO-550 EXP a little too exhilarating, or would like to more accurately match a specific real aircraft, the exact power output of the engine can be easily edited in the aircraft's "engines.cfg" file. You can locate and edit this file in your Community Folder, by following these instructions:

For the Windows Store install:

C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightSimulator_8wekyb3d8bbwe\LocalCache\Packages\

For the Steam install:

C:\Users\[YourUserName]\AppData\Local\Packages\Microsoft.FlightDashboard_8wekyb3d8bbwe\LocalCache\Packages\

Important: Windows 10 by default hides the "AppData" folder, so you will have to go to "View" in the menu of File Explorer, and select "Hidden items" so as to see it.

For the Custom install:

For example, you may have set:
E:\Steam\steamapps\common\MicrosoftFlightSimulator\Community

Once you have found your Community Folder, open the bksq-aircraft-velocityxl folder, and open the "engines.cfg" file. Search for and edit the following line to your liking.

```
max_rated_hp = 400
```

Make sure you save a backup of this file somewhere else on your computer in case you need to restore your changes in the future. This edit should approximate the less powerful stock TSIO-550. Further engine changes are also possible, but it's recommended that an intermediately experienced mod-maker implement these changes as a mod, which can be distributed and installed in the Community Folder.

Why does the mixture behave strangely in the turbocharged version?

Microsoft Flight Simulator's turbocharger simulation has been significantly flawed for several generations. This aircraft has a custom turbocharger that fixes nearly all of these issues, and is much more realistic, as a result. To make these changes, the new "Input Event" system is used to intercept hardware and key-bindings for the mixture control axis. Please make sure that your hardware bindings are using the Key Events, such as "K:MIXTURE1_DECR_SMALL", or "K:MIXTURE1_SET" to set the mixture, and not setting either "A:GENERAL ENG MIXTURE LEVER POSITION:1", or "B:FUEL_Mixture_1_Set".

Can I disable the high-pitched turbocharger sound?

Yes. Just edit the *.flt config files in the aircraft's directory and change the "BKSQ_TurbochargerSound=1" entry to "BKSQ_TurbochargerSound=0". The turbocharger logic can also be disable for other aircraft configurations in the same way by setting "BKSQ_Turbocharged=0".

Change Log

v1.0 - Initial Release

v1.1 - Aerodynamics Update

New Features:

- **TDS GTNxi 750 integration** (PMS GTN 750 still available)

Bug Fixes:

- **Flight model completely revamped.**
- Canard elevator animation fixed.
- Trim sensitivity drastically improved. (T/O indication added)
- Stall is more gentle on landing. (forward wing does not fully stall until 60kts at max gross, 50kts at moderate loading)
- CG envelope improved.
- Aerodynamic stability is reduced. (feels more realistic in wind and turbulence)
- Autopilot will no longer enter oscillations at high speed and aft CG.
- Landing gear drag moment adjusted.
- Glowing tailpipe visuals adjusted.
- Door open sound attenuation fixed.
- Engine idle speed slightly increased. (Note: Engine can still stall after starting without increasing throttle, this is an MSFS problem with high-performance engines, also seen in the Extra 330)
- Electrical system revamped with the use of new software tools to automatically generate more realistic aircraft electrical systems.
- Alternator curves adjusted. (battery will charge above 800 RPM with moderate loads)
- Battery curves adjusted. (fully charged battery will be above 24V)
- Circuit loads are slightly reduced.
- G3X now reads the correct bus voltage for "BATT VOLTS".
- Instrument marking values added to checklists by request.

v1.2 - Major Update: Environmental Control, Door Seals, and Turbocharger

New Features:

- **Complete environmental control system with sounds**, up to current Black Square standards. See the “Environmental Control System” section of this manual for more details.
- This aircraft now incorporates Black Square’s **advanced turbocharger simulation** technology. Experience the challenges of turbocharger operation, and don’t worry about adjusting your mixture control until you reach critical altitude. See the “Turbocharger Operation” section of this manual for more details.
- Working windshield defroster integrated into the environmental control system. See the “Environmental Control System” section of this manual for more details.
- The **door seal system now actually functions to reduce wind noise** in flight when activated. Wind noise is also further reduced at high true airspeed operation due to the effects of the new persistent indicated airspeed variable calculation. For more information on this system, see the “Door Seal System” section of this manual.
- **Audible engine cooling sounds.** The ticking sound an engine makes after shutdown while it cools and contracts can be used to roughly estimate when temperatures are high enough in the engine cowling to vaporize fuel and contribute to vapor lock.
- **Engine and wind sounds have been added to the interior when the cockpit doors are open.** Due to the limitations of the default aircraft’s sound system, this solution is not perfect, but it should be more immersive than without it. Several other Black Square aircraft use this same technique to satisfying effect.
- Have you ever noticed that the wind sound in all other MSFS aircraft is erroneously based on true airspeed rather than indicated airspeed? This makes wind noise during high altitude cruise far too loud. It’s likely the result of there being no persistent indicated airspeed simulation variable that is not affected by pitot-static failures. **All Black Square aircraft now have wind sounds based on indicated airspeed**, which makes them much more enjoyable to fly at high true airspeed.
- Many features of this aircraft are now accompanied by sounds. For instance, air blower fans, air conditioning compressor, environmental control unit, audio amplifier, radio startup static, turbochargers, gear warning, and autopilot disconnect.
- Some of the previously mentioned features were not well simulated with their corresponding circuit’s state and power setting upon initial release. These have been updated to better represent the new systems.

Bug Fixes:

- Overspeed warning variable will no longer activate at low speeds. This also caused 3rd party effects applications like FSRealistic to think the aircraft was in an overspeed condition.
- Door opening sound will no longer loop sometimes when the door is opened and closed quickly.

- Gear light test button will no longer illuminate warning lights without power.
- Adjusted EGT and CHT constants to make wide-open-throttle climbs more manageable.
- Thanks to the aircraft's new persistent airspeed code, overspeed warnings will now activate at the correct indicated airspeed.
- Autopilot engagement is now MUCH smoother, with the aircraft maintaining its present attitude unless commanded to do otherwise. The PID reset mode is set to "current aircraft state" now, which resets the integrator upon engagement.
- Aircraft thumbnails re-rendered with current aircraft capture tool for consistency.
- SU10 ground handling parameters are now in the correct section of flight_model.cfg.
- SU11 localization compatibility.
- SU12 lighting potentiometer fix.
- Operations manual updated to current Black Square standards.

Credits

Velocity XL	Nicholas Cyganski
Publishing	Just Flight
Manual	Nicholas Cyganski
Testing	Just Flight Testing Team

Dedication

My first aircraft for Microsoft Flight Simulator is dedicated to my father, David Cyganski, my closest friend, and the man who introduced me to both aviation, and computer graphics. Before Bruce Artwick and the subLOGIC team (to whom my first Flight Simulator product is dedicated) created the first flight simulator, my father was experimenting in his laboratory at Worcester Polytechnic Institute with the first computer graphics applications. Back then, drawing a handful of filled polygons in real-time was a major accomplishment. In the span of one generation, I now create products like this aircraft with 500,000+ polygons. Coincidently, my father was also a user of Bruce Artwick's graphics library (BGL), which would eventually become the basis for all scenery in MSFS, including my first product.

Advances in computer graphics over the last half century have allowed us to create intricate worlds almost indistinguishable from our own. As much as I love creating products for these digital worlds, they are always a keen reminder to enjoy the time we have in the real world, and spend it with those we love most. This is a small message of great gratitude to my father for sharing his talents, hobbies, support, encouragement, and most importantly his time with me for so many years, and hopefully many more to come.

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