Accu-Sim

"Put the GAUGE back in the game"

A2A simulations

"Passion for Flight"

The A2A Simulations P-47 Razorback Accu-Sim Expansion Pack

ABOUT THIS MANUAL

While much of the information in this manual is basic to many of our readers, we assume that the reader has no knowledge of combustion engine theory. This manual is for ***everyone***, and uses colorful illustrations to teach the basics. The Accu-Sim system, however, is not basic, but is programmed with advanced physics which the professional pilot will appreciate. If you are an advanced pilot, you can likely just briefly skim over the contents of this manual; however, if you are eager to learn a bit about how a great big radial engine works, welcome and read on.

The A2A Simulations P-47 Razorback Accu-Sim Expansion Pack

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Chapter 1: Welcome

INSTALLATION

Once your A2A Simulations Razorback is installed, run the Razorback Accu-Sim expansion pack installer and follow on screen prompts. The installer should find both Flight Simulator X and the A2A Simulations Razorback automatically. If not, it will ask you to BROWSE for the correct location. Keep in mind, if Microsoft Flight Simulator X is properly installed, the Accu-Sim installation should be simple and straightforward.

Refer to Your A2A Simulations Razorback Pilot's Manual

Included with your A2A Simulations Razorback is a detailed pilot's manual. The Accu-Sim upgrade is built into this product from the ground up, so refer to your pilot's manual for specific systems operation and limitations.

DESIGNER'S NOTES

The philosophy behind Accu-Sim was born many years ago. This has all been a dream to us, until now. After many years, we are proud to present our dream to you, our customer.

Accu-Sim is about believing you are there. It's knowing that in the real world certain truths exist. However, we also expect the unexpected, because in life, things do not always fall right into place. When you hit the starter for a great big radial engine, it doesn't always just say, "Yes, sir," and start right up. Sometimes it does, and when that happens you may think, “That was a nice startup.” Other times, the engine does something else – it turns over, it sputters, it coughs, and when just enough things happen to line up, brrrrroooom, the engine fires up. It is not a whole lot different than starting your cold lawn mower engine, but a large aircraft engine just has a lot more going on.

Accu-Sim understands that while one aircraft may be the same model as the next, each aircraft is unique. It also understands that if we do things exactly the same way as we did before, things will not always respond in kind. Most of the time, yes, things will go as we expect. But there is a tolerance we watch for in all things. For example, if your engine tends to run at a specific temperature, say 220 degrees, and that engine is running at 225 degrees, you may consider that normal, or acceptable. Maybe 230 degrees is the point when you think, “That is a little too high,” or maybe 230 degrees is again considered OK by someone else. This is because you, the pilot, are considering not just the temperature of that engine, but all the other factors that go into what makes that engine heat up. Perhaps it's a bit warmer outside the aircraft or you want a little more speed that day so you've closed your cowl flaps an extra inch, trading speed for a little hotter temperature. Maybe the temperature gauge is off a bit, or perhaps you, the pilot, become a bit concerned. Maybe these indicators mean something more is at play. Perhaps you let the engine run a bit too hot on takeoff or maybe something else, completely out of your control, is at work. No matter what it is, the world is not run by absolute numbers; it's run by real things we can see and touch. It's observing the behavior of such things and making decisions based upon what we know to be true. With Accu-Sim, one thing is for certain – no two flights are the same.

Welcome to the world of Accu-Sim.

Scott Gentile
Accu-Sim Project Manager

A2A simulations

The A2A Simulations Razorback Accu-Sim Expansion Pack Features

- Piston combustion engine modeling. Air comes in, it mixes with fuel and ignites, parts move, heat up, and all work in harmony to produce the wonderful sound of a big radial engine. Now the gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about.
- Airflow, density, and its temperature not only affect the way your aircraft flies, but how the internal systems operate.
- Real-world conditions affect system conditions, including engine temperatures. Manage temperatures with engine cowl flaps and oil cooler flaps.
- Use intercooler flaps to cool Carburetor Air Temperatures (CAT), as high temperatures can adversely affect engine performance while low temperatures can lead to carburetor icing.
- Spark plugs can clog and eventually foul if the engine is allowed to idle too low for too long. Throttling up an engine with oil-soaked spark plugs can help clear them out and smoke will pour out of exhausts as oil is burned off.
- Overheating can cause scoring of cylinder head walls which could ultimately lead to failure if warnings are ignored and overly abused.
- Realistic water injection (ADI) system. Pushing the engine too hard without water injection automatically injects more fuel to keep cylinders cooler, creating realistic black smoke from unburned fuel.
- On hot summer days, you will need to pay very close attention to your systems, possibly expediting your takeoff to avoid overheating due to radiant ground heat.
- Brand new sound system allows for many new sounds, including dynamic wind, turbo whine, engine sputters, etc., that will immerse you in flying unlike ever before. Experience a true “Open Cockpit” experience.
- Gauges can vibrate when an engine is not running right.
- Authentic component drag. Dropping your gear will pull your aircraft realistically as the landing gear is deployed along with cooling flaps, ordnance, and even opening the canopy. Drop your gear, deploy your flaps, or just try a dive, and listen to your airframe. It's all there and it's all real.

- System failures, including flaps that can independently jam or break based on the actual forces put upon them. If you deploy your flaps at too high of a speed, you could find yourself in a very dangerous situation.
- Landing gear can jam based on whether it is moving or locked down.
- Total audible cockpit made with recordings from the actual aircraft. Before you fly, enjoy clicking everything.
- Primer system modeled. Accu-Sim monitors the amount of fuel injected and its effectiveness to start the engine. Roughly 2-4 shots needed in hot weather and 4-8 in cold weather.
- Authentic battery. The battery capacity is based on temperature. The major draw comes from engine starting.
- Oil pressure system is affected by oil viscosity (oil thickness). Oil viscosity is affected by oil temp and oil dilution level. Now when you start the engine, you need to be careful and not raise RPM too much until oil temp is high enough to give proper oil pressure. If you raise RPM too high on a cold engine, especially very cold, oil pressure can raise to over 150psi. Oil pump failure can result. Also, extended inverted flight (negative g) can uncover the oil sump and reduce oil pressure. Do not fly in a negative g situation for more than 5 seconds.
- Oxygen starvation (hypoxia) is modeled. Just take off and climb without oxygen to see.
- Experience realistic startups with an authentic inertia starter. Wind it up and engage.
- Authentic engine sounds. When possible, we visit and fly the actual aircraft, capturing every area that makes sounds, namely the engine and how it not only sounds inside and outside, but based on where you are outside. We also have sounds to indicate how your engine is performing. For example, it may cough if the cylinders start getting fouled, or you may hear components start knocking when pushed too hard. This all contributes to you, the pilot, knowing your aircraft and how to read how it is functioning throughout every flight.

Chapter 2: Accu-Sim and the Combustion Engine

THE COMBUSTION ENGINE

The combustion engine is basically an air pump. It creates power by pulling in an air / fuel mixture, igniting it, and turning the explosion into usable power. The explosion pushes a piston down that turns a crankshaft. As the pistons run up and down with controlled explosions, the crankshaft spins. For an automobile, the spinning crankshaft is connected to a transmission (with gears) that is connected to a driveshaft, which is then connected to the wheels. This is literally “putting power to the pavement.” For an aircraft, the crankshaft is connected to a propeller shaft, and the power comes when that spinning propeller takes a bite of the air and pulls the aircraft forward.

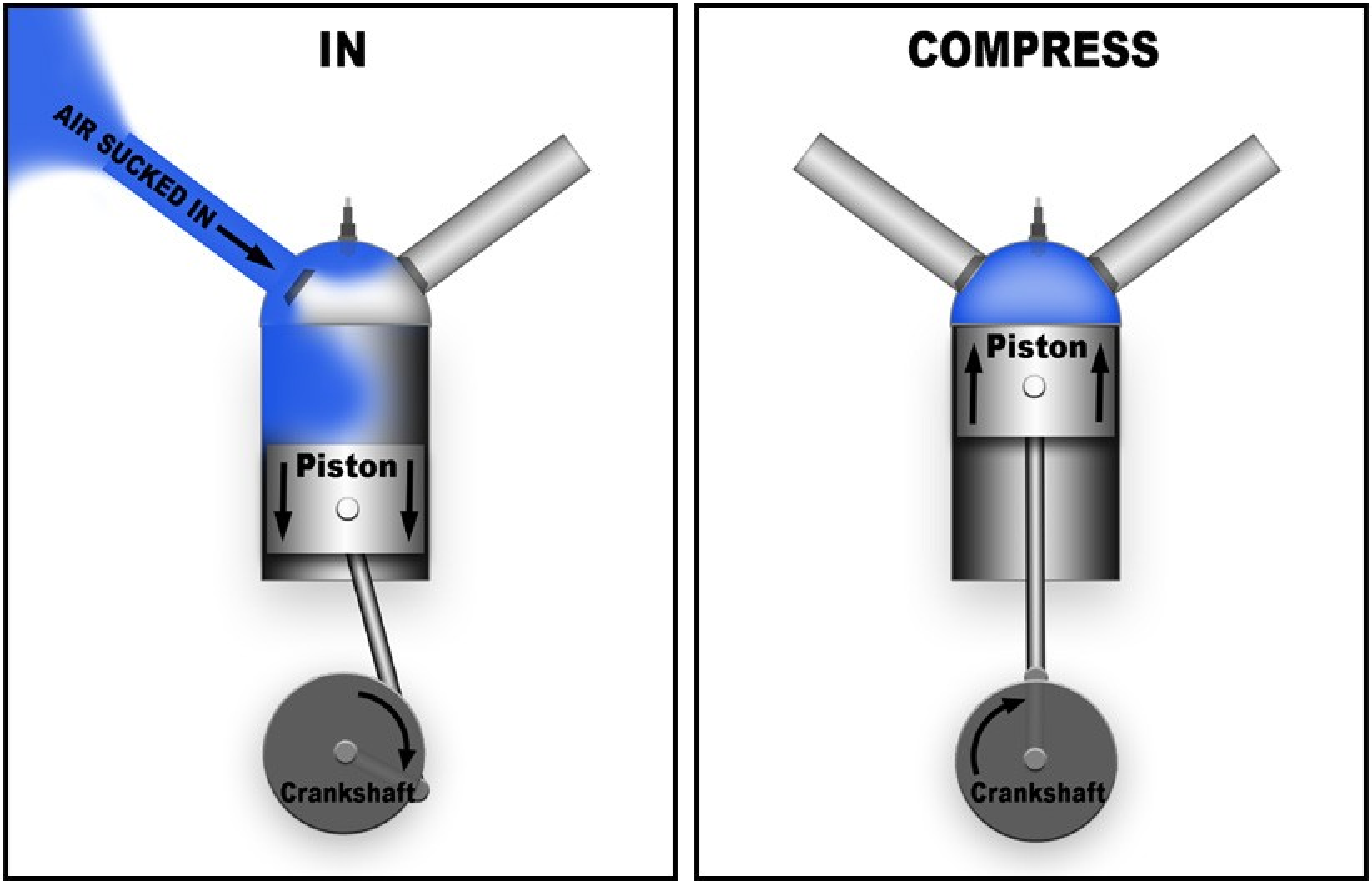
The main difference between an engine designed for an automobile and one designed for an aircraft is the aircraft engine will have to produce power up high where the air is thin. To function better in that high, thin air, a supercharger can be installed to push more air into the engine.

OVERVIEW OF HOW THE ENGINE WORKS AND CREATES POWER

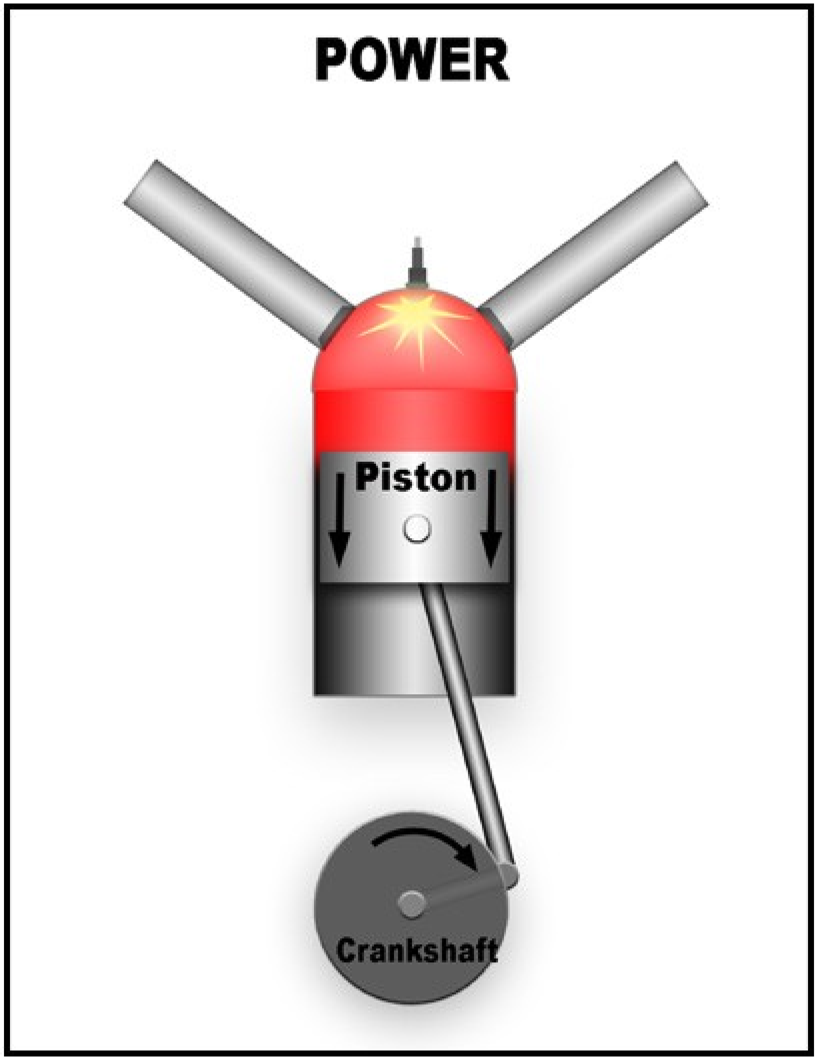
Fire needs air. We need air. Engines need air. Engines are just like us as – they need oxygen to work. Why? Because fire needs oxygen to burn. If you cover a fire, it goes out because you starved it of oxygen. If you have ever used a wood stove or fireplace, you know when you open the vent to allow more air to come in, the fire will burn more. The same principle applies to an engine. Think of an engine like a fire that will burn as hot and fast as *you* let it.

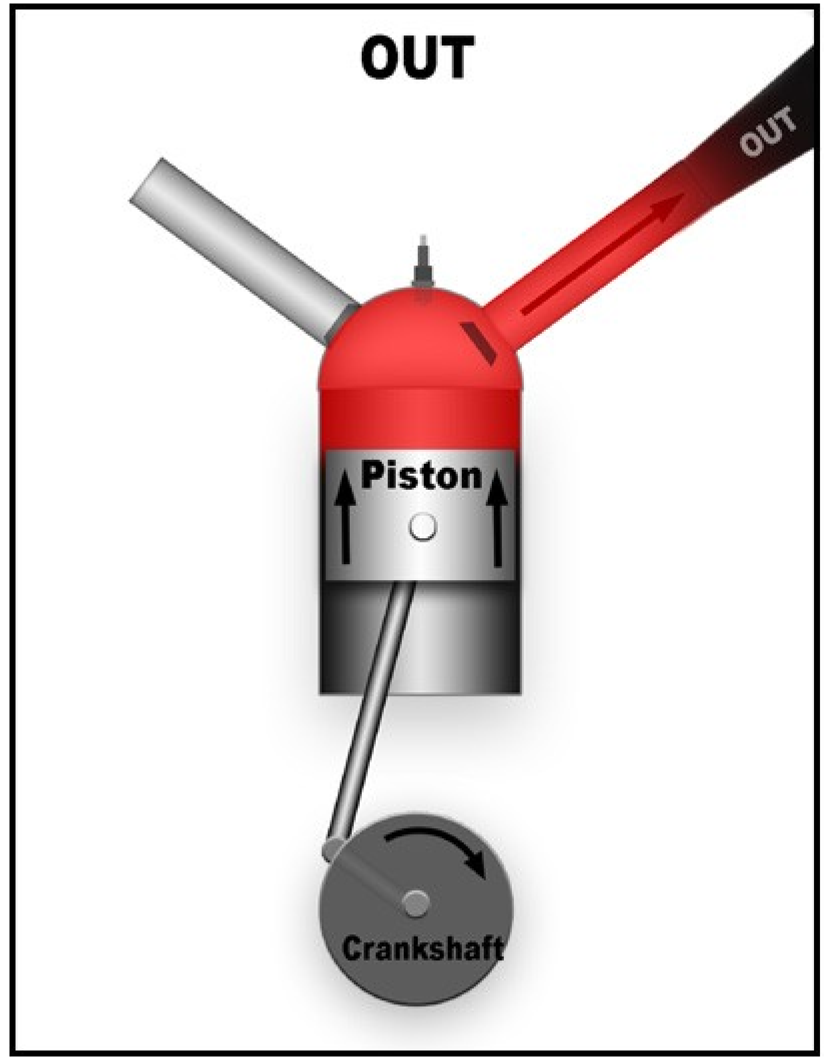
Look at the four pictures below and you will understand basically how an engine operates.

The piston pulls in the fuel / air mixture, then compresses the mixture on its way back up.



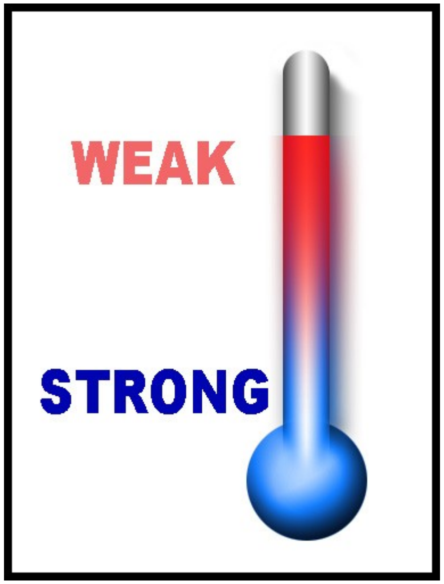
The spark plug ignites the compressed air / fuel mixture, driving the piston down (power), then on its way back up, the burned mixture is forced out the exhaust.





AIR TEMPERATURE

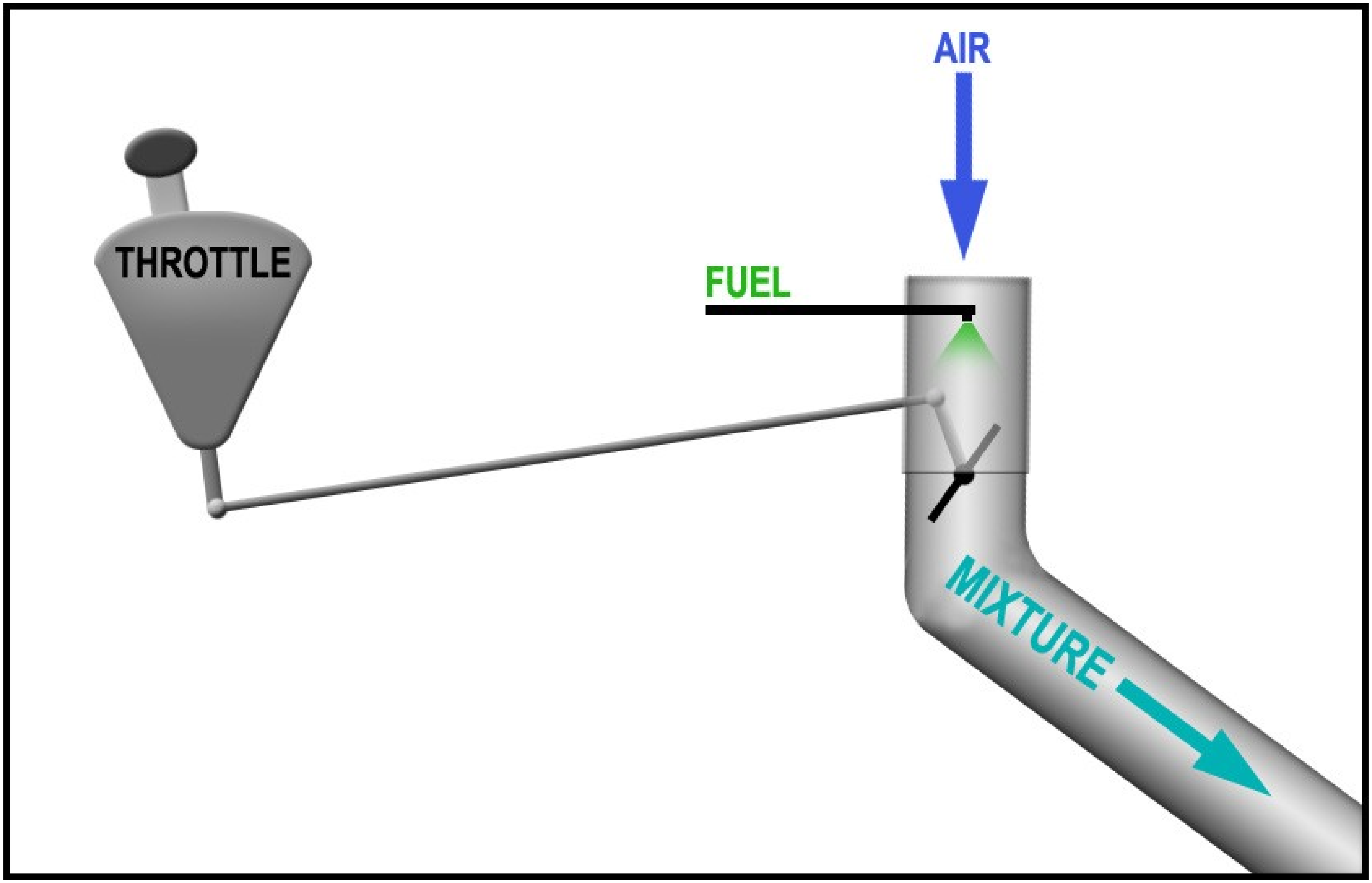
Have you ever noticed that your car engine runs smoother and stronger in the cold weather? This is because cold air is denser than hot air and has more oxygen. Hotter air means less power.



Carburetor Air Temperature (CAT). Your CAT is the temperature of the air just before it enters the engine. On the P-47, air enters just below the engine, travels to the back of the aircraft, gets powered by a turbo, cooled by an intercooler, and forced back up the fuselage and into the engine. Use your intercooler flaps to control this temperature, you can cool your CAT by opening these flaps. However, the more you open these flaps, the increased drag can slow down your aircraft. The key is finding the magic balance between keeping your CAT low and keeping your intercooler flap drag low.

MIXTURE

Just before the air enters the combustion chamber, it is mixed with fuel. Think of it as an air / fuel mist.



A general rule is a 0.08% fuel to air ratio will produce the most *power.* 0.08% is less than 1%, meaning for every 100 parts of air, there is just less than 1 part fuel. The best economical mixture is 0.0625%.

Why not just use the most economical mixture all the time?
Because a leaner mixture means a hotter running engine. Fuel actually acts as an engine coolant, so the richer the mixture, the cooler the engine will run.

However, since the engine at high power will be nearing its maximum acceptable temperature, you would use your best power mixture (0.08%) when you need power (takeoff, climbing), and your best economy mixture (.0625%) when throttled back in a cruise when engine temperatures are low.

So, think of it this way:
For HIGH POWER, use a RICH mixture.
For LOW POWER, use a LEAN mixture.

THE MIXTURE LEVER

Most piston aircraft have a mixture lever in the cockpit that the pilot can operate. Forward is usually rich, and backward is usually lean. The higher you fly, the thinner the air, and the less fuel you need to achieve the same mixture. So, in general, as you climb you will be gradually pulling that mixture lever backwards, leaning it out as you go to the higher, thinner air.

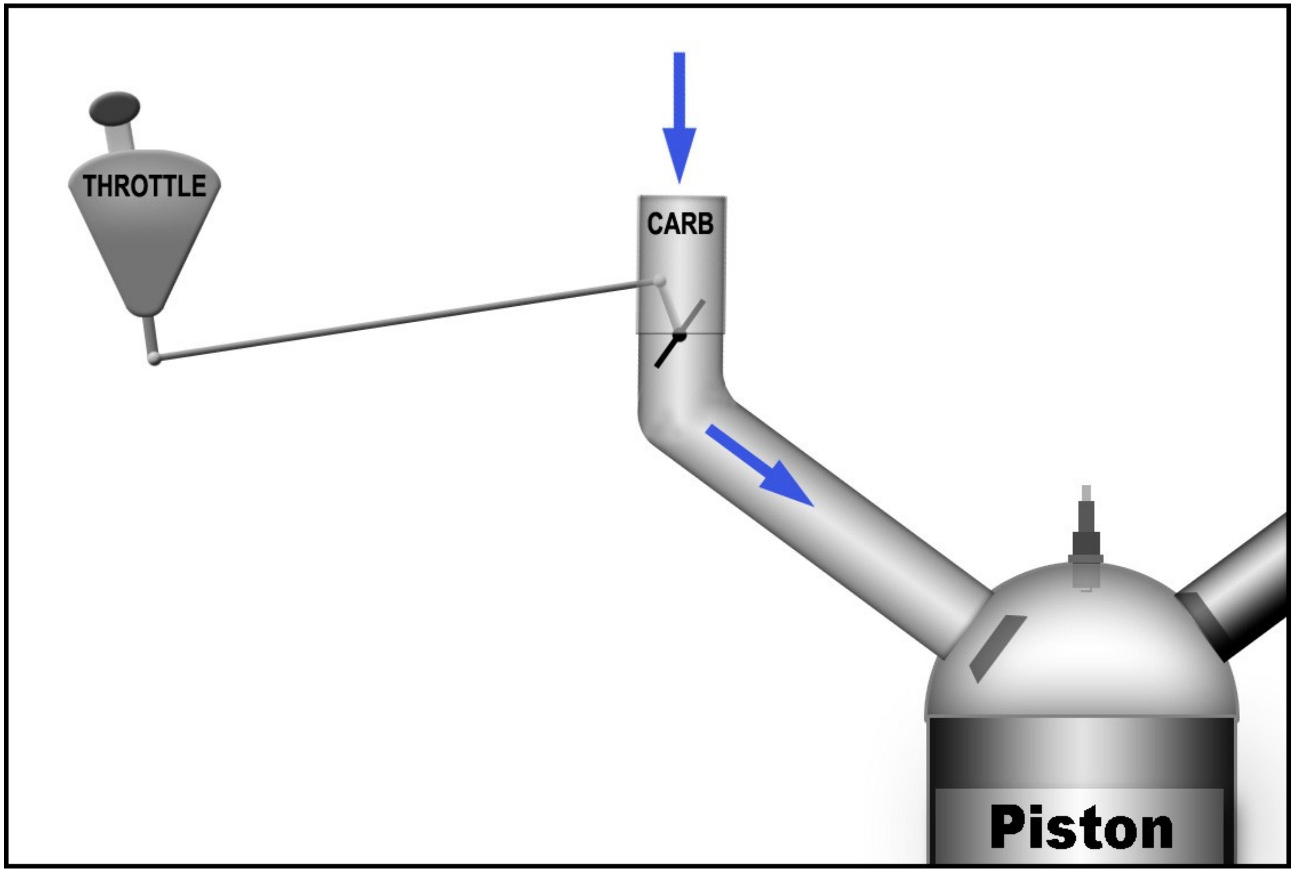
How do you know when you have the right mixture?
The standard technique to achieve the proper mixture in flight is to lean the mixture until you just notice the engine getting a bit weaker, then richen the mixture until the engine sounds smooth. It is this threshold that you are dialing into your 0.08%, best power mixture. Be aware, if you pull the mixture all the way back to the leanest position, this is mixture cutoff, which will stop the engine.

AUTO-RICH AND AUTO-LEAN
More advanced aircraft may have an AUTO-MIXTURE system, with AUTO-RICH and AUTO-LEAN settings. You simply select which one you want and the auto-mixture system automatically adjusts the mixture for you based on altitude and power setting.

INDUCTION

As you now know, an engine is an air pump that runs based on timed explosions. Just like a forest fire, it would run out of control unless it is limited. When you push the throttle forward, you are opening a valve allowing your engine to suck in more fuel / air mixture. When at full throttle, your engine is pulling in as much air as your intake system will allow. It is not unlike a watering hose – you crimp the hose and restrict the water. Think of full power as you just opening that water valve and letting the water run free. This is 100% full power.

In general, we don't run an airplane engine at full power for extended periods of time. Full power is only used when it is absolutely necessary, sometimes on takeoff, and otherwise in an emergency. For the most part, you will be 'throttling' your motor, meaning *you* will be dictating where its limit is.



MANIFOLD PRESSURE = AIR PRESSURE

You have probably watched the weather on television and seen a large letter L showing where big storms are located. L stands for LOW BAROMETRIC PRESSURE (low air pressure). You've seen the H as well, which stands for HIGH BAROMETRIC PRESSURE (high air pressure). While air pressure changes all over the world based on weather conditions, these air pressure changes are minor compared to the difference in air pressure with altitude. The higher the altitude, the ***much*** lower the air pressure.

On a standard day (59 F), the air pressure at sea level is 29.92Hg BAROMETRIC PRESSURE. To keep things simple, let's say 30Hg is standard air pressure. You have just taken off and begin to climb. As you reach higher altitudes, you notice your rate of climb slowly getting lower. This is because the higher you fly, the thinner the air is, and the less power your engine can produce. You should also notice your MANIFOLD PRESSURE decreases as you climb as well.

Why does your manifold pressure decrease as you climb?
Because manifold pressure ***is*** air pressure, only **it's measured inside your engine's intake manifold.** Since your engine needs air to breath, manifold pressure is a good indicator of how much power your engine can produce.

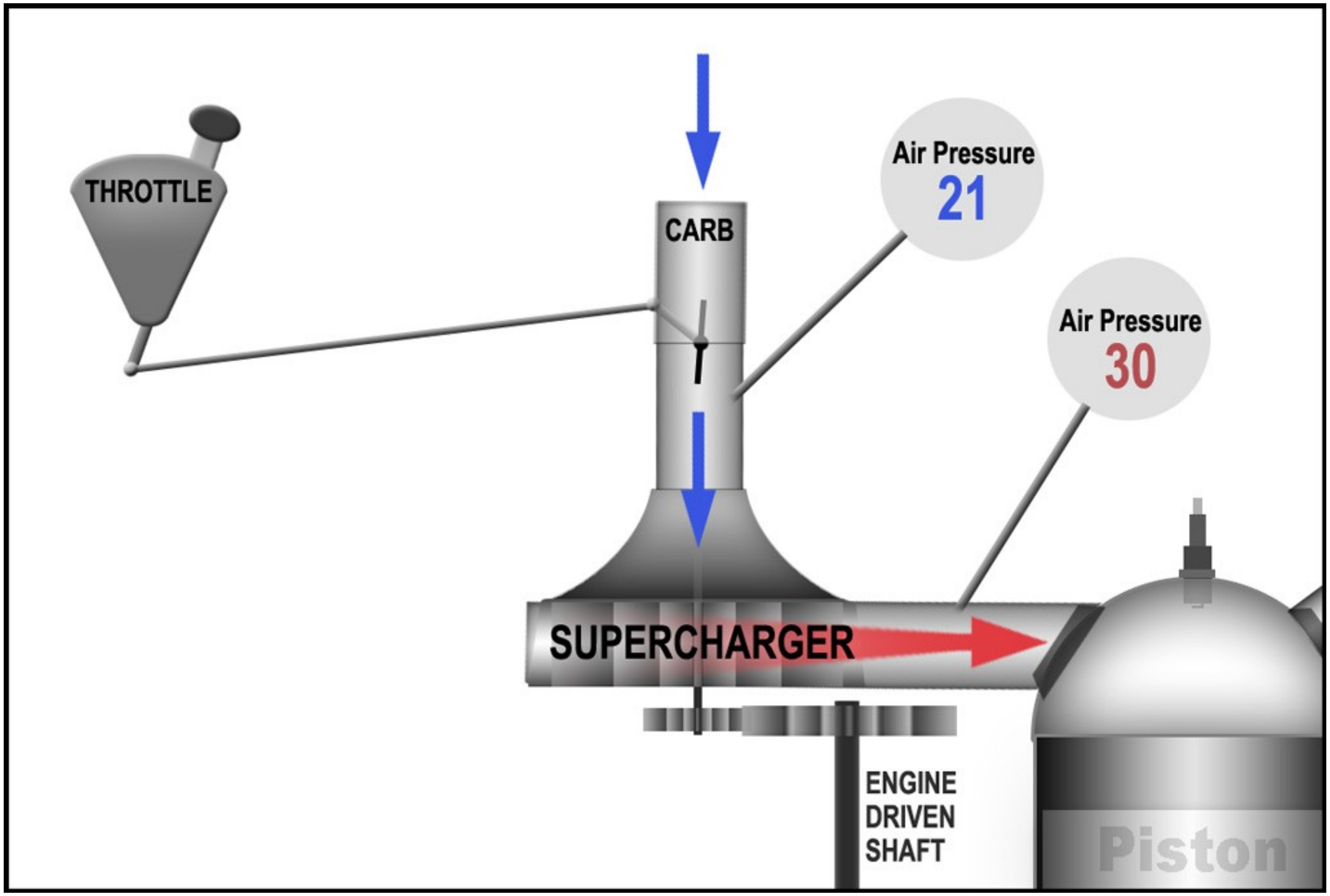
Now, if you start the engine and idle, why does the manifold pressure go way down?
When your engine idles, it is being choked of air. It is given just enough air to sustain itself without stalling. If you could look down your carburetor throat when an engine is idling, those throttle plates would look like they were closed. However if you looked at it really closely, you would notice a little space on the edge of the throttle valve. Through that little crack, air is streaming in. If you turned your ear toward it, you could probably even hear a loud sucking sound. That is how much that engine is trying to breath. Those throttle valves are located at the base of your carburetor, and your carburetor is bolted on top of your intake manifold. Just below those throttle valves and inside your intake manifold, the air is in a vacuum. This is where your manifold pressure gauge's sensor is, and when you are idling, that sensor is reading that very low air pressure in that vacuum.

As you increase power, you will notice your manifold pressure comes up. This is simply because you have used your throttle to open those throttle plates more, and the engine is able to get the air it wants. If you apply full power on a normal engine, that pressure will ultimately reach about the same pressure as the outside, which really just means the air is now equalized as your engine's intake system is running wide open. So if you turned your engine off, your manifold pressure would rise to the outside pressure. So on a standard day at sea level, your manifold pressure with the engine off will be 30".

So how can an engine produce more power at high altitudes where the air is so thin?
Since the power an engine can produce is directly associated with the pressure of the air it can take, at some point during your climb (above 10,000 feet or so), that engine will be producing so little power that the aircraft can no longer climb. This is the point where the engine can barely sustain level flight, and is considered the aircraft's service ceiling. A supercharger can raise this ceiling.

SUPERCHARGING

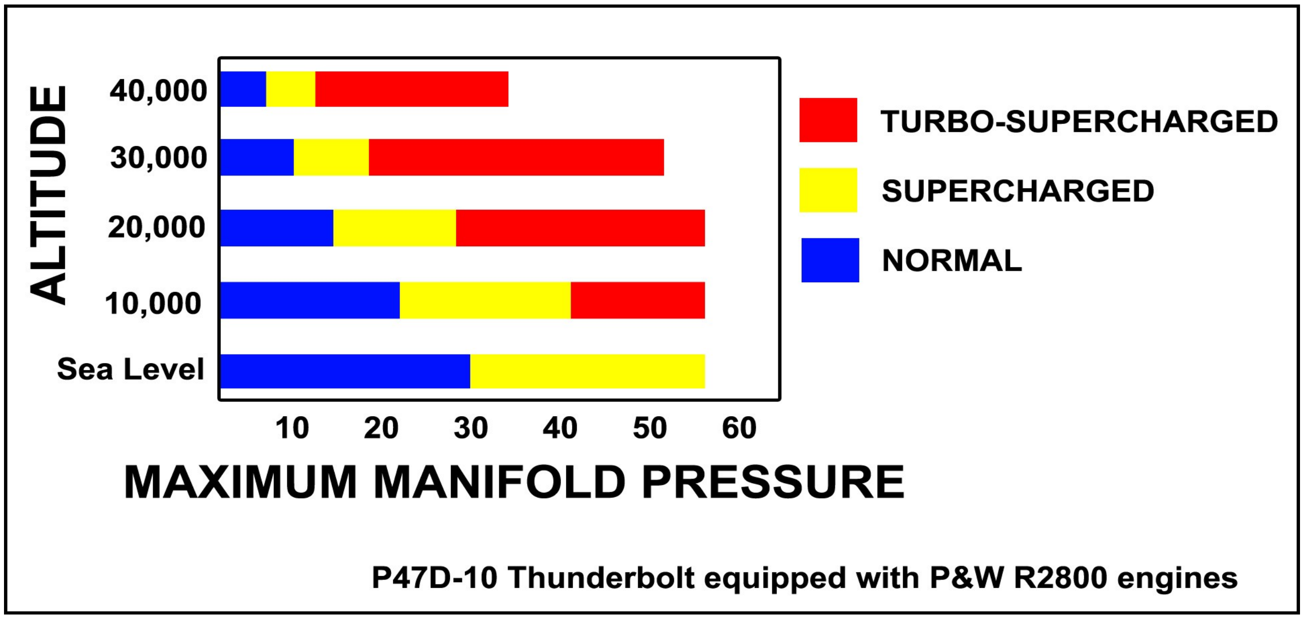
The supercharger has a powerful fan installed in your intake system that forces *more* air into the engine. As you fly higher and the air pressure decreases, your supercharger will help to compensate and keep air pressure higher than it would be otherwise.



Let's say while air pressure at sea level is 30", it is 21" at 10,000. At 10,000 feet, your supercharger fan pushes in more air to increase your manifold pressure to 30". Now your engine will produce the same power at 10,000 feet as it would at sea level. It would feel every bit as strong as it did when you took off.

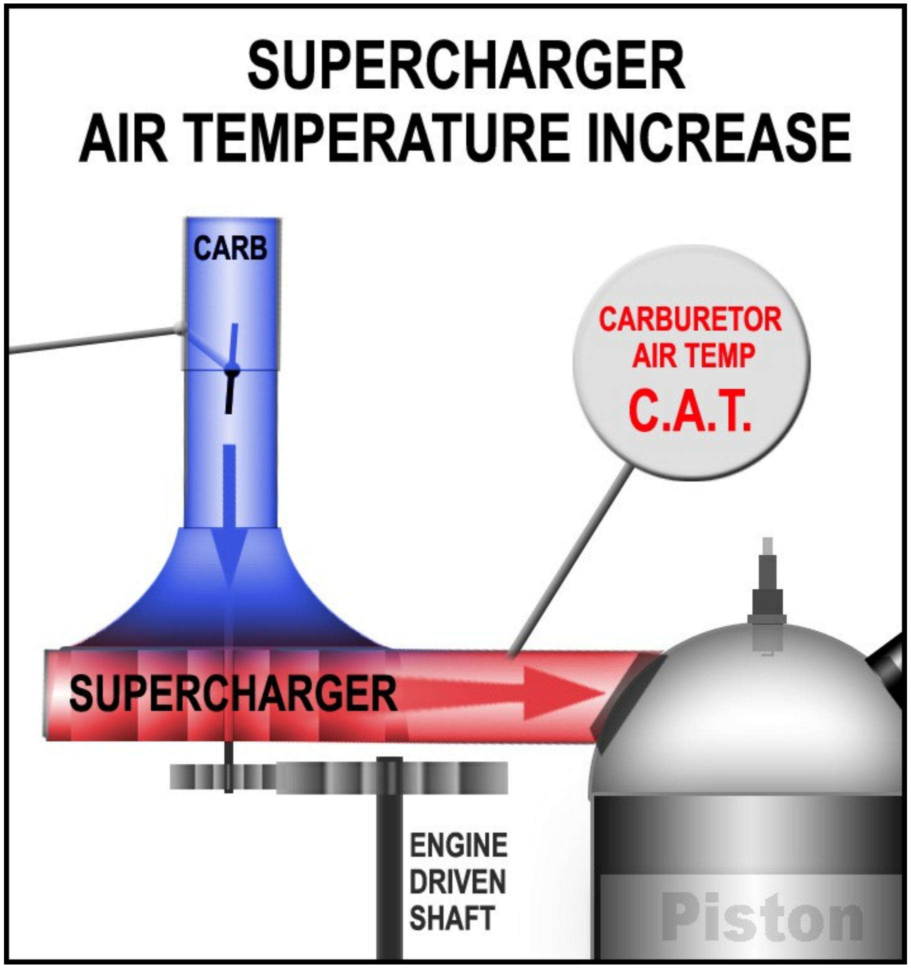
However, even a supercharger has its limitations. At some point, it will hit its own limit of how much air it can force and manifold pressure will again start to drop off. Some aircraft include a second stage supercharger, this is basically a HIGH / LOW gear. Some planes may automatically kick into HIGH at a certain altitude. When you hit this altitude, you will notice a nice punch of power. Other planes, like the P-47 Razorback, use both a turbocharger and a supercharger. A turbocharger does the exact same thing as a supercharger, except while a supercharger is driven directly off the engine by mechanical gears, a turbocharger is driven by the power of the exhaust pressure. This is where the term 'turbo lag' comes from. Turbo lag is the time delay after you apply power and before the exhaust has enough pressure to spin the turbo charger hard enough to push more air into your engine. The turbo, being driven off exhaust, is only applying power when the engine is *producing* power. So the turbo process is a cycle – engine power produces more turbo power that produces more engine power and so on. It's like rolling a snowball down a hill, this is your turbo 'spooling' up. Since the supercharger is gear driven, it moves perfectly in step with engine RPM – it's there and ready when you apply throttle.

While turbo and superchargers can be used to compensate for lost air pressure up high, they can also be used to *over-boost* the power at sea level. This is called "ground boosting." Ground boosting adds more air pressure (and power) at sea level than would normally be available.



If you add power and see your manifold pressure rise above 30", then you have some form of supercharging or turbocharging adding more air into the engine than would normally be available. A normal engine that is producing 1,000 horsepower at 30" will produce 2,000 horsepower at 60", since it is twice the pressure. 45" produces 1,500 horsepower and so on.

SUPERCHARGING HEATS THE AIR

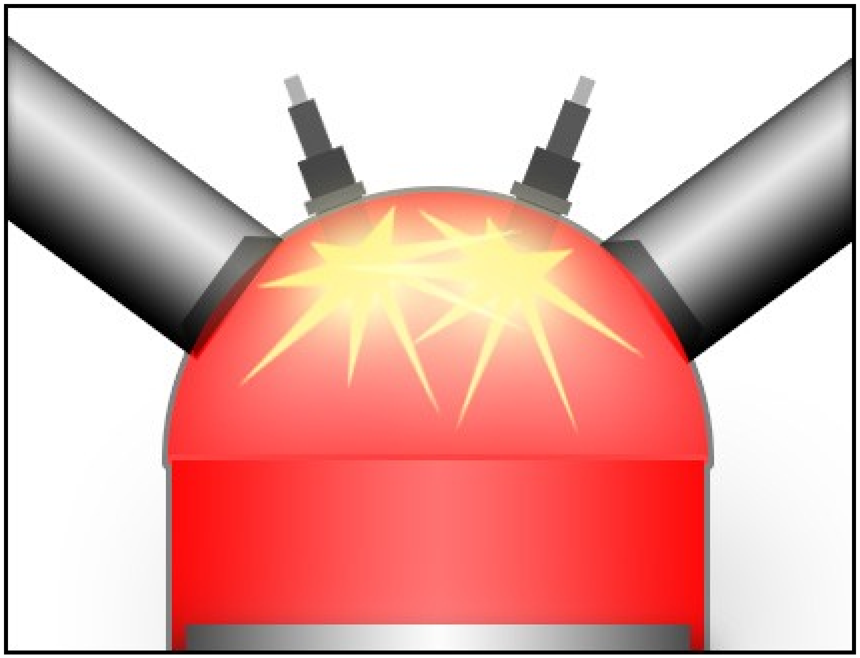


The downside to supercharging is heat. The more you compress air, the more the temperature increases, therefore more supercharging = higher CAT temperatures. The increase in temperature can be extreme. -40 degree air coming into the intake system can be 100 degrees hotter after it exits the supercharger. This is where your INTERCOOLER comes into play. The INTERCOOLER is a heat exchange, and is basically a radiator taking heat out of the incoming air. Use your INTERCOOLER FLAPS to transfer heat out of your intake manifold and out the flap doors. The more you open your intercooler flaps, the more heat you remove. Use your intercooler flaps to keep CAT temps nice and low for a strong and healthy running engine.

IGNITION

The ignition system provides timed sparks to trigger timed explosions. For safety, aircraft are usually equipped with two completely independent ignition systems. In the event one fails, the other will continue to provide sparks and the engine will continue to run. This means each cylinder will have two spark plugs installed.

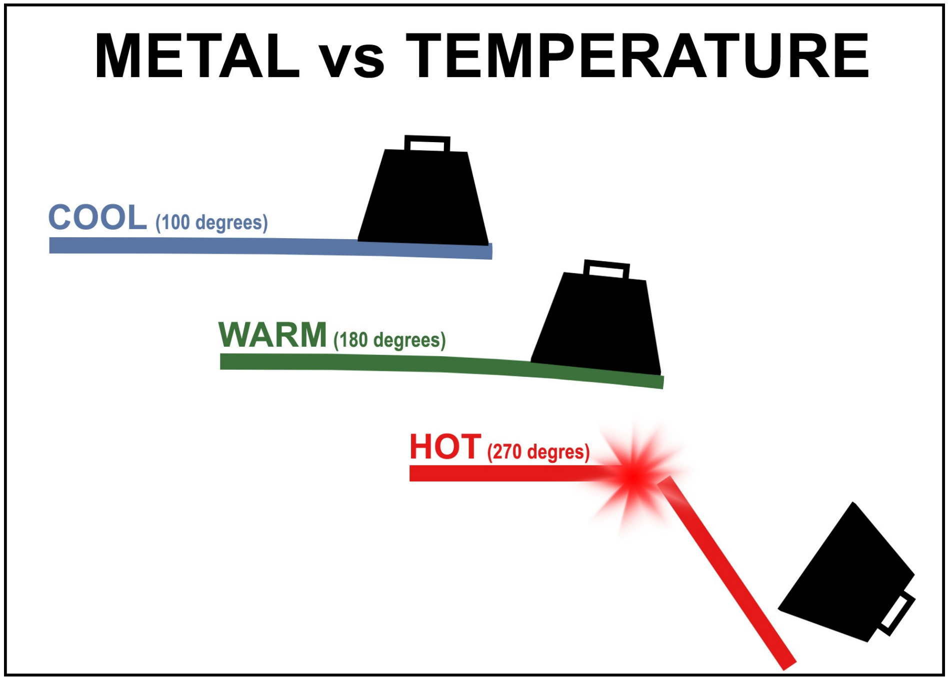
An added advantage to having two sparks instead of one is more sparks means a little more power. The pilot can select Ignition 1, Ignition 2, or BOTH by using the MAG switch. You can test that each ignition is working on the ground by selecting each one and watching your engine RPM. There will be a slight drop when you go from BOTH to just one ignition system. This is normal, provided the drop is within your pilot's manual limitation.



ENGINE TEMPERATURE

All sorts of things create heat in an engine, like friction, air temp, etc., but nothing produces heat like COMBUSTION.

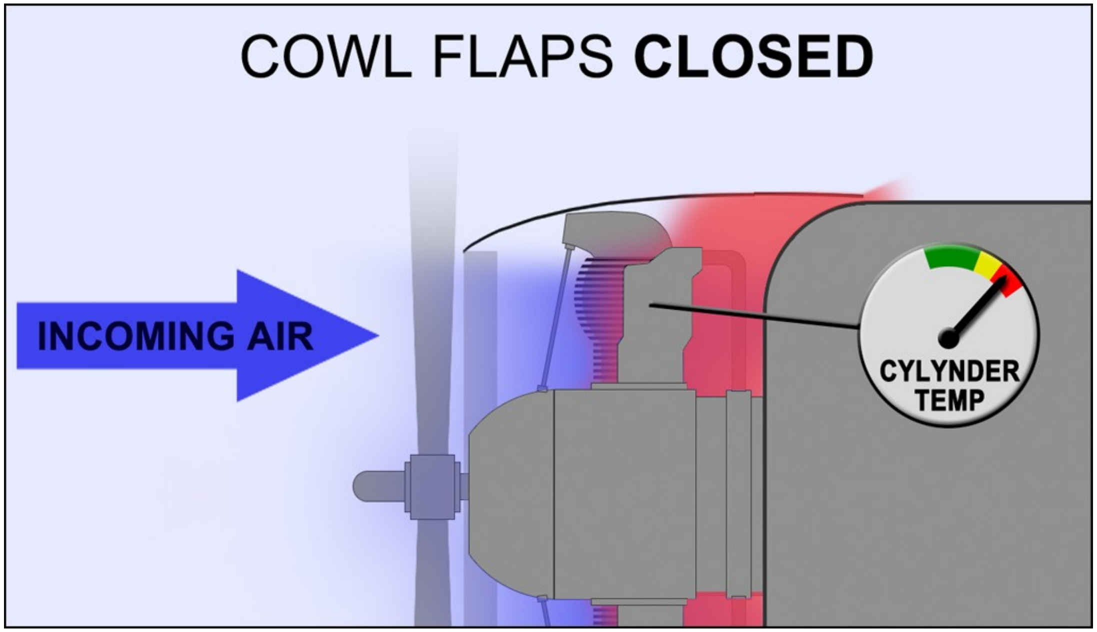
The hotter the metal, the weaker its strength.

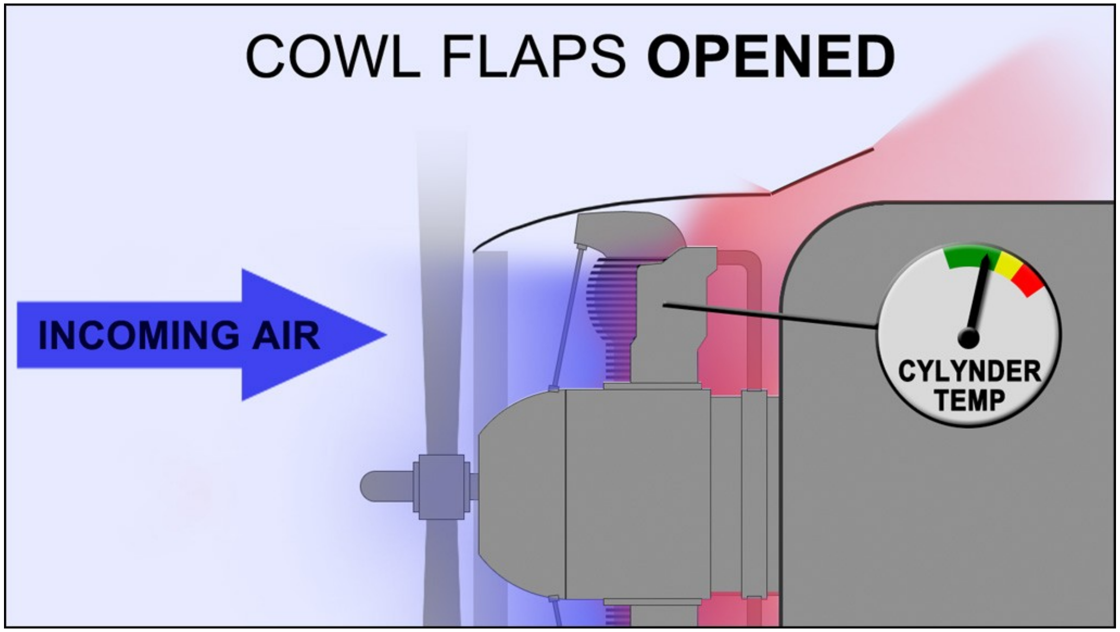


Aircraft engines are made of aluminum alloy, due to its strong but lightweight properties. Aluminum maintains most of its strength up to about 150 degrees Celsius. As the temperature approaches 200 deg C, the strength starts to drop. An aluminum rod at 0 degrees Celsius is about 5X stronger than the same rod at 250 degrees Celsius, so an engine is most prone to fail when it is running hot. Keep your engine temperatures down to keep a healthy running engine.

CHT (Cylinder Head Temperature)

CHT is a measurement of the temperature in the back of the cylinder head. The combustion is happening right inside the cylinder head, so high power will increase temperature rapidly. The key is to watch and manage your cylinder head temperature by being aware of the outside air temp, keeping your speed up, and using your cowl flaps to control how much cooling is applied. The largest CHT rise will come from sitting on a hot ramp, just after takeoff, or in a slow and steep climb.



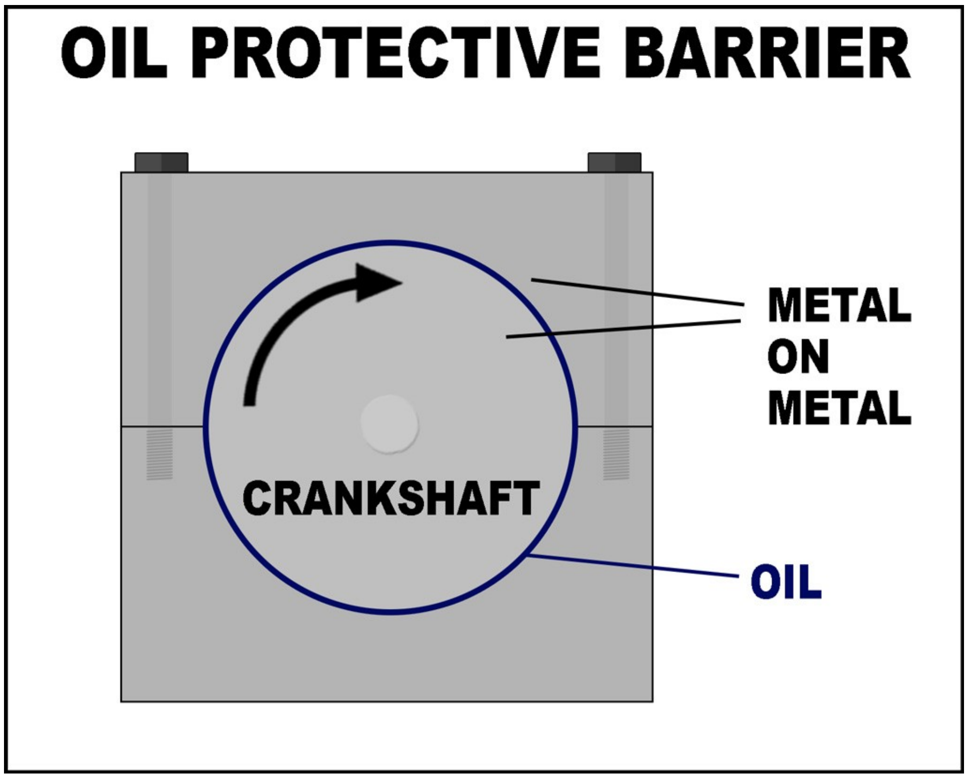


LUBRICATION SYSTEM (OIL)

An internal combustion engine has precision machined metal parts that are designed to run against other metal surfaces. There needs to be a layer of oil between those surfaces at all times. If you were to run an engine and pull the oil plug and let all the oil drain out, after just minutes, the engine would run hot, slow down, and ultimately seize up completely from the metal on metal friction.

There is a minimum amount of oil pressure required for every engine to run safely. If the oil pressure falls below this minimum, then the engine parts are in danger of making contact with each other and incurring damage. A trained pilot quickly learns to look at his oil pressure gauge as soon as the engine starts, because if the oil pressure does not rise within seconds, then the engine must be shut down immediately.

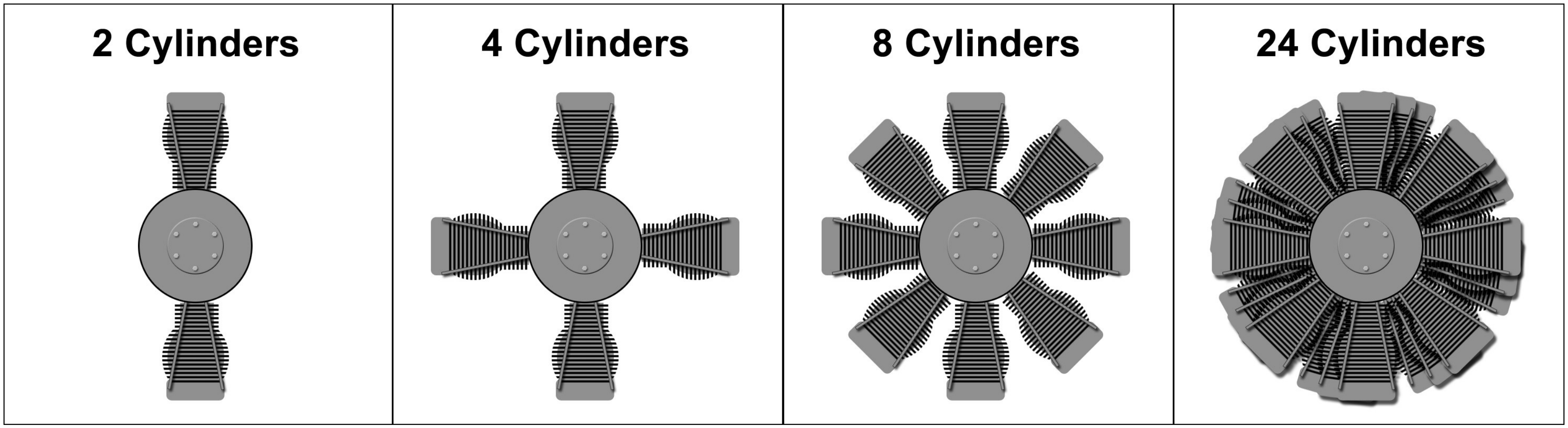
Below is a simple illustration of a crankshaft that is located between two metal caps, bolted together. This is the very crankshaft where all of the engine's power ends up. Vital oil is pressure-injected in between these surfaces when the engine is running. The only time the crankshaft ever physically touches these metal caps is at startup and shutdown. The moment oil pressure drops below its minimum, these surfaces make contact. The crankshaft is where all the power comes from, so if you starve this vital component of oil, the engine can seize. However, this is just one of hundreds of moving parts in an engine that need a constant supply of oil to run properly.



MORE CYLINDERS, MORE POWER

The very first combustion engines were just one or two cylinders. Then, as technology advanced, and the demand for more power increased, cylinders were made larger. Ultimately, they were not only made larger, but more were added to an engine.

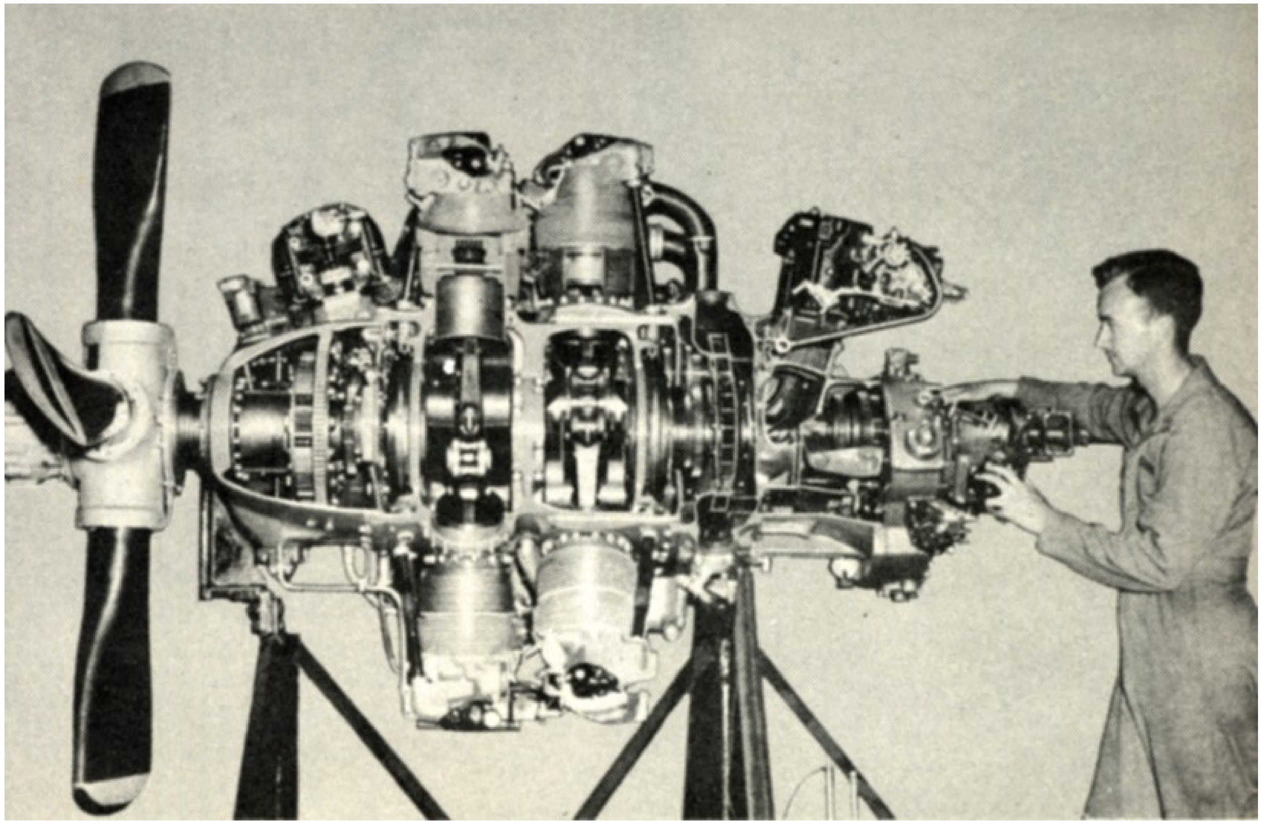
Here are some illustrations to show how an engine may be configured as more cylinders are added.



The more cylinders you add to an engine, the more heat it produces. Eventually, engine manufacturers started to add additional “rows” of cylinders. Sometimes two engines would literally be mated together, with the 2nd row being rotated slightly so the cylinders could get a direct flow of air.

The Pratt & Whitney R2800

Pratt & Whitney took this even further, creating the twin-row, 18-cylinder R-2800. As you can see, there are a lot of moving parts on this engine.



Torque vs Horsepower

Torque is a measure of twisting force. If you put a foot long wrench on a bolt, and applied 1 pound of force at the handle, you would be applying 1 foot-pound of torque to that bolt. The moment a spark triggers an explosion, and that piston is driven down, that is the moment that piston is creating torque, and using that torque to twist the crankshaft. With a more powerful explosion, comes more torque. The more fuel and air that can be exploded, the more torque. You can increase an engine's power by either making bigger cylinders, adding more cylinders, or both.

Horsepower, on the other hand, is the TOTAL power that engine is creating. Horsepower is calculated by combining torque with speed (RPM). If an engine can produce 500 foot pounds of torque at 1,000 RPM and produce the same amount of torque at 2,000 RPM, then that engine is producing twice the HORSEPOWER at 2,000 RPM than it is at 1,000 RPM. Torque is the twisting force. Horsepower is how fast that twisting force is being applied.

If your airplane has a torque meter, keep that engine torque within the limits or you can break internal components. Typically, an engine produces the most torque in the low to mid RPM range, and highest horsepower in the upper RPM range.

Chapter 3: Accu-Sim and the P-47 Razorback

Developed for:

Microsoft Flight Simulator X

ACCU-SIM EXPANSION PACK

Accu-Sim Expansion Pack upgrades core areas of Microsoft Flight Simulator X to provide the maximum amount of realism and immersion possible. Each pack is developed and tailored to a specific aircraft. Our second Accu-Sim pack has been created for our latest and greatest, A2A Simulations P-47 Razorback aircraft.

WHAT IS THE PHILOSOPHY BEHIND ACCU-SIM?

Real pilots will tell you that no two aircraft are the same. Even taking the same aircraft up from the same airport to the same location will result in a different experience. For example, you may notice one day your engine is running a bit hotter than usual and you might just open your cowl flaps a bit more and be on your way, or maybe this is a sign of something more serious developing under the hood. Regardless, you expect these things to occur in a simulation just as they do in real life. This is Accu-Sim – it puts the gauge back in the game.

Realism does not mean having a difficult time with your flying. While Accu-Sim is created by pilots, it is built for ***everyone.*** This means everything from having a professional crew there to help you manage the systems, to an intuitive layout, or just the ability to turn the system on or off with a single switch. However, if Accu-Sim is enabled and the needles are in the red, there will be consequences. It is no longer just an aircraft, it's a simulation.

ACTIONS LEAD TO CONSEQUENCES

Your A2A Simulations Razorback is a complete aircraft with full system modeling. However, flying an aircraft as large and complex as the A2A Razorback requires constant attention to the systems. The infinite changing conditions around you and your aircraft have impact on these systems. As systems operate both inside and outside their limitations, they behave differently. For example, the temperature of the air that enters your carburetor has a direct impact on the power your engine can produce. Pushing an engine too hard may produce just slight damage that you, as a pilot, may see as it just not running quite as good as it was on a previous flight. You may run an engine so hot, that it catches fire. However, it may not catch fire; it may just quit, or run really poorly. This is Accu-Sim – it's both the realism of all of these systems working in harmony, and all the subtle, and sometimes not so subtle, unpredictability of it all. The end result is when flying in an Accu-Sim powered aircraft, it just feels real enough that you can almost smell the avgas.

YOUR AIRCRAFT TALKS

Well, it doesn't come with a talking crew like the Boeing 377 Stratocruiser, but we have gone to great lengths to put in realistic sounds that will help you know how your aircraft is running. Now, when the engine coughs, you can hear it and see a puff of smoke. If you push the engine too hard, you can also hear signs that this is happening. Just like a real pilot, you will get to know the sounds of your aircraft, from the tires scrubbing on landing to the stresses of the airframe to the canopy that is cracked opened.

BE PREPARED – STAY OUT OF TROUBLE

The key to successfully operating your P-47 is to stay ahead of the curve, and on top of things. It's a complex but quite robust and tough aircraft. We have included for you, the pilot, a little “Pilot Notes” panel where you can manipulate things that in the real aircraft may be out of sight, such as the intercooler and oil cooler flaps.

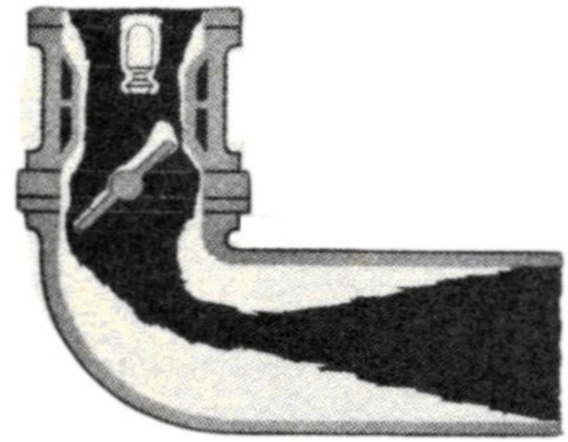
KEY SYSTEMS TO WATCH

CHT (Cylinder Head Temperature). This is a measurement of the actual cylinder heads in the engine. This temperature is quick to heat up and cool down (unlike your oil temperature which takes longer to change). This is your most critical area to watch. Running the engine too hot can quickly result in catastrophe. Never let these temps get above 260 degrees, as you not only risk engine damage but fire. THE MOST COMMON MISTAKE for a junior pilot is FORGETTING TO REDUCE POWER AFTER TAKEOFF. If you watch your CHT temp during takeoff, through your little 2D “Pilot's Notes”, you will see how fast the temperature rises when full power is applied. Make sure you do not begin your takeoff run with a hot engine (over 170 degrees) or you could be overheating the engine shortly after you lift off at the end of the runway.

KEY THINGS TO KEEP CHT IN CHECK

1. Open Cowl Flaps
2. Reduce power immediately after takeoff to climb power
3. Do not climb too steeply to ensure adequate airflow – keep speeds over 165mph

CARBURETOR ICING
If the temperature is right and there is moisture in the air, you can experience carburetor icing. Carb icing is dangerous as it can cause your engine to quit in flight if you do not recognize the symptoms and respond accordingly. The P-47 does not have CARB HEAT like many other aircraft since a **heater is not needed to eliminate icing.**



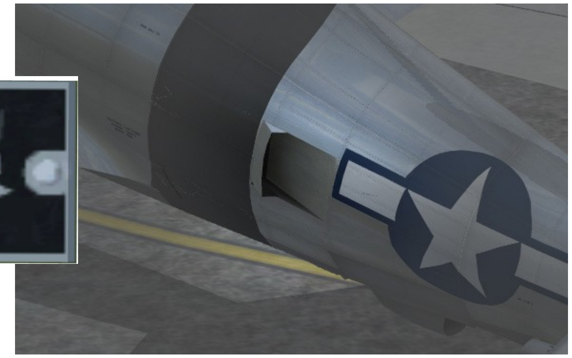
Carburetor icing is evidenced by a loss of power, loss of airspeed, and a decrease in the carburetor air temperature. To counteract, close the intercooler shutters. If the carburetor air temperature doesn't rise to above 12 degrees, cut in the turbo-supercharger. Apply the remedies as long as icing persists.

If the supercharger is not effective in eliminating carburetor icing with reduced power settings, keep up your power and reduce speed by lowering the landing gear and using partial flaps.

CARBURETOR AIR TEMPERATURE (CAT)
This is the temperature of the air before it enters your engine. Use your INTERCOOLER flaps to keep CAT in check. These flaps are located at the left and right rear sides of the aircraft. When closed or opened, they put extra drag on the airframe. When in neutral, they provide the least amount of drag.

TURBO BEARING TEMPERATURES

As you climb, your turbo will work harder and spin faster to continue to keep a good supply of air coming into your engine. The harder it works, the hotter those bearings get. While you do not have a turbo bearing temperature gauge in the P-47, as we have in our Boeing 377, Accu-Sim simulates and monitors these bearings heating up as they are used. Hot turbo bearing temperatures should not be an issue until you start to reach altitudes over 20,000 feet. You must be careful. You can't just run these turbos at full blast at high altitude, as they will run too fast. Faster turbo RPM = higher turbo bearing temperatures.



The turbo RPM has a 20,000 RPM redline. You can, however, push this to 22,000 RPM for 15 minutes only. This is not advised unless there is an emergency that requires this maximum power. If you run it hard, temps will eventually rise and you will have to back off. If you choose to ignore these limits and run these turbos well above their turbo bearing temperature limits, they could fail. A failed turbo at high altitude is serious, as it pretty much takes that engine completely out until you get to lower altitudes. Be careful, once a turbo fails, there is no getting it back until the ground crew can repair or replace it for you.

The turbo RPM gauge should be monitored periodically while the turbo is in operation to keep temperatures within their proper limits.

Also, as a general rule, never advance the turbo boost lever past the throttle. Lead with throttle, then follow with the turbo boost lever. Watch your manifold pressures carefully as it is very easy to overboost this engine.

MANIFOLD PRESSURE

The manifold pressure in your P-47 is your best way to judge the power your engine is producing. However, be aware that manifold pressure is simply the pressure of the air before it enters your engine and, more accurately, is an indication of "potential"power.

Assuming manifold pressure is the same, the following things can affect the actual power your engine is producing:

1. ADI (Water Injection). When you apply high power without water injection activated, the auto mixture system adds more fuel to keep the engine cooler (rich rich). This extra fuel is not burned and actually reduces the power the engine can produce. When you turn ADI on, the auto mixture becomes leaner (power rich) and produces between 10-15% more power at the same manifold pressure.
2. Mixture. If your mixture is too lean or too rich it will produce less power than if it is at the optimum power-rich setting. Your mixture is constantly changing based on the power your aircraft is producing. In certain circumstances, Auto Lean can produce more power than Auto Rich since at high power settings more fuel is added to keep the engine cool. If the power is high enough, Auto Lean may actually provide the best power mixture. However, you do not want to apply high power with Auto Lean, this is just something you should be aware of.
3. Engine health. An old worn engine will not have the tight compression a new engine will have and this older engine will produce less power than the newer one at the same manifold pressure.
4. Carb Air Temperature. For the most part, cooler air is denser and will produce higher manifold pressure, but manifold pressure and power output can be inconsistent at different carb air temps.
5. RPM. Higher RPM means higher power output. Never use low RPM and high manifold pressure. This condition can create critically high torque and stress a motor.

OIL PRESSURE
Accu-Sim models oil thickness (viscosity). The colder the oil temp, the thicker it is, and the more oil pressure there is in the engine. If you start your engine on a cold morning, you may see oil pressures as high as 150 psi. This is far above the limit and it is critical that you do not push the engine with cold, thick oil. Pushing an engine with thick, cold oil can damage the oil system.

You have two options if you have just started a very cold engine:

1. Idle below 1,200 RPM and wait until the oil temperature warms and pressure drops.
2. Turn oil dilution on.

OIL DILUTION
When you turn oil dilution on, you are injecting fuel into the oil which breaks the oil down and thins it out. To dilute your oil, make sure the engine is idling and turn oil dilution ON for 2-4 minutes, or until oil pressure is at the desired level. Once the oil pressure is within safe range and you take off, the oil will heat up and burn off the fuel, returning it to its normal condition.

Also, if you are about to stop your motor and anticipate the engine will be cold (around freezing or below), you should idle the engine, turn on oil dilution for 4 minutes, then stop the engine. If the oil temp is over 70 degrees, oil dilution is not effective as the fuel burns off too fast. In this case, wait until the oil temp gets between 40-60 degrees, then dilute. If you cannot get your oil temp that low, stop the engine, wait until the oil cools, start it back up, dilute the oil, then shut it down. Save your flight. The next time you start, your oil will be diluted, which means easier starting and less risk of damage.

ENGINE PRIMING
Accu-Sim models the priming system which basically pumps fuel into the intake so the engine can start. If you do not prime the motor prior to starting, it is unlikely it will start. Over priming can also make for hard starts. If you do over prime, wait a few minutes then try to start again. In cold weather, use 4-6 prime strokes and in hot weather 1-3 prime strokes.

INERTIA STARTER

The Pratt & Whitney R2800 is a big heavy engine, and turning it over to start requires a lot of power. A conventional starter is heavy and back in the 1940's during wartime, lowering weight was critical. The solution was an inertia starter. Basically, an inertia starter starts by spinning a wheel up to very high speeds (takes up to 20 sec to reach its maximum RPM), then engage that spinning wheel to the engine. If you have ever jump started a car, the inertia starter uses the same principle. When you push a car and "pop it" into gear, you are taking the stored energy (momentum) in the moving car and using that energy to turn the motor. In the case of the inertia starter, the energy is stored in the spinning wheel. When you engage this spinning wheel, the prop will lunge ahead. You may get 5 or 6 blade moves before the energy is absorbed and the engine stops. In this case, start the process over again.

To start, make sure the engine is properly primed and crack the throttle open. Click the starter switch to the LEFT to ENERGIZE. You will hear the wheel begin to spin. In about 10-20 seconds, you will notice the wheel is at its peak speed. At this moment, move the starter switch to ENGAGE.

DROP TANKS AND ORDNANCE

You can use the loading screen to load up a wide variety of ordnance combinations. Be aware, with Accu-Sim we model the actual drag of these tanks and weapons. The drag of large belly tanks or rockets can be extreme, and you may find speeds over 200mph are difficult or climbing to high altitudes impossible. You may also hear a rumble as you fly at higher speeds. Listen to this rumble – it is the air buffeting as it pushes hard on these components.

LANDING GEAR

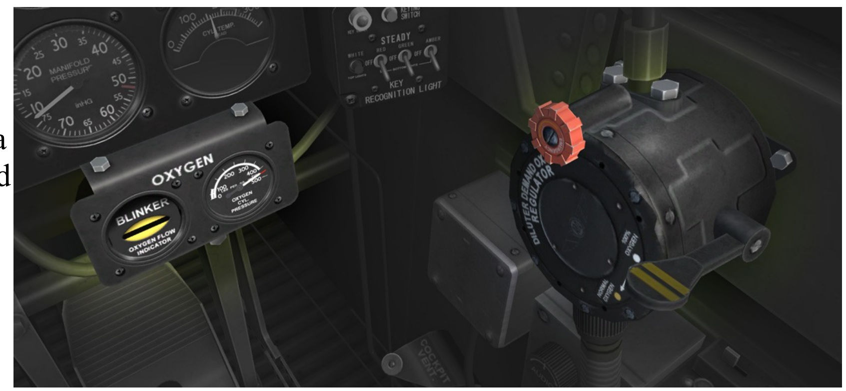
Do not lower your landing gear if you are above 200mph IAS (indicated airspeed). Moving the gear under these speeds can damage or jam it. Once the gear is down and locked, you can go as fast as 250mph IAS before you are in danger of damaging it. The landing gear not only creates enormous drag, but does so out on each wing. To make matters worse, the left and right landing gear do not operate in sync. So, as you drop your gear, one wheel may pop out while the other is still in the wheel well. At this point, you will experience a possible extreme yaw to that side. This is normal and is experienced in the real P-47.

FLAPS

Do not lower your flaps above 195mph IAS. Doing so can damage, jam, or possibly even break your flaps. Accu-Sim measures the forces on the flap based on the actual air pressure on the flap itself. As the flap moves to higher angles, the pressure (and drag) quickly builds up. If you were to, for example, jam your left flap down and then raise your flaps, you could be in a dangerous situation. If this happens, lower your flaps until they are equal and land at the nearest airfield. If you were to break a flap at high speeds when deployed, your aircraft could immediately go into an uncontrollable flying attitude. Watch your speeds and LISTEN to your aircraft.

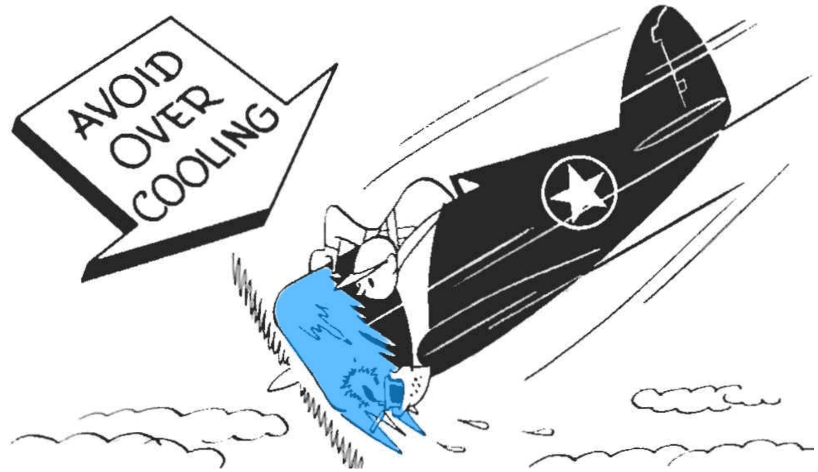
OXYGEN AND HYPOXIA

The higher the altitude, the thinner the air, and the less oxygen available for each breath you take. Without an oxygen mask, above 12,500 feet you can start to feel the effects of hypoxia (oxygen starvation). Hypoxia is very dangerous as it can sneak up on a pilot without him realizing, and render him unconscious. As you gain experience as a pilot, you learn to notice these signs.



Accu-Sim has secret and subtle ways to let you know you are starting to experience hypoxia. At some point, you may notice your breathing is heavy. If this happens, make sure your oxygen is working properly. If not, IMMEDIATELY dive to lower altitudes. If you end up not responding to these signs and pass out, you will lose complete control of the aircraft. Only when you return to lower altitudes will you awaken.

CYLINDER HEAD AND OIL TEMPERATURE. Engine temperatures will rise based on the power, air temperature, and the air flow through the engine. Use common sense and make gradual adjustments with power and speed. Avoid high power, steep climbs, and low power descents with cowl flaps opened.



WATER INJECTION (ADI). Your ADI is basically water injected into the engine to keep temperatures down so you can push the engine harder (run higher manifold pressures). If your ADI is OFF, and you are applying HIGH POWER, your engine will automatically enrich the mixture to a RICH RICH to keep your engine cooler. You will notice black smoke under these conditions. Do not be alarmed, but be aware you should never apply FULL POWER with ADI OFF. Doing so can cause permanent engine damage.

ENGINE HEALTH. Every time you load up your Accu-Sim P-47, you will be flying the continuation of the last aircraft. Things will sometimes be different, however. The gauges are never exactly the same. There are just too many moving parts, variables, changes, etc., that continuously alter their condition. Sometimes, however, your engine may be running too hot, or may just not be producing the same power. You will need to learn to keep an eye on that one engine until you get your plane on the ground so it can be looked at by maintenance.

Signs of a damaged engine may be lower RPM, lower torque values, lower manifold pressure, or possibly hotter engine temperature.

SOUNDS
Microsoft Flight Simulator X, like any piece of software, has its limitations. Accu-Sim breaks this open by augmenting the sound system with our own, adding sounds to provide the most believable and immersive flying experience possible. The sound system is massive in this Accu-Sim Razorback and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, gear doors and hydraulics, cowl flaps, intercooler flaps, oil flaps, inertia starting, dynamic touchdowns, authentic simulation of air including buffeting, shaking, canopy, turbine whine from the turbocharger, jammed flaps, broken flaps, jammed gear, oxygen sounds, primer, and almost every single switch or lever in the cockpit is modeled. Most of these sounds were recorded from the actual aircraft and this sound environment just breaks open an entirely new world. However, as you can see, this is not just for entertainment purposes; proper sound is critical to creating an authentic and believable flying experience.

PHYSICAL GAUGES
Each gauges has mechanics that allow it to work.   Some gauges run off of engine suction, gyros, air pressure, or mechanical means. The RPM gauge may wander because of the slack in the mechanics, or the gyro gauge may fluctuate when starting the motor, the magnetic compass, which is sitting in oil, will yaw to the side and may be moving back and forth so much you cannot read it until it settles, or the gauge needles may vibrate with the motor or jolt on a hard landing or turbulent buffet. The gauges are the windows into your aircraft's systems and therefore Accu-Sim wants these to be real.

BATTERY
Accu-Sim installs a more authentic battery than is available by the default Microsoft FSX system. This battery can last 30 minutes with the engine stopped if you do not abuse it. The available power capacity for this battery is less in cold weather, just like a real battery. Your main source of draw on your battery is when you run your inertia starter. You should be OK as long as you get your aircraft started in the first several attempts. If you fail to do so, you can always bring up the CONTROLS panel (SHIFT-3), click on “recharge battery,” and start the engine. If you drain your battery and then start the engine, your amp meter may read a bit too high. This is normal as your generator is

charging the battery.

LANDINGS

Accu-Sim watches your landings, and the moment your wheels hit the pavement, you will hear the appropriate sounds (thanks to the new sound engine capabilities). Slam it on the ground and you may hear metal crunching, or just kiss the pavement perfectly and hear just a nice chirp or scrub of the wheels. This landing system part of Accu-Sim makes every landing challenging and fun.

ENJOY

Accu-Sim is about maximizing the joy of flight. We at A2A Simulations are passionate about aviation, and are proud to be the makers of both the A2A Simulations Razorback, and its accompanying Accu-Sim expansion pack. Please feel free to email us, post on our forums, or let us know what you think. Sharing this passion with you is what makes us happy.


G8

CREDITS

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Accu-Sim

A2A simulations

"Passion for Flight"