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CHEROKEE

ACCU-SIM CHEROKEE 180

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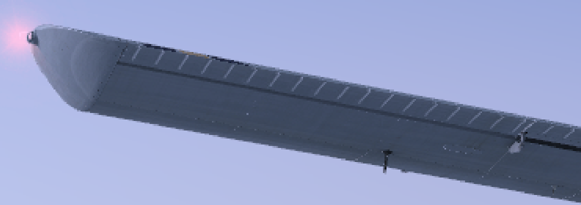


PIPER CHEROKEE PA-28-180 AN AEROPLANE FOR THE REST OF US

By Mitchell Glicksman

This flying machine may rightly be called a "Goldilocks" aeroplane. It is not too big and not too small, not too complex and not too simple, etc. The Piper Cherokee 180 is, as the little flaxen-haired girl so famously declared, "Just right!"

The entire PA-28 Cherokee line from the humble two- seat 150 h.p. PA-28-140 to the swift, retractable undercarriage PA-28R-200 Arrow, to the powerful, heavy load-carrying 235 h.p. PA-28-235 Dakota, is respected as being one of the most popular, commercially successful series of aircraft containing within some of the most pilot-friendly aeroplanes ever built. Each member of the Cherokee family fills its particular niche at least as well as, and often better than other aircraft of similar type. However, of all of the many Cherokees the Cherokee 180, sitting as it does right in the middle of the pack has proven itself to be most popular and justifiably so.

Introduced to the public in 1961, the first Cherokee, the 150 hp PA-28-150 was immediately well-received setting the pace for its later siblings who went on to provide pilots of all levels of experience with honest, dependable and well-performing aircraft which are fun and satisfying to fly, reliable, safe and economical to own and operate. However, getting to this place took some time and some very astute business and aeronautical skills and sense.

HIGH FLYING ON HIGH WINGS

After a necessary hiatus during World War II the industry known as "General Aviation" (GA) which encompasses all privately (as opposed to government and airline) owned aircraft recommenced in a far better economic environment, the Great Depression not actually having ended until the U.S. entered W.W.II on December 8, 1941. For the first post-war years of the later 40's, however, it was very slow going in the GA market. The virtually universally held high expectations that droves of ex-service pilots would enthusiastically seek to own their own aeroplanes turned out to be more than somewhat optimistic.

As the turbulent and violent early 40s and the uncertain, transitory late 40's passed into history, and after

1961 Piper PA-28-150 Cherokee 150

A real Piper J-3 "Cub"

1948 Stinson 108-2

1947 Luscombe 8a Silvaire

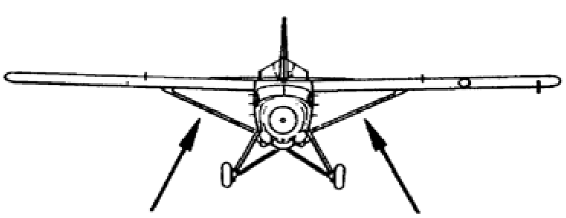
1948 Taylorcraft BC-12d

1950 Aeronca 7AC Champ

the first three years of the next decade in which a new, smaller, but no less vicious conflict in Korea came and went, a new, thriving American middle class began to enjoy the substantial positive changes engendered by the new peacetime culture and economy. As the economic boom of the '50s began to improve the lives of so many, all markets, and no less the GA market, began to grow and thrive as well. By the end of the '50s very few aircraft of the pre-war era were still being manufactured; however, in their place promising, new, exciting, and for those times revolutionary aeroplanes began to become available.

But old conventions die hard. In the immediate post-war era and for more than a decade most GA aeroplanes still had wings which sat up atop of the fuselage (known as the "high wing" design) as they had in the pre - war years. The prominent post-war manufacturers of GA aeroplanes, Piper, Cessna, Taylorcraft, Stinson, Aeronca, Luscombe and such all exclusively offered aircraft with high wings and, naturally, that was how the public pictured all GA aeroplanes, all of which they generally deemed to be "Piper Cubs".

The prolific and successful high-wing design has a number of virtues: it is easier to design and build a wing which does not have to support itself (non-cantilever), but which may be held up with struts attached to the wings and the bottom of the fuselage. The high- wing



A. NONCANTILEVER WING WITH EXTERNAL SUPPORTS.

B. CANTILEVER WING WITH NO EXTERNAL SUPPORTS.

Left: 1947 Cessna 190 showing an unusual cantilever high wing

design was also the choice of most GA aircraft manufacturers because a strut- braced wing is economical to build being that it is lighter, thinner, and requires fewer parts than a cantilever wing. Except for aeroplanes like the Cessna 190/195 models, the Helio Courier STOL (short take-off and landing), and the Dornier Do. 27/28, high-wing aeroplanes of the 50's were virtually all strut braced.

Of course, the struts themselves add back some the weight savings of a non-cantilever high wing and additionally impose a drag penalty which the cantilever wing design, requiring no support struts, does not. However, while more aerodynamically clean, the weight penalty of the heavier and bulkier cantilever wing may be as great a detriment in its way to overall aircraft performance as is the drag coefficient produced by wing support struts. Properly designed, a wing strut's production of drag may be minimised. Aside from economical concerns, another of the virtues of a high-wing design is that the pilot's and passengers' are granted an almost unobstructed view of the ground during flight. In addition, for purposes of visual navigational orientation as well as for sightseeing, a high wing gives good service.

Today, and since the introduction of the Cherokee series of aircraft in 1961, Piper Aircraft has come to be known as a manufacturer of mostly low- wing GA aeroplanes, the PA-18-150 Super Cub being the lone exception. However, for 24 years, from its founding in 1930, when businessman and oil speculator William T. Piper purchased the assets of the bankrupt Taylor Aircraft Company for $761.00, except for a small number of interesting Piper low-wing prototypes along the way (PT-1 Trainer-1942, PA-7 Skycoupe-1944, PA-6 Skysedan-1945, and PA-8 Skycycle-1945, none of which went into production), Piper Aviation had exclusively produced high- wing aircraft until the twin-engine PA-23 Apache in 1954. The Taylor/Piper Cub and its progeny, the PA-15/17 Vagabond, the PA-16 Clipper, PA-18 Super Cub and the PA-20 Pacer with its variants including the revolutionary tricycle- undercarriage PA-22 Tri-Pacer were all high- wing, fabric- covered aeroplanes. The PA-22 Tri-Pacer which was introduced to the public as early as February 1951 predated Cessna's first tri-gear singles, the 172 and 182 by five years.

Typical wing struts

1960 Piper Pa-18-150 Super Cub

1954 Piper PA- 23-150 Apache

Piper Pa-22-150 Tri-Pacer

THE BONANZA BONANZA

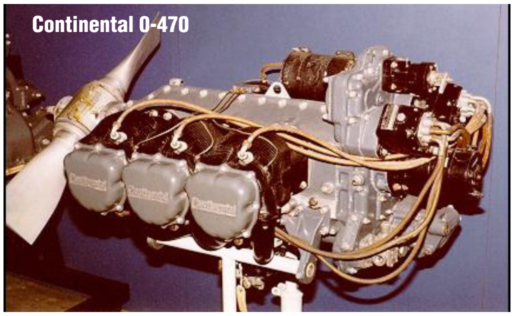
Of course, amongst all of this GA high-wing high-jinx there were a few exceptions with one very strong standout, the remarkably prescient Beechcraft Bonanza Model 35, designed in 1945 and introduced in 1947. Well named, this aeroplane was a remarkable economic success for Beechcraft, the first GA success story of the immediate post-war times. In fact, it was the enormously positive response to the Bonanza in 1947 that fuelled many GA aircraft manufacturer's starry-eyed optimism and belief in the sales boom that never happened.

Designed by Ralph Harmon and his associates in 1945 as the war was coming to an end, Bonanza Model 35 had its first test flight on December 22, 1945. Incorporating what was then known of aerodynamics, aviation technology and modern manufacturing techniques, its clean, stressed skin (monocoque) all-metal structure was reminiscent of the recently lionised Spitfires and Mustangs and in many ways was a distinct departure from previous GA aircraft. With a retractable undercarriage, V-tail, seats for four adults, constant speed propeller and powered by a simple to manage and inexpensive to run six-cylinder, horizontally opposed, air cooled 165 hp Continental 0-470- E165 engine, it was the first of a new breed.

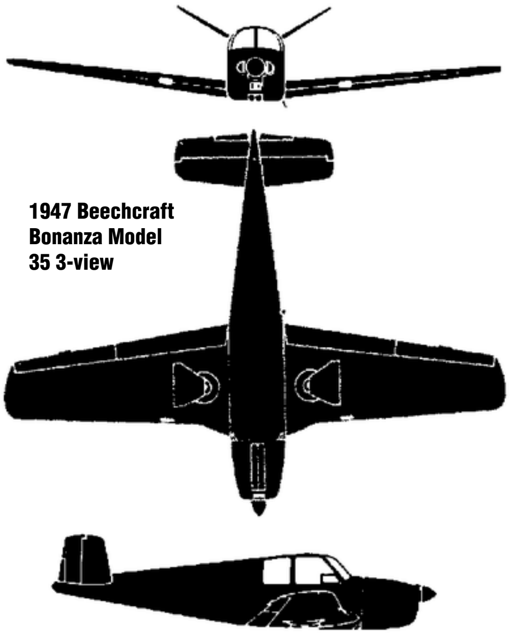
In its class and for its time the Bonanza was the epitome of aeronautical design and engineering — fast, sturdy, and looking like nothing that had come before. Sure, it was pricey at the then great sum of $7,975.00 ($7,975.00 in 1947 had the same buying power as $85,165.95 in 2013, annual inflation over this period being 3.65%), but to its purchasers it was worth every dime. Upon its introduction, corporations, businesses and wealthy professionals placed almost 1,500 orders in advance of its release making the Bonanza an unqualified and immediate roaring success.

While Cessna and many other manufacturers seemed to be still tied to old, pre-war designs and concepts, Beechcraft's Bonanza was an entirely new breed, a leap forward that looked like and in every way was "the very model of a modern" aeroplane. Throughout the 50's the Bonanza's sales continued to soar and its place at the top of the food chain remained essentially unchallenged.

1947 Beechcraft Bonanza Model 35 instrument panel with 50's style non- "T" instrument layout and early classic Narco "Omnirange" VOR receiver as almost an afterthought. Note- no ILS equipment and 30's-40's throwback throw-over yoke system, toe brakes only on left rudder pedals.



Continental 0-470



1947 Beechcraft Bonanza Model 35 3-view

1947 Beechcraft Bonanza Model 35

1958 Piper PA-24-250 Comanche with one - piece windshield and aftermarket spinner

1960 Piper PA-24-250 Comanche instrument panel with 50's style non- "T" instrument layout. As in contemporary Bonanza, radios seem to be almost an afterthought. Note- modern-style VOR but no ILS equipment, dual controls but toe brakes on only left rudder pedals, large flap handle but no Johnson bar brake handle.

THE BONANZA KILLER

Most painfully cognizant of the Beechcraft Bonanza's well-deserved success, by the end of the 1950s Piper Aviation was anxious to produce its own modern, all metal, retractable undercarriage, high performance single-engine aeroplane. Seeking to enter and to dominate the high-performance GA business aeroplane market and unseat the Bonanza, Piper Aviation made ready to topple the King and to take its place on the GA high- performance throne.

To this end, Piper designed and developed the PA-24 Comanche, "The Bonanza Killer". Piper Aircraft's ambitious intent was to not only put an end to the Bonanza's long- held high-performance single- engine commercial reign, but to put Piper firmly on the map as GAs leading and most advanced aircraft manufacturer. Piper knew that to do all of this would require an exceptional aeroplane, one that performed to the highest standards, was fast, comfortable and safe. Of all, this last requirement was key.

Piper Aviation has traditionally leaned heavily towards flight safety in its designs. Gentle and predicable stall characteristics, inter-connected rudder and ailerons to prevent inadvertent spins on some models, slow landing speeds and the like had been regularly and scrupulously designed into Piper aircraft from the beginning. Accordingly, by the mid 1950s Piper had not been historically known for producing fast, all-metal, high-performance aircraft; but all that was going to dramatically change before the decade was out.

TAKING THE LOW (WING) ROAD TO SLAY THE KING

William T. Piper knew that in seeking to enter the high-performance, single-engine business aeroplane market and challenging the iconic Bonanza that he was he was taking on a very tough, commercially risky task.

By January 1958 the first Piper PA-24-180-Comanche was delivered to the public. Its cruising speed at 75%

1964 Piper PA-24-250 Comanche with unpainted spinner, aftermarket one-piece windshield and tip-tanks

1967 Piper PA-24-250 Comanche with 3-blade propeller, aftermarket spinner, one-piece windshield and tip-tanks

1959 Piper PA-24-250 Comanche Note- tail low ground stance, large nose wheel and short main undercarriage legs.

at 8,000’ is 139 knots (159.85 mph) which in its day was excellent for a four-seat, 180 hp aeroplane, but not quite fast enough to seriously compete with the 165 knot (189.75 mph) 240 hp Bonanza 35H at 75% power.

The first low-wing GA aeroplane produced in over a decade, the Comanche was something new and exciting. A breathtakingly beautiful design, its novel swept-back tail, its gracefully tapering wings and sleek fuselage gave it the look of innovative modernity in the same way that Lancaire and the Cirrus aircraft appear to us today.

Accordingly, Piper began to immediately test the installation of a 250 hp Lycoming O-540 engine in the Comanche. The PA-24-250, introduced in April 1958 has a very competitive 75% cruise speed at 8,000’ of 160 knots (184 mph).

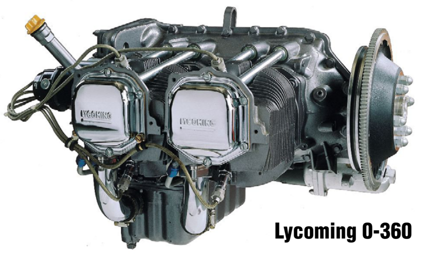
So, did the Comanche actually kill the Bonanza? Well, the answer is clearly, no. However, it did compete well with it and better in that regard than anything else in its time. Piper and Beechcraft continued to strive with each other until the Comanche suddenly ceased production in 1972, along with the excellent, sleek and speedy Twin-Comanche, as a result of catastrophic damage to Piper’s Lock Haven, PA factory caused by the record rising of the nearby Susquehanna River due to Hurricane Agnes. Today, as newer and even sleeker modern composite designs vie with it for top dog in the GA high-performance, single- engine market the Bonanza lives on, albeit in the shape (if not the name) of the venerable, conventional tail Debonaire, and is still in production with no end in sight.

While its time in the market as a new aeroplane was relatively short (1958-72), since its introduction the Piper Comanche has been and still is one the most highly- respected and desirable GA aeroplanes. A good one in good condition is considered a prime find on the used aircraft market. Today there are many thousands of loyal Comanche adherents who firmly believe, and with good reason, that it is the most beautiful, elegant and overall best performing single-engine GA aeroplane ever built. Right, Scott?

Second test proto-type of Piper PA-24-180 Comanche

1958 Beechcraft Bonanza H35 with tip-tanks

1959 Beechcraft Bonanza 35J



Lycoming 0-360

Piper PA-24- 250 all original

Piper PA-30- 160 Twin Comanche - R. I. P.

contemporary Beechcraft Bonanza G36

HOW ABOUT AN AEROPLANE FOR THE REST OF US?

Without any question, the Bonanza and the Comanche were and are very high performance single-engine GA aircraft aimed at distinctly well-heeled potential private/corporate owners. However, there also existed a significant segment of the GA market that wished to own a new, reasonably fast (if not the fastest), modern, all-metal, four-seat aeroplane, but who could not afford the Comanche's and especially the Bonanza's high price tag. FBOs (fixed-base operators), flight school operators and flying clubs were also looking for aircraft that they could rent out at rates that the average weekend private pilot could afford.

As the prosperous second half of the 1950s came to a close, Piper understood that the time of the fabric- covered Tri-Pacer and Colt had come to its end. Studies within Piper Aviation in the mid- 50's showed that with modern manufacturing techniques it was actually now more cost-effective to produce an all-metal aeroplane than to continue to produce the old school parts and labour- intensive, metal frame, fabric- covered Tri-Pacer and Colt.

Even with plans to build the Comanche already drawn, the factory tooling up to manufacture it, and with Piper's well-founded hopes and expectations that its new beauty would well-establish Piper Aviation in the high-performance single-engine, business aeroplane market, William T. Piper knew that if Piper was going to survive and flourish into the next decade and beyond that, further aeronautical invention and progress was wanted. He, his son Pug and the entire Piper team knew that they had to produce a new, modern entry to mid-market level aeroplane as soon as possible in order to compete with Piper's true rival, the only other major aircraft company that was actively and successfully servicing that segment of the GA market, Cessna.

Immediately upon the introduction of the all- metal Cessna 172 in 1956 Piper knew that its internal evaluations regarding the obsolescence of fabric-covered aircraft were indeed valid and that their then single-engine star, the Tri-Pacer, had already been eclipsed. While the exceptional Comanche had, in fact, turned out to be highly competitive in the high-end GA niche, giving the equally exceptional Beechcraft Bonanza a good run for the money, Piper well understood that in order to compete in and command a viable position in the entry/middle price market it needed to offer something new,

Rib- stitching a fabric covered Tri-Pacer's wing before doping — one of this process's many labour-intensive steps.

something that would give potential owners an attractive alternative to Cessna's popular 172.

Looking to produce a four-seat design which would be simpler and which could be produced less expensively than the complex, retractable gear, constant- speed propeller Comanche, Piper also knew that in order to be competitive in the lucrative trainer market they needed to build a replacement for the two- seat Colt which had been commercially greatly overtaken by the all metal Cessna 150. If these two needs could be resolved by one overall design, so much the better.

A product of the prosperity and economic confidence of the late '50's in the United States was a wave of new student pilots. Flight schools and clubs were popping up at virtually every local airport and business was very brisk. Since its introduction in 1958, the all-metal, two-seat Cessna 150 had become by far the most popular aircraft in this burgeoning trainer market. As the last of the J-3's, Aeronca Champs and other similar tail-wheel (then called "conventional undercarriage") aircraft began to disappear from attrition mostly due to tail-wheel induced taxiing and landing accidents, they were quickly being replaced by the tricycle undercarriage 100 hp Cessna 150 and, to Piper's disappointment, to a far lesser extent the 108 hp, two seat version of the old Tri-Pacer, the fabric- covered Piper Colt. It was understood that the old tail- wheel trainers did not offer as relevant a training experience to student pilots who looked for-

1961 Cessna 172

1959 Cessna 150

1960 Piper PA-22-108 Colt

1956 Cessna 172

1956 Cessna 172 interior

ward to soon flying higher performance aircraft, all of which had tricycle undercarriages.

Also, unlike the J-3, etc. where the student and instructor sit in tandem, in the new trainers the instructor and student sit side- by- side, facilitating communication as well as increasing the confidence of the student and making it easier for the instructor to demonstrate maneouvers and to teach the lesson. Additionally, and most significantly for FBOs, flight schools and clubs, with the advent of these new tricycle- undercarriage trainers, ground loops and nose overs whilst landing as well as collisions whilst taxiing became a thing of the un- mourned for past.

The Tri-Pacer shared the same market as Cessna's 172; however, except that they were both high-wing, four place aeroplanes of similar power, they actually shared few similarities, particularly with regard to construction and appearance.

Firstly, the Tri-Pacer was fabric covered whilst the 172 was all metal. The higher maintenance cost of a fabric covering as well as the anticipated expense of an inevitable fabric re-covering was a strong market motivator toward the all- metal l72.

Secondly, the Tri-Pacer's frame has many steel components within which can and do rust, and eventually cause major repair headaches. The 172's stressed-skin covered airframe is sturdy, low- maintenance and is all aluminium.

Thirdly, the Tri-Pacer, which had been introduced in 1951 was distinctly showing its age and was, in fact, something of an anachronism by the beginning of the following decade. Its foreshortened appearance gave it a somewhat stodgy look and sitting seemingly precariously upon its closely spaced undercarriage, it garnered the unfortunate nickname "Flying Milk Stool". Piper had to face it; the Tri-Pacer just didn't imply a clear and definite sense of modernity as surely as the Cessna 172. Taking everything into consideration, Piper saw the writing on the wall.

Ironically, the Tri-Pacer's performance is excellent, competing well with and in some instances beating the newer Cessna 172. The 160 hp Tri-Pacer climbs at approximately 800 fpm loaded at or near MGW with a top speed of 123 k (141.5 mph) and a 75% cruise of 117k (134.5 mph) at 7,500'. Its useful load is 890 lbs., and its take-off and landing performance as well as its slow and departed flight performance is overall better than the 172's. The Tri-Pacer is more responsive than the Cessna 172 and many pilots have found it to be more fun to fly. Nevertheless, by the end of the 1950's the more modern-looking Cessna 172 was running away with the middle GA market.

Before 1961 one might well be excused for thinking that with the exception of the low-wing twin-engine Apache, the Comanche and the Pawnee crop-duster that Piper leaned heavily towards the production of high-wing aeroplanes. After three decades and thousands of fabric-covered, high- wing Pipers this trend changed dramatically, marking the end of one era and

1959 Piper PA-22-150 Tri-Pacer

1967 Cessna 172/Skyhawk

1960 Piper PA-25-235 Pawnee crop duster

Left: Fred Weick's brilliant and innovative 1936 Erco 315CD "Ercoupe"

Center: Very rare photograph of experimental retractable Ercoupe

Right: Fred Weick with his Ercoupe Note- constant speed propeller with anti- icing boots

the beginning of a new one when the first of the all metal low-wing PA-28-150 and PA-28-160 Cherokees were introduced to replace the Tri-Pacer and the Colt which were then withdrawn from production.

CREATING AN AFFORDABLE LEGEND

In 1957, Karl Bergey, Assistant Chief Engineer at Piper's brand new Vero Beach facility which was built to design, test and ultimately manufacture the Cherokee, led the team of engineers and designers whose task it was to create an aeroplane that would establish the new, modern Piper Aviation in the present and secure it well into the future. Pug Piper sought to create a small team of engineer/designers who had reputations for having the foresight and imagination to create something new. To that end, Pug Piper's friend, the talented, progressive and imaginative 1928 Collier Trophy winner, Fred Weick was invited to join the team.

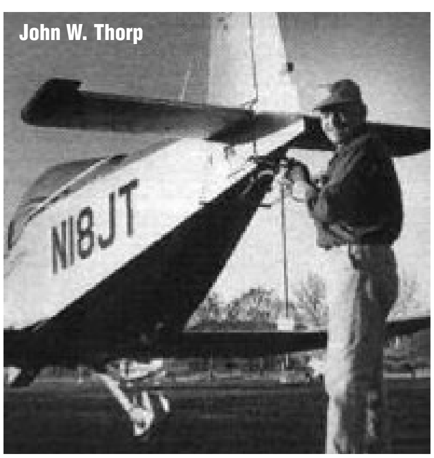
Weick was one of the first American aeronautical engineers who had, among other things, worked closely with the United States Postal Service in the early 1920s to establish and to develop the U.S. Air Mail Service. In 1925, whilst an engineer working for the National Advisory Committee for Aeronautics (NACA), Weick was the chief design engineer and responsible for developing streamlined cowlings to improve aerodynamic efficiency while enhancing engine temperature control. He also helped to design the first full-scale propeller wind tunnel.

By 1936, as chief designer at ERCO, Mr. Weick designed the revolutionary ERCO 310, better known as the "Ercoupe", designed to be virtually stall and spin-proof with integrated rudder and aileron controls (no rudder pedals), a crosswind resistant undercarriage, and one of the first aeroplanes designed with a tricycle undercarriage.

Both William Piper and his son, Pug greatly admired the extraordinary talents of the brilliant and prolific aeronautical engineer/designer John W. Thorp who agreed to join the team. In the course of creating the Cherokee this stellar design team found Thorpe's keen aeronautical mind to be a great and powerful resource. The design of the Cherokee ultimately greatly benefited from many of John Thope's ideas and from his excellent past designs. In particular, the team incorporated many features from Thorp's amazingly ahead of its time, the 1945 all- metal T-211.

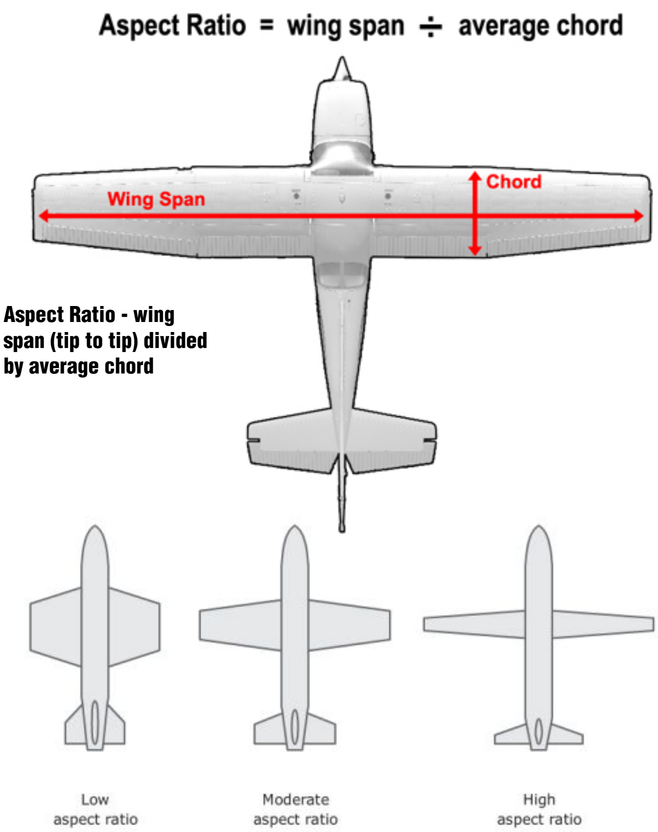
A MOST DELICIOUS WING

The first thing that Pug Piper told his team was that the new aeroplane would have a low wing for a new Piper look and so that drag producing struts of any kind could be avoided. He wanted Piper Aviation to build on the excellent reputation that the low-wing Comanche had already established and envisioned an aeroplane that would look and be as entirely different from the Cessna 172 as possible.



John W. Thorp

1945(!) Thorp "Skyshooter" T211 showing the true genesis of the Cherokee design. Note the Hershey Bar wing, undercarriage configuration, corrugated skin rudder and the stabilator with anti-servo tab.



Aspect Ratio - wing span (tip to tip) divided by average chord

An all metal, cantilever 160 sq. ft. (15.14 m^2), 30’ (9.2 m) span, 5’ 3” (1.6m) constant-chord (non-tapering) wing, popularly called the “Hershey Bar” wing because of its similarity in shape to that most famous rectangular confection, became the basic platform upon which this new aeroplane was built. This wing’s aspect ratio (span divided by chord) is on the low side at 5.63. This was not a problem or a new situation at Piper. The immediate predecessors of the Cherokee, the so- called “short wing” Pipers, the Vagabond, the Clipper, the Pacer, the Tri-Pacer and the Colt which the Cherokee series of aircraft was to replace had even lower aspect ratios. By comparison Cessna 172’s aspect ratio was 7.448.

It was a deliberate design choice to raise the new Cherokee’s wing’s aspect ratio a bit from the short-winged Pipers in order to increase its Cl (coefficient of lift) and thereby its efficiency. Up to a point, a higher aspect ratio wing promotes better high altitude cruise, climb and glide performance. However, a wing with a lower aspect ratio has at least one advantage — it has a higher critical angle of attack (Alpha), i.e., the positive Alpha at which it will stall; additionally the stall itself tends to be gentle. The old short-wing Pipers were not very efficient power-off gliders (I recall that the Colt, particularly, glided like a stone); however, they were extremely forgiving at low airspeeds and in extreme departed flight attitudes. They could, with sufficient power applied, seem to “hang on their propellers” with their noses sitting way up in the air whilst flying at very low airspeeds. It had been Fred Weick’s lifelong goal to build aeroplanes such as the Ercoupe that were easy to fly and by extension, safe. All agreed that forgiving flight characteristics would be a most attractive feature to the low-time pilots and FBOs that were Pipers commercial target.

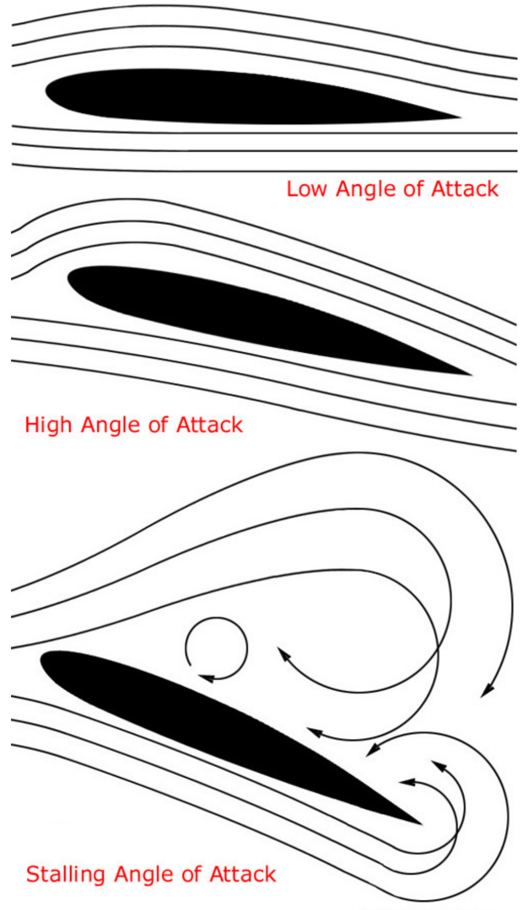
The team designed the Cherokee’s wing to be mounted at an angle of +2º to the fuselage’s longitudinal datum line in order to permit a distinctly nose-down attitude, thus promoting good forward visibility for the aeroplane’s occupants on the ground and in flight, and reducing P-effect (combination of twisting slipstream* and induced propeller yaw in the opposite direction of the turning of the propeller when at positive Alpha) during the takeoff run. They wanted to improve upon the Comanche’s distinctly nose-high stance on the ground which creates a good deal of P-effect on takeoff requiring lots of right rudder to keep it on the centreline.

*For what it’s worth, this writer does not hold very much with the theory of a twisting slipstream as a major P-effect force for a number of reasons to lengthy to go into here. Also, remember, P-effect operates in the yaw axis, torque in the roll axis.

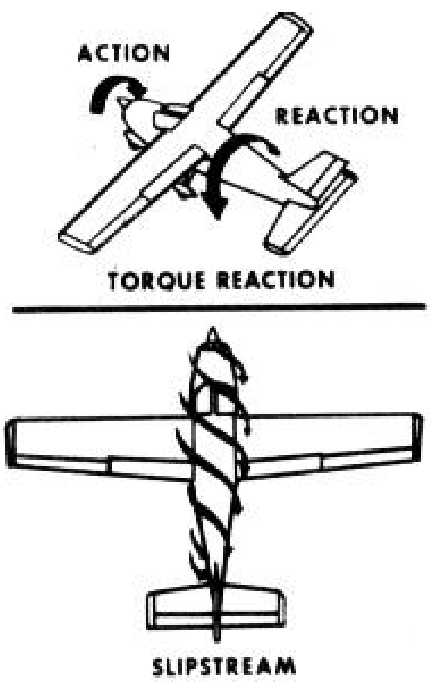
Being a low-wing aeroplane, the Cherokee’s overall vertical centre of gravity (C.G. v) is low, however, it is necessarily at a point above its low wing. This promotes poor stability in the lateral (roll) axis while enhancing maneouverability. While enhanced maneouverability is a good thing in a fighter, aerobatic show or sport aeroplane, it is not necessarily so good in an aeroplane

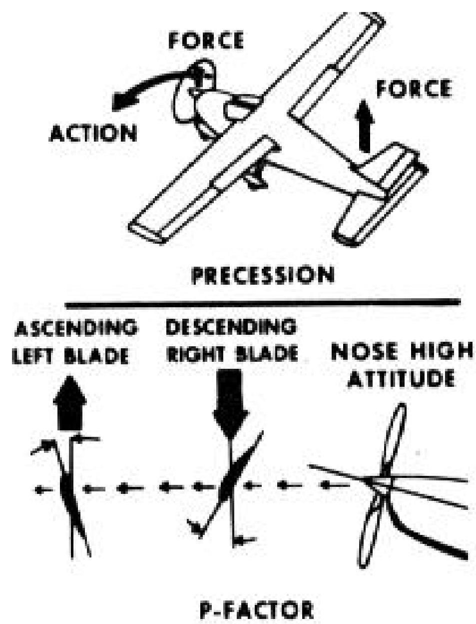
Left to right:
1) Piper PA-16 Clipper
2) Piper PA- 17 Vagabond
3) Piper PA-22 Pacer (Tri-Pacer in red above)
4)1964 Piper PA-28-140 showing original “Hershey Bar” rectangular wing



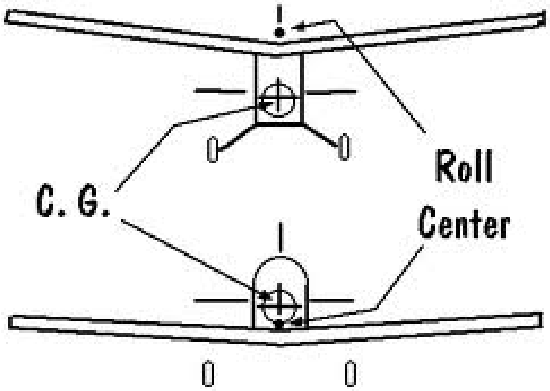


Angle of Attack (AOA) also called "Alpha"





P (propeller) -Effect



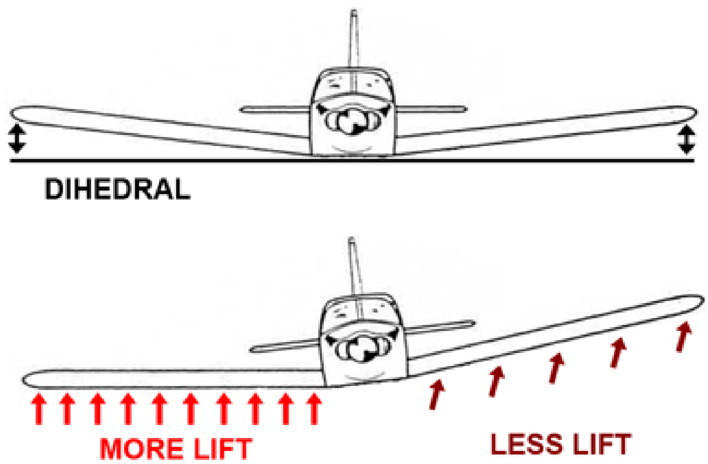
Hershey Bar Cherokee showing 7 degrees of dihedral
Cessna 172 showing 3.5 degrees dihedral

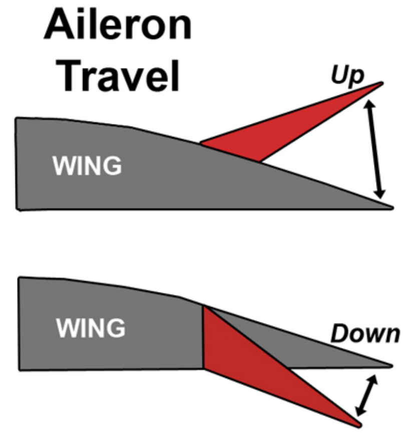
designed to be used for training new pilots and for comfortable and easy touring. To create good lateral stability a low- wing aeroplane requires dihedral, more dihedral than is required for a high wing aeroplane. Also, a low wing aeroplane requires greater dihedral to provide for adequate wingtip clearance when on the ground and when a wing may be lowered during a cross-wind landing. Accordingly, the Cherokee's low wing has 7º of dihedral which gives it very good lateral stability which is especially welcome on long trips and when in mildly turbulent conditions.

The vertical centre of gravity (C.G. v) of a high-wing aeroplane is also low, but at a point below the wing which promotes good stability in the lateral axis. This means that less dihedral is required for high-wing aeroplanes. Accordingly, the high wing Cessna 172's dihedral is only 3.5º.

Dihedral causes a self-levelling force to occur when the aeroplane is displaced from level in the roll axis. As any force, such as turbulence, begins to roll an aeroplane from level, the downward moving wing's Alpha increases, creating lift. In addition, the lowered wing assumes a more horizontal attitude than the higher wing and, concurrently, the lower wing creates more lift because of this, as well. Both of these effects tend to roll the aeroplane back towards level.

Of course, too much dihedral can lead to a reduced roll rate as well as over-sensitivity in turbulence, making for an uncomfortable ride in all but the calmest air. Compensating for its generous dihedral, the rectangular wing Cherokee's large and most effective ailerons produce a rapid roll rate which is faster than that of most GA aeroplanes. This is due in part to the reduced lateral damping effect of the low aspect- ratio, slightly foreshortened Hershey Bar wing. The Cessna 172's wingspan is 6' greater than that of the rectangular wing Cherokee and, accordingly, it creates more lateral axis damping which somewhat reduces its roll rate. Accord-





Differentially rigged ailerons

ingly, the Cherokee is maneouverable, laterally stable and rides quite well in all kinds of turbulent air. Accordingly, it seems that the Cherokee's wing's dihedral, like so much else about this aeroplane, appears to be just right.

Adverse yaw is the tendency for an aeroplane's nose to yaw in the opposite direction of bank and is caused by the rising wing pulling back because of increased induced drag created by lift. To reduce adverse yaw, virtually all modern aeroplanes, including the Cherokee, have ailerons which are differentially rigged; that is, there is more upward aileron movement than down, causing there to be less lift- induced drag in the rising wing and thereby reducing its tendency to yaw the aeroplane away from the turn.

To simplify the Cherokee's construction and to keep costs to a minimum, a few new wing mounting techniques were incorporated. As mentioned, the Comanche's left and right wings are joined in the middle in the factory making the wing one piece. The entire wing is then attached to the bottom of the fuselage, the main spar being bolted to a receiving 3-sided box. This construction makes for a very strong +7g wing, perhaps stronger than necessary in a non-aerobatic GA aeroplane. It is also quite costly. Piper's team looked for another way to mount the wing to the fuselage that would be strong enough but also simple and economical.

What they came up with is this: The Cherokee's wings are attached individually to each side of the fuselage. Each of the Cherokee's wings' main spar is in the form of an "I" beam which is inserted into to a box beam built as a part of the fuselage frame located under the rear passenger's seat, spanning the width of the fuselage. Once the wings' spars are seated within the box beam they are secured with eight heavy bolts essentially making the wing one piece. The inner ends of the forward and aft wing sub- spars are bolted to the fuselage through matching mounting plates in the wing root and on the fuselage. This greatly simplifies assembly as well as making major wing repairs or replacement less expensive. An additional plus is that this method of mounting the wings separately permits the use of a much shorter shipping crate, thus saving transportation costs of the unassembled airframe.

Piper reports that it has thoroughly tested the Cherokee's wing mounting system, running at least 480,000 load and unload cycles with no damage to the wing mounts.

The Cherokee's constant-chord, rectangular wing planform did not, however, come about without some friction and dissent within the design team. "Pug" Piper wanted tapered wings as on the Comanche, both for aesthetic and aerodynamic reasons. Both Thorp and Bergey also initially thought that a tapered wing for the new aeroplane would be best even though Thorp, in particular, had been a long-time, outspoken advocate of non-tapered wings for GA aircraft (see the Thorp T-112).

Supermarine Spitfires showing elliptical wings

The team considered a tapered wing for three basic reasons:

At first, Karl Bergey was, as was his boss, Pug Piper, in favour of a tapered wing for the new design which he said more closely emulated the commonly accepted ideal wing plan form, the ellipse, as found on R. J. Mitchell's spectacular and beautiful Supermarine Spitfire. Piper, Bergey and Thorp initially agreed that an elliptical wing produces less overall lift-induced drag than a rectangular wing and is quite efficient.

The second argument for a tapered wing was that since the tapered outer part of the wing has a shorter chord it has less overall area than the inner part of the wing. This reduced wing area would cause less upward bending pressure on the root of the wing when in flight than if it the chord was constant to the tip. With less bending to worry about, a simpler, lighter inner wing structure could be designed.

The third and perhaps the most practical reason for a tapered wing (from a marketing perspective at least) was that they look sleek and aerodynamically "correct". Always most aware of the importance of marketing with regard to of any commercial product, Pug Piper, as had his father so many times before him, found this argument to be highly persuasive.

It looked like the Cherokee was going to have a tapered wing similar to the Comanche's when Thorp began to advocate for a rectangular wing instead. After ruminating about the issue for a while and he began to discount the structural argument for a tapered wing. He reasoned that the difference in the structural weight of a tapered verses rectangular wing of the same size was too small to consider. Combining this with his aerodynamic analysis he said that aerodynamic scale effect makes it possible to use a smaller rectangular wing (rather than a larger tapered wing) for a given stalling speed. He went on to explain that therefore the tapered wing, though possibly inherently slightly lighter, must ultimately be of greater span in order to provide equal wing area to that of the un-tapered wing, thereby erasing any weight saving.

As to the elliptical wing planform theory, Thorp rejoined Piper and Bergey's opinions and held that there was more to the issue than that so- called "ideal".

He argued that while the total of aerodynamic forces indeed seemed to favour an elliptical wing form, where the wing's chord was shorter near and at the tip of such a wing, or in any tapered wing seeking to emulate an elliptical form, the Reynolds Number (RN)* is similarly lower near and at the wing tip, therefore causing a great propensity for the wing tip to stall before the rest of the wing.

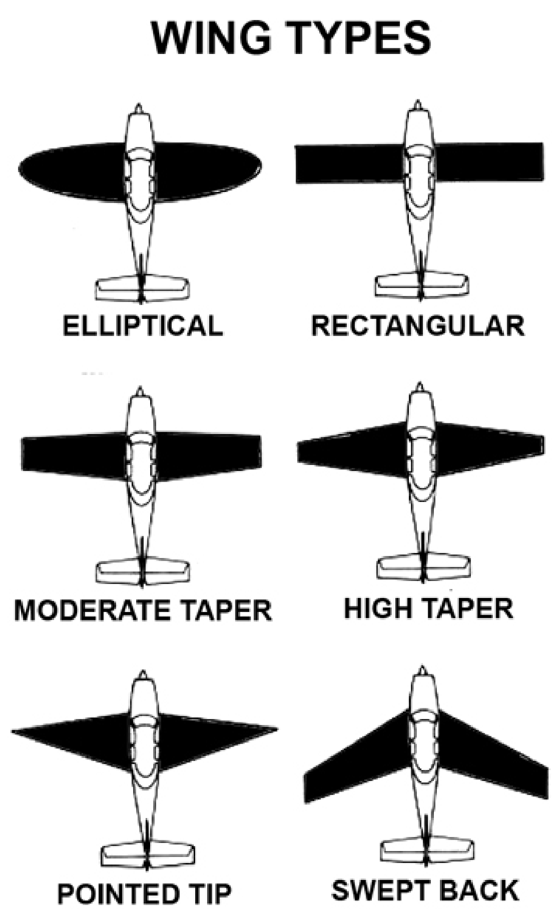
$$\text{Reynolds Number} = \frac{\text{V(speed) x L (length of chord)}}{\text{Kv (kinematic viscosity)}}$$

Without getting too deep into the math of this formula, the kinematic viscosity (Kv) is a measure of the "stickiness" of the air. For simplicity you can use the value 6327 for the Kv of air at the standard temperature of 59 degrees Fahrenheit at Sea Level. The speed value is in feet per second and the length is the chord of the wing in linear feet.

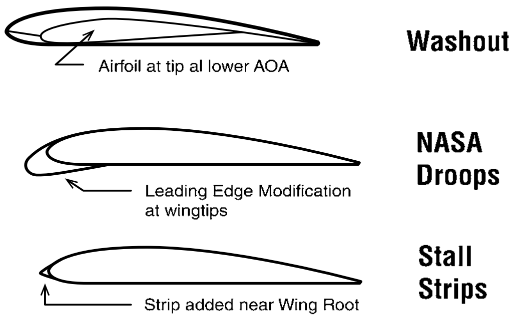
The Reynolds Number is an essential measurement of wing/aircraft performance and if you are a serious student of aerodynamics you will want to know a good deal about it.

The others recognized Thorp's argument to be sound because, as is well-known, where the RN is lower the maximum Cl is necessarily lower, creating less lift at any given airspeed as compared to any other part of the wing where the chord is longer. Accordingly, it follows that where the maximum Cl is smaller, that part of the wing must stall first.

Thorp further argued that the relatively small size of GA aircraft's wings and their relatively slow takeoff and landing speeds exacerbates the tip stall problem in a tapered or elliptical wing as the outer wing's RN is therefore even lower. Additionally, a tapered or elliptical wing is more readily likely to have reduced aileron effectiveness. While it makes sense that the aileron on a tapered wing may be less effective being mounted at the tapered portion of the wing which has a shorter chord and thus a lower RN causing lower efficiency and



STALL TAMERS



Some fixes for tip stall

a lower maximum Cl; it is also true that the tapered wing's outer section produces less aerodynamic lateral damping force in a roll than does a constant chord wing. Therefore, all else being equal, with properly designed ailerons a tapered wing could have as fast or a faster rate of roll than a constant chord wing of identical area and span.

As a tapered wing for the Cherokee was being seriously discussed, the various known "fixes" for tip stall were considered. The commonest of these is wing twist or "washout" where the outer portion of the wing's trailing edge is built to ride slightly higher than the leading edge (producing lower local static Alpha). Additional preventative measures for tip stall are aerodynamic devices which are attached and/or added to the wing such as drooped or enlarged leading edges, stall strip at leading edge, more greatly cambered (curved) outer- wing airfoil sections, fixed or automatic leading edge slots or slats, and downward curved wing tips.

While these fixes do help the problem to some degree, they all add complexity, and/or weight to the wing and all produce additional airspeed- robbing drag which tends to negate the advantage that the tapered wing was supposed to deliver in the first place.

In final analysis, Thorp, Bergey and Weick (who admired Thorp's sound reasoning on the matter) agreed that nothing of any value, especially airspeed, would be gained by incorporating a tapered wing, and admitted that, in fact, the tapered wing in its pure "unfixed" form was more prone to tip stalls and spins. They agreed that a rectangular wing with a few degrees of washout would be as or more efficient as an elliptical or tapered wing without any of the tapered wing's attendant tip-stall problems and without the complexity and additional expense of building a more complicated tapered wing structure.

The team finally agreed upon a rectangular, constant- chord, "Hershey Bar" wing for the Cherokee, which indeed proved to possess a high degree of cruise efficiency, near to ideal lift distribution characteristics, and which is highly stable at low airspeeds, near-stall, stall and departed flight conditions.

Always seeking to improve the Cherokee, in 1969 an extension of the wing span was proposed in order to improve load carrying ability and rate of climb. However, preliminary tests showed that a longer wing would necessarily increase positive bending pressure on the wing root and inboard wing structure requiring an entirely new and more robust inner wing design which would necessarily add to manufacturing costs. The idea was tabled for the time being.

In 1973 Piper revisited the Cherokee's wing design and decided to go with the original idea of a tapered wing. While Thorp and Weick's original theories regarding tapered vs. rectangular wings were correct and had been well-proved, much to the dismay of many within and without Piper Aviation, a new, tapered wing was approved for the PA-28-150.

This aeroplane also incorporated a few other upgrades, improved wing fairing and seals and was renamed the PA-28-151 "Warrior". Thereafter, if a Piper aeroplane has a "1" as its last number, as in PA-28-151, etc. it has a semi-tapered wing. The "Warrior" broke Piper's tradition which began in 1954 with the twin engine Apache of exclusively naming its aircraft after the English language names of Native American tribes, and began a new tradition of also naming aircraft using words such as "Tomahawk", "Arrow", "Archer", "Papoose", etc. that closely suggested and alluded to that noble culture.

The new PA-28-151 was very similar to the old PA-28-150, except for its tapered wing, which is actually only tapered from the mid - span point to the tip on each side and therefore ought to more properly be called "semi-tapered". The new wing was also increased by 5' in span to make up for the decreased area of the tapered

Piper PA-28-161 showing semi-tapered wing
PA-28-181 Archer showing semi-tapered wing

section, as Thorp had said would be necessary. The increase in span raised this new wing's aspect ratio to 6.66 from 5.63 and likewise slightly raised its Cl. The product of the additional span is a slight gain in rate of climb and high altitude cruise speed and a flatter power-off glide.

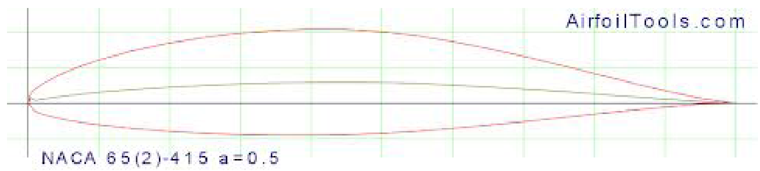
Some of these performance gains were initially credited solely to the new semi- tapered wing itself; but upon closer inspection and analysis it was discovered that they were at least partially, if not mostly due to the improved wing/fuselage seals and fairing incorporated in the PA-28-151. At the same time, the semi-tapered wing's increased aspect ratio, which in addition to its said performance enhancements also reduces the effective range of Alpha at which the Cherokee may fly before stalling. This causes the semi-taper wing Cherokee's Alpha at the stall to be lower than that of the Cherokee with a rectangular wing.

In 1976 the PA-28-180 was re-designed with a semi-tapered wing becoming the PA-28-181 "Archer"; and by 1979 all Piper single- engine aircraft had received semi-tapered wings, all of them, accordingly, both gaining and losing therefore as mentioned above.

As far as performance goes between the Cherokee with a rectangular or semi-taper wing, all else being equal and without wheel pants, from sea-level to approximately 6,000' the rectangular wing is actually faster than the semi-tapered wing. However, as altitude increases past 6000' the rectangular wing loses airspeed more rapidly. As mentioned, the semi-taper wing Cherokee has a slightly better rate of climb and also a flatter glide. Flatter glide is good in itself, but has a down side in that the semi-tapered wing Cherokee is more sensitive to airspeed when landing than is the rectangular wing. This means that if there is any amount of excess airspeed at the flair, the semi-tapered wing tends to float a while before touching down where the rectangular wing settles down more quickly and with less float.

Whatever the reasons may be, the semi-taper wing's performance increases are very slight. This writer, having flown both versions of Cherokees prefers the rectangular wing over the semi-tapered wing for its speed, sprightlier handling and its excellent landing, low-airspeed and stall characteristics; or perhaps it's also out of a sense of tradition and nostalgia.

Hershey Bar vs. semi-tapered wings



Cherokee wing root without flap or aileron, "wet wing" fuel tank removed (leading edge facing left)

This is the Cherokee's airfoil straight black line- chord curved grey line - mid line or mean camber line

FOILED AGAIN

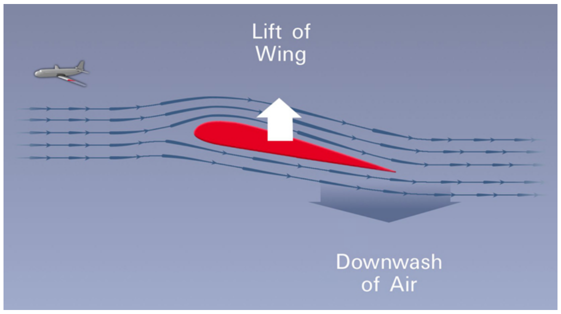
After careful analysis, the team selected the rather thick at 15% NACA 652-415 laminar-flow airfoil as it was highly efficient at the airspeeds and altitudes at which the Cherokee was expected to cruise while still preserving good low airspeed characteristics and a most gentle, benign stall.

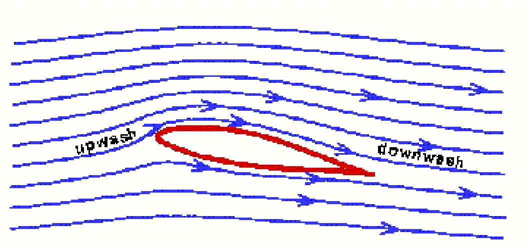
This airfoil is an NACA "6" series airfoil, has its area of minimum pressure 50% of the chord from the leading edge, maintains low drag at 0.2 above and below the lift coefficient of 0.4, has a maximum thickness of 15% of the chord, a= 0.5 means that the airfoil maintains laminar flow over 50% of the chord.

Despite the NACA numbers, the Cherokee's wing's thickest point is actually closer to 40% back from the leading edge.

Just a quick word or two about airfoils and what a "laminar flow airfoil" is. The wing's airfoil is its cross-section shape from leading to trailing edge and is primarily and most importantly an air diverter*. Among other things, the airfoil diverts the air through which an aeroplane's wing travels downwards at the wing's trailing edge so that lift may be generated (see Newton's Third Law of Motion). In order to do this the "boundary layer", which is the very thin, viscous layer of air closest to the surface of the wing, must adhere to the wing and not become turbulent or detach from the surface of the wing. As long as the boundary layer adheres smoothly and uninterruptedly to the surface of the wing, the wing will continue to divert air downward at the trailing edge and thereby produce lift.

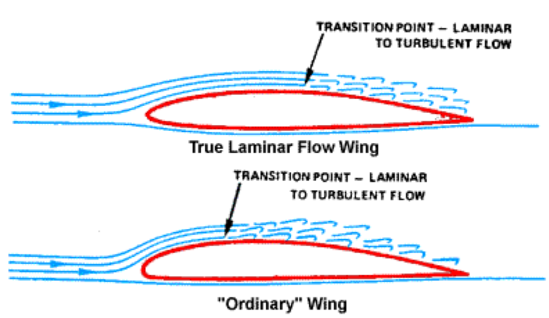
*There are many theories of lift, some traditional, some imaginative and seemingly intuitive. However, in recent years most of the traditional theories have been discredited as they were found to be flawed, entirely improbable or simply wrong as aeronautical knowledge and understanding has progressed. It is most likely that there are numerous ways in which a wing produces lift. The airfoil as a downwash "air diverter" at the trailing





edge is and has for many years been what this writer thinks is the most probable correct theory. Of course, the true scientific mind must always be open to new facts and disclosures. This writer awaits with great interest what is yet to be discovered.

Also, a smooth and adherent boundary layer produces minimum pressure and/or parasite drag enabling the aeroplane to fly faster for any given amount of power. Slight micro-turbulation in the boundary layer actually increases its adherence to the surface of the wing; but, when this turbulation becomes more severe and becomes a turbulent flow, lift is reduced and pressure drag increases. If this turbulence becomes too severe, which typically happens at critical positive Alpha, the turbulent boundary layer detaches from the surface of the wing creating random eddies and vortices causing considerable parasite and pressure drag to be produced. Upon boundary layer flow separation from the surface of the wing the former downward diverted air flow ceases and, concurrently, the wing ceases to generate lift. This is the “stall”. An airfoil designed to produce maximum uninterrupted, adhesive boundary layer flow at the surface of the wing and minimum drag is called a “laminar flow airfoil”.



Laminar Flow

NACA NUMEROLOGY

The first number, “6”, of NACA 652-415 indicates that this is a NACA “6-series” airfoil. The second number, “5”, indicates the position in percentage x 10 of the chord (leading to trailing edge) where minimum pressure occurs — here indicating the 50% chord position. Minimum pressure usually occurs at the thickest part of the airfoil.

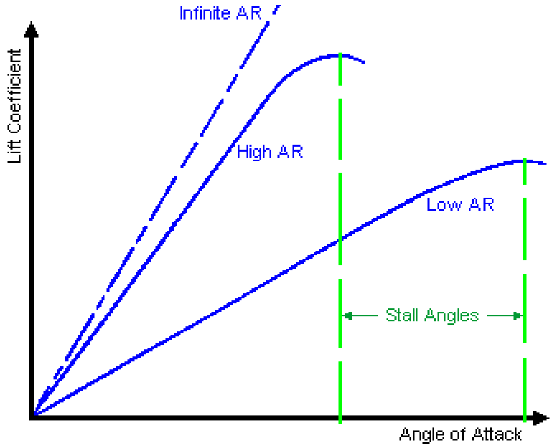
The subscript “2” indicates that this airfoil’s drag coefficient approximates its minimum value between plus or minus 0.2 of the airfoil’s design Cl. The NACA 65(9)-415 airfoil which is a later refinement of the NACA 652-415 has been used in the Cherokee as well, the only difference between it and the NACA 652-415 being that in the latter airfoil the airfoil’s drag coefficient approximates its minimum value between plus or minus 0.9 of the airfoil’s design lift coefficient.

The number “4” indicates the lift coefficient in tenths; here, 0.4.

The last two numbers, “15”, indicate the wing’s maximum thickness as a percentage of the chord; here, 15% of the chord.

A laminar flow airfoil is typically designed so that its thickest point is usually at approximately 50% of the chord. A normal airfoil’s thickest point is usually at approximately 25% to 33% of the chord. The laminar flow airfoil shape combined with a very smooth wing surface best promotes a smooth and adherent boundary layer. The North American P-51 “Mustang” was the first mathematically designed aeroplane and its wing was the first to be deliberately designed with a “laminar flow” airfoil, however, even a very slight ripple or bump in or on the surface of the wing can prevent the true laminar flow effect. Despite all good intentions the P-51’s wing surface is not sufficiently smooth and uninterrupted nor was it optimally built or usually sufficiently maintained in the field to promote true laminar flow. The Cherokee’s wing surface, however, is actually far smoother and if kept scrupulously clean, promotes a stable, adherent boundary layer very well.

A salient characteristic of the Cherokee’s airfoil is that it has a fairly flat Cd (Coefficient of Drag) curve and thereby looses lift very slowly as the stall is approached. Unlike many others, this airfoil does not possess a single critical angle of attack (positive Alpha) at which it will stall. The NACA 652-415 airfoil flies within a fairly broad range of positive Alpha and does not break sharply at the stall unless very aggressively forced into an extreme positive Alpha condition called a “deep stall”. Spins are likewise very difficult to enter unless aggressively pursued. Additionally, the Hershey Bar wing’s low 5.63 aspect ratio helps to promote the Cherokee’s distinctly anti-stall/spin behaviour. That these gentle stall/spin characteristics were incorporated in the Cherokee’s design is no coincidence and very much in keeping with Fred Weick’s life-long design practices, particularly with regard to his Ercoupe design which, as mentioned, was



Simple Polar showing relative differences between high and low aspect ratio wing (here - AR)

specifically designed to be virtually stall and spin-proof.

Those who have flown a Cherokee will surely attest to its remarkably benign handling at low airspeed and its reluctance to stall or spin. In fact, at one "g" with power off it does not really break at all at the stall, but merely oscillates gently forward and aft while descending rapidly, which is the only indication that the wing has in fact stalled. Pilots generally find the Cherokee to be reluctant to stall with power on; although in this configuration the stall break may be a bit more definite with the left wing falling due to engine torque at high power. With power on the Cherokee rarely loses aileron control. This is a sharp contrast to the Cessna 172 which loses aileron control quite readily when near or at the stall. These stall characteristics apply to both semi-tapered and rectangular wing Cherokees, the rectangular wing being the more benign and reluctant to stall due to its higher Alpha before stall due to its lower aspect ratio.

Because the Cherokee's NACA 652-415 laminar-flow airfoil's thickest point is near the wing's mid-chord, approximately 40%, the main wing spar is located farther aft than is possible with non-laminar airfoils. Accordingly, as the main wing spar runs longitudinally across the wing at its thickest point, its profile is deep and great strength is gained therefrom. Also, the location of the main spar so far aft locates it under the rear passengers' seat, permitting the cabin floor to be flat and unobstructed.

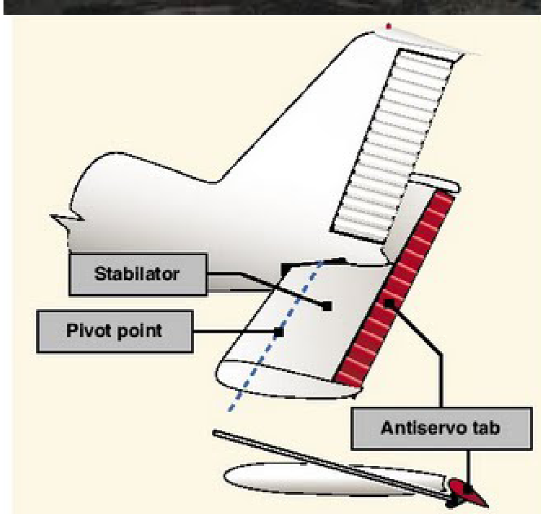
KEEPING THINGS STABLE

Following the successful Comanche design, instead of the usual horizontal rear flight surface consisting of a fixed stabilizer with a hinged elevator, the Cherokee incorporates a one piece, all- flying "stabilator" with an anti-servo tab (also called an anti-balance tab) upon which, not likely coincidentally, John Thorp holds the patent. A one-piece (i.e. non-hinged), all moving stabilator pitch control surface produces less drag when the surface is displaced and is more efficient than a conventional fixed stabiliser and hinged elevator. Accordingly, it may be of less overall area than a similar conventional fixed and hinged pitch control surface. Accordingly, the early Cherokees' stabilator was designed to be approximately two feet shorter in span than later ones making these Cherokees with shorter stabilators slightly less effective in pitch control, particularly at slower airspeeds.

An anti-servo tab is located at the trailing edge of the stabilator, similar to a trim tab; however an anti-servo tab is mechanically linked to the stabilator to move in the same direction as the stabilator when the stabilator is displaced by the pilot. This provides a proportional opposing force to the displaced stabilator, thus avoiding negative aerodynamic stability (the tendency of a balanced, moving, aerodynamic surface to deflect further as it is displaced from neutral) and which, by increasing the load on the stabilator as it is displaced, prevents over- sensitivity in the pitch axis control system at all airspeeds.

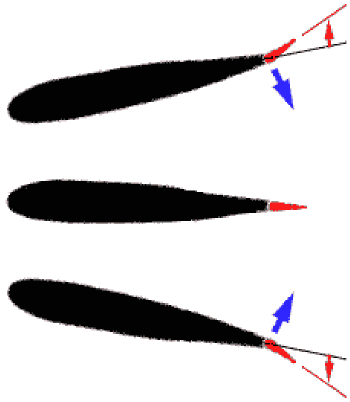
In the Cherokee pitch trim is controlled by changing the angle of the entire stabilator and anti-servo tab. At the time that the Cherokee was being designed the all-flying anti-servo stabilator was already a well-proved, smooth and highly efficient pitch control system which possessed the additional properties of being lighter and, as mentioned, producing less overall drag than

Cherokee showing stabilator and anti-servo tab



An antiservo tab attempts to streamline the control surface and is used to make the stabilator less sensitive by opposing the force exerted by the pilot.

How a stabilator with anti-servo tab works



the usual hinged stabilizer and elevator. A stabilator/ anti servo tab horizontal surface very similar to that which was incorporated in the Cherokee appeared on John Thorp's 1945 T11 and T211. While Thorp's original design for the stabilator was innovative and effective, it was also a bit complicated as to linkages and such. Ever seeking to economise on production costs, Piper's Assistant Chief Engineer Karl Bergey modified Thorp's system and was able to simplify it while still bestowing its essential benefits on the new aeroplane.

Speaking of pitch trim, early Cherokees followed Piper's unique method of elevator trim control, a horizontal hand-crank and position indicator located in the ceiling between the front two seats. Tri-Pacers, Colts and the first Comanches have the same control. It works fine except that even though it is well-marked, many pilots (me too) have a devil of time remembering which direction to turn the handle for up or down trim. BTW, it's clockwise for up and anti-clockwise for down.

Accu-sim Piper PA-28 Cherokee in development (20th December 2013)

SWEPT AWAY

We might as well get it out of the way here — the swept back rudder and fin — does it serve any useful aerodynamic purpose as opposed to a straight tail or was it merely intended to sweep customers off their feet with a sweeping new design? (apologies)

Piper had incorporated a swept vertical tail on the 1958 Comanche, which this writer believes is the first time such appeared on any mass-produced GA aeroplane. The Beechcraft Debonaire with its swept rudder and fin was not introduced until 1960. Having innovated this feature, Piper made it a priority to incorporate it as a signature design on its next and subsequent Piper aeroplanes. In any event, the aeroplane that Piper was most competitive in the GA entry/middle market, the 1960 Cessna 172A, now had one. In the late 50's a swept vertical tail on a GA aeroplane was new. It certainly looked modern and streamlined and suggested the tail surfaces of jet fighters and all. The marketing strategy went something like this: Everyone knows that jet fighters go fast and that they have swept back surfaces; so, if your Piper has a swept back rudder/fin similar to a jet fighter, well then, it ought to go fast as well, right? Of course, the swept surfaces on jet fighters have much to do with trans-sonic and super-sonic flight which Comanches, Cessnas and Cherokees, etc. have little to worry about. For all of that did the swept rudder/fin on the Comanche, any of the Cessnas or, more to the point, the Cherokee enable any of them to fly faster? No, knot at all.

From a strictly aerodynamic perspective a swept-back rudder, its uppermost portion anyway, is located slightly farther rearward than a straight rudder mounted in the same position. This slightly moves the rudder's CP (centre of pressure) rearward and increases the uppermost part of the rudder's moment arm which therefore ought to increase its effectiveness to a small degree.

Others have postulated that the swept back fin/rudder is actually less effective and that it somewhat compromises directional stability and spin prevention. It may be, however, that with regard to this it was an earlier straight- tailed 172 which was compared to a 1963 or later swept-tail Cessna 172/Skyhawk with "Omni-Vision" . If so, it is more likely that the cause of any perceived reduced rudder/fin ineffectiveness, etc. was not necessarily the swept vertical surface but was actually the later

Piper PA-28-160 Cruiser showing swept-back fin and rudder

1967 Mooney M-20C Ranger

1962 Mooney M-20C Ranger

aircraft's cut - down rear fuselage which provides for the "Omni-Vision" rear cabin window, and that the reduced side area of the fuselage behind the C.G. is the real culprit for any directional stability or spin issues.

Also, if the aeroplane is banked a displaced swept-back rudder will tend to couple with both the aircraft's pitch axis (as usual) and also positively to greater than usual degree with the aircraft's roll axis. Accordingly, a swept forward displaced rudder will couple negatively with the aircraft's roll axis.

What a swept rudder/fin actually does as compared to a straight one with regard to relatively low- speed GA aircraft might be able to be measured in a wind tunnel or by a very sensitive set of in-flight instruments, but this writer is not aware that any such study has been conducted. Having often flown versions of the same aircraft (C-172 and 182) with both straight and swept tails this writer has not noticed any appreciable difference in the performance and handling thereof that might be due solely to the rudder/fin configuration. Taking everything we know into consideration it seems that a reasonable conclusion regarding this matter is that the swept back rudder/fin on GA aeroplanes is nothing more than an eye- catching marketing tool which is, after all, still a legitimate reason for its existence.

One last, possibly definitive note on this subject; Al Mooney ostensibly designed the Piper Comanche with its swept back rudder/fin. However, all of his designs for Mooney Aircraft incorporate rudder/fins that famously sweep forward.

COMFORT AND ECONOMY

Comfort: One of the important issues that Piper's design team had to consider was the creation of a new aeroplane that would cost far less to build and thereby be able to be sold at a much lower price than the Comanche. While the team considered that designing an aeroplane that was less costly to build would not be so arduous a task (Weick and Thorp had been designing inexpensive to build aeroplanes for decades), simultaneously providing the new aeroplane with a cabin as or more comfortable than anything in its class was a bit more daunting.

Cabin size and particularly cabin width is a tricky thing to consider when designing a small aeroplane. Every extra inch expands the frontal area and, accordingly, increases parasite and form drag, resulting in a higher Cd and reducing performance for available power across a broad spectrum.

Piper's target competition, the Cessna 172's cabin is a fairly cosy 39 ½" wide. This is a relatively tight fit for full - sized adults, 1/2" narrower than Piper's previous single- engine flagship, the Tri-Pacer, with its snug 40" cabin width. In years past this writer flew many pleasant hours in Tri-Pacers and somehow does not remember that it was such a tight fit; but then that was many years ago and this writer was then, let's say, a bit smaller.

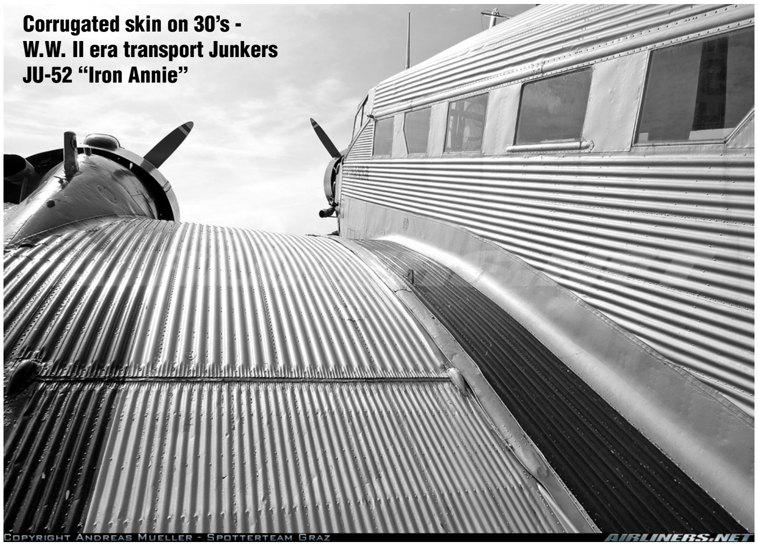
The planned cabin width of the new aeroplane was at first to be a generous 44", the same width as their then single-engine flagship, the Comanche. However, Piper felt that its new, more economical aeroplane ought not compete so closely with its flagship aeroplane and it wanted to reserve to the Comanche just a bit more cabin comfort than its less expensive brother. Accordingly, the Cherokee, as the new aeroplane was finally named, would have a 40 1/2" wide cabin, still an inch wider than its closest competitor, the Cessna 172.

Another way that the Cherokee was designed to increase cabin space while keeping construction cost low was by utilizing the fuselage's external belly skin, strengthened with external stiffening members, as the cabin floor. This was inexpensive, light and required fewer parts than did many contemporary designs. This ingenious design treatment added cabin headroom without the need to expand the outer dimensions of the fuselage and thus increase parasite and form drag.

In addition to cabin size, Piper wanted their new aeroplane to be quieter than its competition. The Cessna 172's design approach is towards a definite lightness of structure which results in a less noise- insulated cabin due to the 172 having a rather thin firewall, doors, windows and other structural members resulting in a fairly noisy cabin. Well-understanding Cessna's design preferences, Piper looked to find a way to gain an advantage by reducing the Cherokee's cabin noise. This was done by generally using thicker, sturdier structural members particularly in and around the cabin and by placing the engine as far forward as possible without jeopardizing good pitch control balance. This kept the engine's twin exhaust stacks, which are located near the front of the engine, as far away from the cabin as possible. The upshot is that the Cherokee has a very quiet cabin, not usually requiring headphones for its occupants to converse in flight.

Economy: One of the ways that an aeroplane may be produced more economically is for it to be designed with as few parts as possible. The Cherokee was, accordingly, designed to be extremely simple to construct with much redundancy (i.e., all wing ribs were the same size, identical left and right parts where possible, etc.) as well as having very few complex curves requiring more costly and labour intensive aluminium panel construction, shaping and fitting. Accordingly, the new Cherokee was designed with less than ½ as many parts as the more complex and more expensive to build Comanche. A demonstrative example of this is that the Cherokee uses 1,785 rivets while the Comanche uses more than twice that amount at 3,714. (Yes, I did count them all myself — not)

Another example of intentional simplification is that the Cherokee's ailerons require ten parts to construct while the Comanche's ailerons require thirty-six parts. Additionally, and in keeping with his long-held and successful design practices, John Thorp designed all of the Cherokee's tail surfaces, flaps and ailerons to be as lightweight, simple and thereby less expensive to construct



Corrugated skin on 30's - W.W. II era transport Junkers JU-52 "Iron Annie"

Piper Cherokee rudder showing corrugated skin

Cherokee unpainted stabilator showing corrugated skin

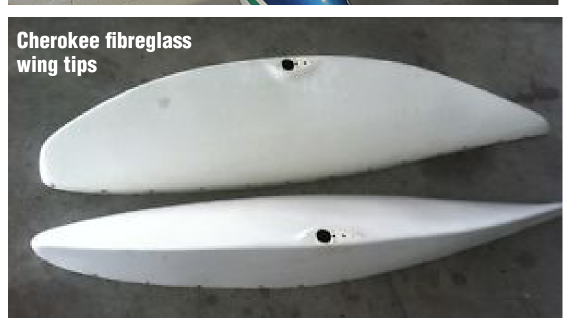
Cherokee unpainted fuselage and fin showing corrugated skin

as possible by requiring no internal ribs or heavy internal structures within them. This particular weight- saving practice is also found in the designs of many GA aircraft. Stiffness of the Cherokee's tail surfaces, flaps and ailerons is provided by beaded (corrugated) surface skins, similar to that which was pioneered by and appeared on Junkers aircraft of the W. W. I era and later and which was also largely utilised by John Thorp on many of the aircraft which he had previously designed in order to save weight and to foster simplicity of construction. Piper was familiar with this construction technique as its PA-18 Super Cub's metal ailerons and flaps are covered with the same kind of corrugated skin for stiffness.

Another parts- count, weight and cost saving was the Cherokee's incorporation of "wet wing" or "integral" fuel tanks formed by the wing's leading edge structure rather than the usual practice of installing separate fuel cells within each wing. The wet-wing fuel tank maximises the quantity of fuel that may be carried on board while requiring the least amount of wing structure to contain it. Of course, the fuel- carrying part of the wing must be designed and built with great integrity so that all panels, rivets, connectors, etc are leak-proof and will not even slightly separate under flight loads. Possibly the earliest application of wet wing fuel tanks appeared in Fred Weick's remarkably prescient 1936 Ercoupe.

Another cost and weight saving measure applied to the Cherokee was the innovative and extensive use of inexpensive- to- produce fibreglass parts in place of aluminium for the wing and stabilator tips as well as for the cowling. The use of fibreglass in these areas was also potentially cost-effective for the Cherokee's owner in the event that these parts were ever damaged and had to be replaced as the vulnerable wing and tail tips and cowling are often the common victims of "hangar rash" and other inadvertent abuse.

Cherokee with "wet wing" fuel tank removed



Cherokee fibreglass wing tips

WHEELS AND FLAPS

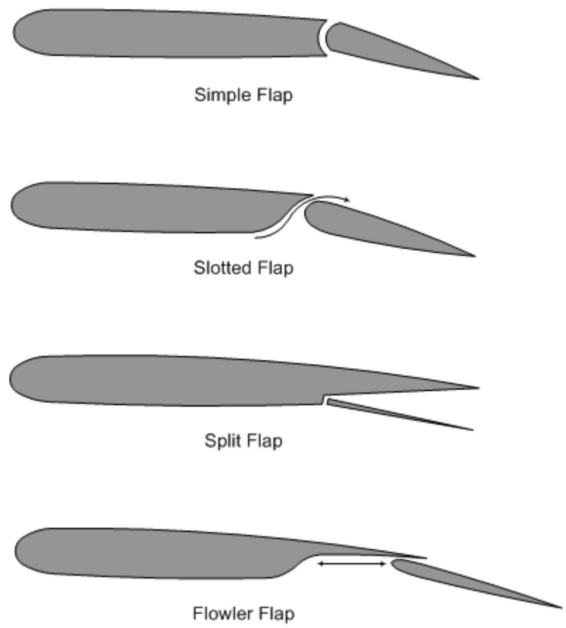
The Cherokee's undercarriage is tri-cycle with a fully steerable nosewheel, independently sprung but directly connected to the rudder control system which was the same arrangement as was used in the Tri-pacer and Comanche. In early Cherokees the main undercarriage brakes were not operated by toe pedals but by a single, centrally located "Johnson Bar" brake handle, also as in the Tri-Pacer. This system somewhat limited tight, precise ground steering and was not a popular feature. While trying to save on manufacturing costs by using previously designed, well-proved and readily available parts and components from the Tri-Pacer, the fact was that some of these were long overdue for an upgrade. The Cessna 172 had toe- operated brakes on both sets of rudder pedals from the get go which was a notable feature discrepancy. Within a few years and after many complaints Piper relented and installed dual individual main toe brakes for both sets of rudder pedals in the Cherokee, operated by depressing the tops of the rudder pedals individually to turn or both together to slow or stop.

Simple, easy to manufacture and to maintain straight oleo (compressed nitrogen and hydraulic fluid) struts are used throughout. The Cherokee has a distinct advantage over the Cessna 172 in that, as a low-wing design, its main undercarriage is attached directly to the main wing spar providing maximum strength and stability. The Cherokee's 10' wide main undercarriage tread provides excellent and stable ground handling under all conditions while the Cessna 172's main undercarriage which is a pair of steel struts attached to the fuselage, has a tread of a little more than 8' 4".

Fred Weick had done a number of advanced undercarriage tests when he was designing the Ercoupe which showed that in a tri-cycle undercarriage the nosewheel was often under the greatest load. He also determined that for operations on grass and on other soft fields that all three tires ought to be the same size. Accordingly, the Cherokee has 6.00 x 6 tires on all three wheels. With regard to the Cherokee's undercarriage, Piper evidently got it right as pilots have universally praised the Cherokee's easy, dependable ground handling.

With regard to the Cherokees' flaps, they are narrow in chord and have a simple, inexpensive up/down linkage with an over-centre lock when up. They are manually controlled by a bar with a release button at its top located between the front seats. The flaps have four positions: up, 10º, 25º and 40º down. Although the rectangular wing's flaps are more effective than those of the semi-taper wing's, with regard to flaps the palm must go to the Cessna 172. It has larger and more effective broad-chord flaps, linked so that as they lower they also move rearward out of the wing, increasing their overall area.

Most (me, too) would call the C-172's flaps "Fowler flaps" because of their rearward-moving, area-increasing feature; but in all of the FAA approved official C-172 POHs, Cessna calls them "Slotted Flaps" and therefore that is the only correct answer if you ever are tested on the subject by your instructor or the FAA (you're welcome). The Cessna's flaps have slots (openings along the hinge line to allow oncoming air to pass through when the flaps are lowered) which prevent their large size from creating uncomfortable induced rumble, vibration and turbulence when deployed. As it is there is still a distinct audible and visceral rumble when you lower the flaps in a 172, but most pilots don't mind this much as the flaps are effective and do their job well.



Simple flap - Piper and most GA aircraft

Slotted flap – Cessna and some other GA aircraft

Split flap - Many 1930's and W.W. II era aircraft

Fowler flap – mostly airliners and heavy aircraft

In any event, don't get too exited by the Cherokee's 40º down flap position. The Cherokee's flaps do what flaps are intended to do, but even when fully lowered they perform to a lesser extent than those of the 172. In 1964 when the Cherokee had been out only two years Cessna "upgraded" the 172's manual flaps to an electric operating system. Whether or not this was intended as a one-up on the Cherokee, this writer does not see this as a positive advance as electrically operated flaps are not really necessary in an aeroplane as light as the 172.

In aeroplanes of this class, this writer prefers the direct control granted to the pilot with the manual flap control. For instance, with a manual flap control the pilot can instantly raise the flaps and thereby dump lift upon touchdown to set the tires firmly against the runway for braking if and when such is desired. A manual flap system allows them to be extended or retracted at any rate the pilot wishes while the electric system extends and retracts the flaps at a fairly slow, pre-set, non-adjustable rate. Also, should the aeroplane's electrical system fail, manually operated flaps would be unaffected.

VICTORY — EVOLUTION AND REFINEMENT

Once Pug's, Weick's, Thorp's and Bergey's design was named, solidified and its exact details determined, the Cherokee was assigned Piper Aviation production model number PA-28 and a prototype for flight testing was built. This first flying Cherokee was essentially what would become the PA-28-160 and was powered by the highly reliable 160 hp Lycoming O-320-B2B engine (later PA-28-160's would also use the O-320-D2A). Thomas Heffner, chief test pilot for Piper, had the honour of being the first Cherokee pilot to fly the first of over 33,000 Cherokees built on either 10 or 14 January 1960 depending upon what you may read.

The new Piper flew, as it is said, "Right off the drawing board" and everything that its brilliant design team had intended and built in to it was realised. The first production Cherokee, the 160 hp PA-28-160 was type certified on 31 October 1960 and went into production in January 1961. After a short period of pre-release promotion it was released for sale to the public, and soon thereafter it was joined by the slightly less expensive 150 hp PA-28-150. Both of these aeroplanes were instant hits with the aviation public. Flight schools, clubs and private owners all throughout the Unites States placed orders and Piper sold 286 Cherokees in its debut year. Gratified (but not, I dare say, entirely surprised) with this a great success, plans which had been made to expand the Cherokee family if all went well went into immediate action.

It is said that when one door shuts, another one opens, and vice versa. This was no less true at Piper Aviation. Simultaneously with the introduction of the Cherokee, the parts inventory, tooling, jigs and part manufacturing stations, all of which had been used to build the once revolutionary PA-22 Tri-Pacer and its two- seat version, the Colt, were disassembled and disposed of. With a sigh and perhaps a tear or two, these aeroplanes passed into aviation lore.

For one year the 150 and 160 hp Cherokees represented the entire line. However, Piper's well-laid plans to expand it to include Cherokees of greater power were busily being implemented. On 3 August 1962 the PA-28-180 powered by the versatile and by now ubiquitous workhorse of GA, the 180 hp Lycoming O-360 A2A (yes) was type certified and began to roll out of the new Piper factory at Vero Beach, Florida in early 1963. With a useful load of 1,170 lbs., this was the first Cherokee in which four substantially sized adults could fly in addition to full tanks (50 US gallons).

By the end of 1963, Piper could quite rightly claim victory and justifiably feel that its bourne had indeed gloriously arrived and had produced most excellent fruit. The Cherokee PA-28-160 equalled or bested the Cessna 172C in virtually every area of performance. Additionally, and surely much to Cessna's discontent, when Piper installed the 180 hp 0-360 Lycoming in the Cherokee airframe creating the Cherokee PA-28-180 for which Cessna had no equivalent model, the additional 20 hp gave it even better performance over the 172. (Figures below supplied by Piper and Cessna*)

*Just a note about manufacturer's published performance figures: Of course, there is always the temptation to, let's say out of politeness, "exaggerate" these numbers. However, the FAA does not permit this practice to go too far as pilots must be able to rely on accurate published performance numbers so that they may, among other things, safely plan cross-country flights. All official aircraft POHs must be certified as containing information which is based upon real-world testing and which is as accurate as possible. To get around this, manufacturers have been known to publish performance numbers, particularly in advertisements, that were obtained when the aeroplane was loaded at less (sometimes much less) than MGW.

Versatility is one of the many charms of the Cherokee's basic airframe and it has been effortlessly adapted

	Cherokee 160	Cherokee 180	Cessna 172C
Max. speed at sea level	120 kts (138 mph)	132 kts (151.8 mph)	120 kts (138 mph)
Cruise- 75% power at 7,000'	115 kts (132.25 mph)	124 kts (142.6 mph)	114 kts (131 mph)
Rate of Climb @ gross weight - sea level	700 fpm	750 fpm	700 fpm
Stall – flaps down power off	48 kts (55.2 mph)	50 kts (57.5 mph)	45 kts (51.75 mph)
Takeoff: ground roll	740'	720'	825'
over 50'	1,700'	1,620'	1,830'
Landing: ground roll	550'	600'	690'
over 50'	890'	1,150'	1,140'
Service ceiling (100 fpm climb)	15,000'	16,000'	14,550'
Useful load	990 lbs.	1,170 lbs.	990 lbs.

Note: The Cherokee 160 and 180's performance reports were made while being tested at MGW. We cannot confirm that Cessna 172 was similarly tested at its MGW. Also, note that the Cherokee 180's excellent performance was measured while it was carrying 180 lbs. more useful load than either the Cherokee 160 or the Cessna 172.

Lycoming 0-320 B2B

1963 Piper PA-28-180

to engines of varying power, from 150 to 300 horsepower, with little airframe modification being required.

Piper Aviation and its brilliant engineering team had accomplished what it had set out to do, to provide a real choice in the GA market between the new Piper aeroplane and the Cessna 172. As William T. Piper, with his hand ever firmly on the aviation public's pulse had predicted it would be, the introduction of the Cherokee was greeted most enthusiastically, which enthusiasm has not and shows no sign of waning.

THE CHOICE

Fitting neatly between the Cessna 172 and 182, when it was introduced in 1963 the Piper Cherokee 180 filled a niche that had long wanted filling. Accordingly, it became and remains one of GA's most popular aeroplanes. In both its latest incarnation, the PA-28-181 Archer TX and LX, and in the many PA-28-161 Warriors which have had a 180 hp Lycoming engine replacement,* the combination of the Cherokee airframe and a 180 hp engine truly is the magic touch, the Goldilocks aeroplane indeed.

The first difference that one notices regarding the Cherokee vs. the 172, putting all of the performance numbers aside for a moment, is obvious — the wing. 172s have a high wing, Cherokee's, a low one. As mentioned, the pilot and passengers of a high wing aeroplane have and almost entirely unobstructed downward view which is excellent for sightseeing and which facilitates navigational orientation. The problem with most high - wing aeroplanes (excepting those few high-wing designs where the pilot sits well-forward of the wing) is that the wing obstructs visibility whilst in a turn. This may not be much of a problem enroute when few turns are made and the sky is mostly clear of traffic; however, when in the pattern at a busy airport, the problem becomes clear.

In a high-wing aeroplane, even though a pilot may be properly diligent in checking that the sky is clear prior to making a turn, once in the turn he or she is blind to all that may be to the inside of the turn. Additionally, for the duration of the turn, short of lifting the wing and stopping the turn to re-clear the sky, the pilot has no way to know if another aeroplane has entered that area.

A low- wing aeroplane has no such problem in the pattern. The inside- turn wing politely gets right out of the way in the direction of the turn, granting the pilot an unobstructed view of where he or she is flying. As to downward visibility, the low wing does not obstruct the view nearly as much a one might think. In all of the many, many hours that this writer has spent flying low wing aeroplanes, there has never been an instance that comes to mind when a want of downward visibility was an issue.

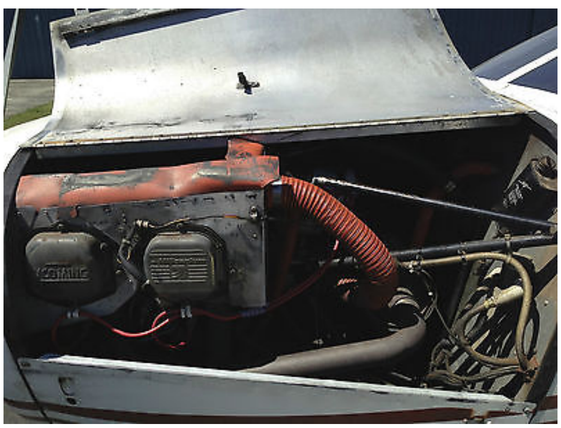
Another difference between the high-wing 172 and the low-wing Cherokee is ground effect during takeoff and landing. Ground Effect is that property of aerodynamics which causes a "bubble" of lifting air to form under a wing when it is flying within approximately at ½ of its span from an incompressible, solid surface which, of course, includes water. Because of its proximity to the ground a low-wing aeroplane will usually create stronger ground effect than a high-wing aeroplane, and when descending to the runway, it will be felt sooner as well. During takeoff as well, all else being equal, the pilot of a low-wing aeroplane will most often feel the onset of lift more readily than the pilot of a high wing aeroplane. Of course, the pilot of the low wing (or any) aeroplane must be cautious and not try to climb out too soon on the ground effect bubble, but must wait until the aeroplane has accelerated to its proper airspeed before climbing further.

On takeoff, at neutral trim the Cherokee will not (unless somewhat aft loaded) lift off by itself as will the Cessna 172. Some affirmative, but gentle aft yoke at the appropriate airspeed, approximately 50-55 knots (57.5 63.25 mph) depending upon gross weight, will be necessary to rotate and lift off. This is because the Cherokee normally sits at a level or slightly negative Alpha during the initial takeoff run. Also, and for the same reason, in neutral wind conditions, minimum right rudder input to

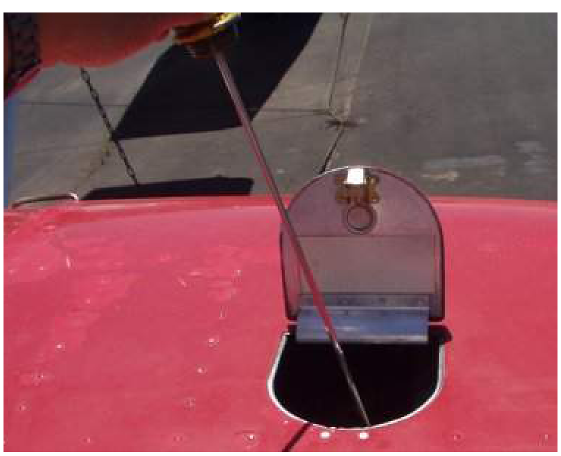
* *Just a word about Warrior engine upgrades, it is this writer's understanding that the popular Sykes STC (Arch-Warrior SA2946SO) and the few others that exist which permit and regulate the installation of a 180 hp Lycoming 0-360, and which also require the installation of a larger propeller on the Warrior airframe, curiously do not include a concurrent increase in he Warrior's MGW (maximum gross weight), making the choice to do this expensive, PITA upgrade somewhat dubious. Better to just sell the Warrior and buy a good Archer.*

Fuelling a Piper Cherokee

Checking fuel level in Cessna 172 left tank



Piper Cherokee with left cowling open for engine inspection during walk-around (both sides open similarly)



Some Piper Cherokees offer large doors on both sides of the cowling while others offer the entire top cowling to be easily removed.

offset P-factor is required during the takeoff run.

The Cherokee's roll rate, particularly with a rectangular wing, is faster than that of most other GA aeroplanes. At the commencement of a turn the rectangular wing produces little or no adverse yaw, less in any event than does the semi-tapered Cherokee wing and definitely less than does a Cessna 172. Overall, the Hershey Bar wing Cherokee feels more maneouverable and sprightly than the 172, and very like a sport aeroplane.

When landing a Cherokee the onset of ground effect can be clearly felt and may enable very gentle and satisfying touchdowns. While a gentle landing may certainly also be made in a Cessna 172, in this regard the Cherokee is more consistent and seems to require less finesse.

When the wind blows strong the Cherokee has an obvious advantage over the Cessna 172 whilst on the ground. As mentioned, the Cherokee's vertical centre of gravity (C. G. v) is much closer to the ground than that of the Cessna 172. Also, the Cessna's wing sitting up above is more likely to catch the wind than the Cherokee's low wing. Accordingly, the Cherokee naturally sits on the ground more firmly and stably and is less prone to be tipped over by a mighty blast than is the 172. Additionally and most significantly, as mentioned, the 172's wide undercarriage is only 83% as wide as the Cherokee's undercarriage which also handicaps it when attempting tight turns whist taxiing.

Not only does the Cherokee's wider undercarriage permit easier and tighter turns, it is far more stable than the 172 in a fast turn. Additionally, the high-wing Cessna 172 is more vulnerable to cross- winds on takeoff than is the Cherokee. This writer recalls being almost tipped up onto the downwind wheel in a Cessna 172, when a sudden powerful cross- wind gust struck the aeroplane during takeoff. This writer recalls that the Cherokee in similar winds just tends to shrug off such a gust and takes off with little problem. Our good friend Darryl knows something about dangerous cross winds in a Cessna 172.

The Cherokee's stall and departed flight characteristics are far gentler than that of the Cessna 172. As mentioned, the Cherokee does not break much if at all at the stall while the 172 has a most definite and vigorous break. While neither the Cherokee nor the Cessna 172 may be legally spun whilst at normal category, at any weight the Cessna 172 is far more likely to inadvertently spin out of even a mildly a cross- controlled stall than is a Cherokee.

More practically, because of its low wing it is much easier to look into and fill the Cherokee's fuel tanks than the Cessna 172's tanks which require a somewhat awkward and tenuous step up and climb to check the fuel quantity. On the other hand, it is far more awkward to stoop down low under the Cherokee's wing to check and to drain the wing tank's sumps prior to takeoff than to do the same under the high wing of a Cessna 172. Also, where the Cherokee allows a complete visual inspection of the entire engine and its components during the walk-around by "un- dzusing" and removing the top of the cowling, the 172 has only a small door on the right side of the cowling for accessing the oil dip stick.

However, the 172 does have an advantage over the Cherokee with regard to entering the aeroplane — it has a door on each side of the cabin. The Cherokee unfortunately follows what has become something of a tradition regarding low-wing GA aircraft. It has only one door on the right side of the cabin which is, in any event, rather large enough, larger in fact than the Cessna 172's doors. The Cessna 172's high step- up onto a step on the main undercarriage leg and then up into the cabin is no less awkward than the Cherokee's step- up onto the wing root and then down into the cabin; but the 172 is quite a bit less awkward to depart from than is the Cherokee, just giving the Cessna 172 the edge over the Cherokee in this regard.

As mentioned above, the Cessna 172's cabin is slightly narrower than the Cherokee's. The 172's 39 ½" cabin width means that even two moderate sized adults will soon become very friendly within. At 40 ½" wide, the Cherokee's cabin is not overly spacious either, to be sure; but as she said, that extra inch makes a difference. The Cherokee cabin also has more headroom which is mighty handy in turbulence, let me tell you; so it just squeaks out a win in the space race.

Overall, while the Cessna 172 is a safe and well-made aeroplane, many find that the more lightly built 172 feels to be less substantial and durable than does the Cherokee. As mentioned, it is not a secret that with regard to the 172, the Cessna design is biased towards lightness of structure. The lighter feel of the 172's airframe as compared to the Cherokee carries through in the way each of them feel in flight as well.

Regardless of the power of the engine, the Cherokee always feels larger and heavier than it is. Not that it lacks nimbleness when such is called for; Cherokees with both rectangular and tapered wings have a very fast rate of roll as well as very good control harmony and balance in all axes. The Cessna 172 is also quite nimble; however, it does give up just a bit of maneouverability to the semi-taper wing Cherokee and just a bit more to the sporty- feeling Hershey Bar Cherokee.

Both the Cherokee and 172 are excellent IFR (Instrument Flight Rules) platforms being stable at low airspeeds and easy to keep on the localizer and glideslope. Many feel that the Cherokee is a bit more stable in turbulence and handles a cross- wind approach and landing a bit better than the 172. Here, it is the Cherokee's low wing, low centre of gravity design which makes the difference.

The Cherokee is famously very easy to fly and some say it may be too forgiving to make it the best basic trainer. A good argument can be made that the Cessna 172's definite and sharper breaking stall presents a better departed flight training example than the Cherokee's almost imperceptible stall. However, the Cherokee's gentle and predictable flight characteristics are bound to impart confidence and a sense of achievement in student pilots. Pilots graduating from the Cherokee to higher- powered, higher performance and perhaps a bit less well-mannered aeroplanes will often experience some period of adjustment; but this is always true as a pilot moves up the chain of performance to the next faster, more powerful aeroplane.

The AOPA (Aircraft Owner and Pilots Association) has found that the accident rate of all Cherokee models is significantly less than ½ of comparable aircraft while it found that the Cessna 172's accident rate shows that it only has "a very slight edge over the comparative aircraft."

For the private owner, no aeroplane can be too undemanding, safe and reliable when it comes to hauling those kids and the spouse around, or on those balmy hundred- dollar hamburger days with good friends. FBOs and flying clubs also appreciate that a rented Cherokee will virtually always be returned to the flight line in the same condition it was in when it departed. In this the Cherokee stands at the top of the heap.

UP, UP AND AWAY

The immediate popularity of the Cherokee and of its successful, substantial challenge to the Cessna 172 put the competitive bit in Piper Aviation's mouth. In 1964, the year after PA-28-180 was introduced Piper went after the Cessna 172's more powerful and larger sibling, the Cessna 182/Skylane. With the generally revered Cessna 182 square in their cross-hairs, Piper bolted the robust 235 hp Lycoming 0-540 six cylinder, horizontally opposed engine onto the Cherokee's airframe and slightly lengthened its rectangular wing. Increasing both the wing's area and aspect ratio increased efficiency and in particular load carrying ability. The PA-28-235, later named "Dakota", once again created a bold, viable and attractive alternative to an existing Cessna aeroplane.

1964 Piper PA-28-235

1964 Cessna 182/Skylane

When at its 2,900 lb. MGW, the Piper PA-28-235 does not quite match the excellent performance specs of the Cessna 182 in most areas; however, it does greatly exceed the 182/Skylane's 1,190 lb. useful load. The 235 can lift a whopping 1,433 lbs. of useful load. It had been said that the Cherokee 235 will lift anything that you can shoehorn into it. One might expect that if the Cherokee 235 was unloaded to that of the 182's 1,190 lb. useful load that its performance would at that weight would then likely match or perhaps exceed the 182.

Striking at the other end of the Cessna line in the same year, Piper took what it had successfully put into competition with the Cessna 172 and entered it squarely against with what was then the most popular basic training aircraft in the world, the Cessna 150. In 1964 Cessna had just redesigned the 150 to incorporate the "Omni-Vision" rear window cabin which was seen as by many as a definite improvement with regard to making its very snug cabin seem to be brighter, airier and less claustrophobic. However, the Cessna 150 still retained its 100 hp Continental O-200. In 1964 the C-150's useful load was upgraded by 100 lbs., but was still only 490 lbs.


1964 Piper PA-28-140 Trainer

1960 Cessna 150

It had only two narrow seats in the cabin with a small, dubiously useful 120 lb. maximum weight, two- passenger child seat option for the baggage compartment. All of this greatly limited its overall utility except, of course, with regard to its role as a basic trainer which it performed very well.

Piper's newest entry into the basic trainer market was the economical 150 hp PA-28-140 which was type certified on 14 February 1964 and introduced to the public shortly thereafter. Stripped of some of the luxury amenities of the Cherokee 160 to keep its price competitive with the Cessna 150, the Cherokee 140 was larger, roomier, and more powerful than the Cessna 150, with a useful load of 949 lbs and with four full- sized seats all located within the Cherokee's cabin (some budget model Cherokee 140 trainers had the rear seats removed). Shortly after its introduction, as Piper had hoped, the humble Cherokee 140 was beginning to be seen by many FBOs, flight schools and flying clubs as a better bang for the buck than the two- seat Cessna 150. Not only was the 150 hp Cherokee as excellent a basic trainer as the Cessna 150, it could also do triple duty as a primary/instrument trainer, and as an excellent and comfortable touring aeroplane for three or, with less fuel on board, four adults. With its 150 hp Lycoming the PA-28-140 is the only Cherokee whose PA- number does not match its horsepower.

After the Cherokee's more than six years of resounding success and the entire Cherokee line enjoying world -wide popularity, in 1967 the development of the first retractable undercarriage Cherokee, the PA-28R-180 "Arrow" commenced. With a 180 hp, fuel injected Lycoming IO-360-B1E and a constant speed propeller, a slightly smaller nosewheel (5.00 x 5) to accommodate the nosewheel's retracting mechanism, the "Arrow" was type certified on 8 June 1967 and was essentially, at first, a retractable undercarriage version of the Cherokee 180. Upgraded in 1969 with a 200 hp Lycoming IO-360-C1C engine, at 75% power and at 7.000' the 200 hp Arrow cruises at 144k (165.6 mph) with a top speed of 153k (175.95 mph). It's not the fastest in its class to be sure, but fast enough and possessing all of those excellent Cherokee qualities which have made the Arrow a very popular cross county aeroplane. Relatively inexpensive for a retractable, four-seat single, many FBOs and flight schools keep an Arrow or two on hand so that aside from doing some speedy touring, pilots may use it to economically obtain an FAR 61.31 complex aeroplane endorsement (retractable undercarriage, flaps, controllable pitch propeller).

The versatile and highly utilitarian basic Cherokee airframe would go on to be widened and stretched to accommodate six on board, given engines of greater and greater power, T-tailed, pressurised, tweaked and refined into a world-class high-performance aeroplane.

The mid-market, just right aeroplane, the Cherokee 180 continuously received refinements over time,

1972 Piper PA-28R-200 "Arrow" with "Hershey Bar" wings and aftermarket "anti-vortex" wing tips

a third side window, a more aerodynamically efficient cowling, more luxurious interior appointments, lever engine controls, and even eventually a semi-tapered wing. However it may be dressed up, with more than 10,000 and counting having been built, the Cherokee PA-28-180/-181 "Archer" series has been and remains one the best-loved and most popular GA aeroplanes ever built.

In the end, just as there are cat people and dog people, Chevy people and Ford people, there are also high- wing and low- wing people and Cessna and Piper people as well; and you know, in this great world there is room for us all. Whatever your particular preference may be, I think that it is well to recognise and celebrate Piper Aviation's great prescience, willingness to invest in and to chance the unknown outcome of providing GA with a brand new, economical, dependable, versatile and highly competitive low- wing design which has stood the test of time and has ultimately enriched and enhanced all of aviation by bringing to life an aeroplane for the rest of us.

1976 Piper PA-28R-201 Arrow

1979 Piper PA 28R-201T turbocharged, T-Tailed Arrow

CHEROKEE SPRING

Mitchell Glicksman © 2014

ROLLING AND BUMPING ON THE TRAIN FROM Rockville Centre to Amityville I am thinking how much I am going to enjoy today's flying lesson on this lovely early Spring Saturday. The air is not really cold, but more brisk-like and I think that in the sultry depths of the dog days of August how welcome such clear, fresh air would indeed be.

Having hard-earned the $12 at my after school job that I would need for an hour's lesson, I feel that I couldn't possibly put it to better use. All week I would go over and over the last week's lesson in my head, what I had learned, what I did wrong and what I did right. I even drew a full size J-3 instrument panel and taped it to the front of my desk and imagined the needles appropriately moving when I moved the stick I had made from a broom handle and pushed imaginary rudder pedals.

There I was at my desk, taxiing to takeoff and up, around the pattern, coordinating each turn (mind now, ball in the centre), maintaining correct airspeed and levelling off at exactly 900', reducing the imaginary throttle, then downwind until the runway threshold is off my shoulder, throttle back and down and around to base (watch that ball, now), then on final approach, airspeed right on the money, and then the flare and…bump…a good landing (this time), maybe a little dance on the rudder pedals if the wind is contrary, don't let it swing, and then off the runway to taxi back and do it all again.

Little could I have imagined in 1961 what flight simulation would one day become; but you know, the imagination of a thirteen year- old can be quite powerful. This crude drawing was my monitor. I "saw" those instruments changing and I "felt" every turn, climb and descent. I flew the flight simulator of my mind every day for hours on end and completely and easily suspended disbelief.

So, having finally gotten off the train at Amityville station (the 30 minute trip always seems to take all day) and taken one of the waiting taxis to Zahn's Airport, I am home. This is where my soul lives. I leave it here for safe keeping every Saturday afternoon and rejoin it again the next Saturday morning that the weather permits.

I walk from where the taxi leaves me off on Albany Avenue onto hallowed ground -- the airport. Even the loose, dusty dirt and sparse, grey-green, weedy grass seems special here. As I approach the main "building", not really more than an old wooden shack, the smell of aviation fuel sharpens my senses and the aeroplanes haphazardly strewn about the place fill my eyes. Half a dozen yellow J-3s, three or four Piper Colts, a Tri-Pacer or two, all with the big, round, green "Amityville Flying Service" sticker on their tails (AFS is a Piper dealer, after all). Mixed amongst these flying school planes is a Helio Courier, a Comanche 250, a blood-red Staggerwing Beech and a blue and yellow Stearman, and on different days every type and kind of aeroplane that I had ever heard of, even a civilianized B-17G that once came to visit.

But something is different today; today there is a sort of a crowd surrounding an aeroplane that I had not seen there before. It's parked at the gas pumps in front of the operations shack. As I ease my way forward I see that it's that new Piper, the one that I had seen in Flying magazine ads, it's the new Cherokee 160, the first one on Long Island.

White with red trim it sits low on its tricycle undercarriage, a large, smooth spinner at the nose. Like the Comanche before it, it has a low wing, still a strange look for a Piper. Some men are up on the wing looking into the open door. I can see the black instrument panel and the red leather seats. I hear some guys talking about how this aeroplane and others like it, too, soon will be available for instruction and rental. This really gets my attention and I ask one of them how much it will cost to rent. They don't know, they say, but it's bound to be at least as much as the Tri-Pacers, probably a bit more.

I had taken a lesson in one of the Tri-Pacers [pict] just to see what a heavier and more powerful aeroplane felt like. It was expensive for me, but very exciting. At all other times I had to be content to fly a J-3 with the instructor up front blocking all but the smallest amount of forward view. I was getting pretty good at flying the old Cub, but I was still 2½ years from being old enough to solo. When I first came to Zahn's to fly Cubs I already had 12 hours of flight instruction time in a Luscombe 8A floatplane. I had started flying when I was just 12 years-old. I was a big kid for my age and they didn't ask me to give them a parents' permission note. Suburban Seaplane Base at the Long Beach bridge was an easy- going outfit, very professional and all but also loose and passionate about flying in that old-time aviation style of the 20's and 30's. They did a rush hour Manhattan run four times each day in a Cessna 195 on floats for businessmen who didn't want to spend hours in traffic and who could afford the ticket. That was their main source of income. They also had two Luscombes for flight instruction at $16 per hour with Gene, their instructor, a man of no more than 20 or 21 at that time whom I worshipped.

I could only afford half-hour lessons and even at that, $8 was hard to come by. Still, the feeling of being up in the air and at the controls of a real aeroplane was electrifying and addicting. No other seventh grader was doing anything like this that I knew of. Even those guys at school who bragged, truthfully or not that they had slept with a girl had nothing on me (who definitely had not). I flew aeroplanes, dammit; beat that!

As I gazed at the Cherokee's gleaming white beauty along with all the other pilots there, I decided that one day I would fly it and see what a real aeroplane felt like to fly. It took a while, but I finally had enough money coming in from a second job and a little more than a year later I took one hour dual for $26 in their brand new Cherokee 180.

The feel and sound of all that power up front was thrilling. I taxied it to the side of the runway and did the run up according to the checklist. The instructor was very patient, he knew that I had a lot of hours already and was just waiting to turn 16 so that I could solo. He let me do everything. Checking that there was no one on final, I took the active and opened the throttle. That acceleration was so much greater than I had ever felt before in an aeroplane that I was flying. The instructor told me to rotate at 60 mph, I did and up we went, climbing out at almost 1,000 feet per minute (we were lightly loaded). This was no Cub, that was for sure. The first climbing turn away from the airport was so easy; the Cherokee was a real pussycat. It was even smoother than the Tri-Pacer (which is also a very nice aeroplane to fly).

We climbed to 4,000' in no time, it seemed, and the instructor let me do whatever I wanted to. I did lazy eights and chandelles and steep turns and stalls and all. I even did a spin or two as we were loaded within the utility category. It was the most fun I had ever had up to that time. As the hour was waning fast (too fast) I flew the Cherokee back to the airport, entered the pattern and with the instructor calling out the appropriate airspeeds, I brought it down to a pretty good landing -- not at all bad for a 14 year old kid.

After the flight, as the instructor was signing my log book, he said that as far as he was concerned I was now checked out in the Cherokee and that he would solo me in it if I were old enough. Well, that made my day, week and year. It still resonates within. I was so proud, as I felt the pilot in me had had truly arrived. When I finally did solo just after my 16th birthday at MacArthur (now Islip) Airport in a Cessna 150 I remember thinking back to that day in that Cherokee 180 and how it had given me the confidence and ambition to go on and really learn the art of flying.

In the years after that I flew a great many kinds of GA aeroplanes including all kinds of Cherokees, but in my mind I can still see and feel that first time I saw one, and the first time I flew one. All first times are unique and thereby precious, and those first times still ring clear as among the most precious of all.

DEVELOPER'S NOTES

YEARS AGO we discussed how great it would be to Accu-Sim both a Cessna 172 and a Piper Cherokee, and if you are reading this manual, then that moment has finally come.

Both the Piper Cherokee and Cessna Skyhawk are the two most popular aircraft in general aviation. However, while they have similar performance numbers, their designs are quite different. If you prefer high winged over low-winged aircraft (or vice versa), you can for the first time experience and compare these characteristics in a flight simulation.

Piper marketed these differences as advantages, saying the low wing design offered better visibility and was more stable on the ground with its wider landing gear (using struts). The wings are also a newer cantilever type (internally braced that require no external bracing) which gives both strength and a more modern, sleek look Piper also focused on the Cherokee's economical design and its ability (Cherokee 180) to carry four 170-pound adults. Lastly, the Cherokee is famous and almost unique with its most gentle stall characteristics.

With its release in 1960, the Cherokee was an instant success. Over the years many Cherokee owners remained happy with their new aircraft. When people use and get to know a well designed machine of any type, over time it's natural to become attached and even loyal to the machine. That is because we see through the nuts and bolts and into its heart that lives from human ingenuity and dedication. The Cherokee exemplifies a machine with a "heart" as it continues to impress and perform over five decades later.

However, in a changing world of over-regulation and lawsuits, general aviation almost became an endangered species. Both Piper and Cessna were forced to close shop on the production of their two single engine icons. Lawmakers responded with common sense legal reform that offered shelter to aircraft companies; allowing both of these legends to return to production. More reform is needed still, in regards to the over regulated laws governing aviation today, especially for these small private aircraft. Personal responsibility is what made general aviation flourish in the past and it is needed once again.

A2A Simulations is proud to present the legendary Piper Cherokee in a form that is similar to what you might find at your local airport today. Our aircraft is based on a mid- 1960's design, in the peak of general aviation aircraft production. The next time you are at an airport and see a Cherokee, first look to see if it has the constant chord Hershey bar wing. If it does, count the number of windows it has on the side. If it has two windows, chances are, if you look inside, you will see something quite similar to what you will experience with the A2A Accu-Sim Piper Cherokee 180.

Thank you for purchasing our Cherokee. We look forward to a long future of providing immersive flying experiences to both home and large, commercial simulators. Long live the communities of aviation and flight simulation!

A2A simulations

THE AIR TO AIR SIMULATIONS TEAM

FEATURES

- A true propeller simulation.
- Interactive pre-flight inspection system.
- Gorgeously constructed aircraft, inside and out, down to the last rivet.
- Physics-driven sound environment.
- Complete maintenance hangar internal systems and detailed engine tests including compression checks.
- Visual Real-Time Load Manager.
- 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 Lycoming 360 engine. Now the gauges look beneath the skin of your aircraft and show you what Accu-Sim is all about.
- Bendix King Avionics stack with authentic period LED's. Three in-sim avionics configurations including no GPS, GPS 295, or the GNS 400. Built-in, automatic support for 3rd party GNS 430 and 530.
- STEC-30 Autopilot built by the book.
- Electric starter with accurate cranking power.
- Dynamic ground physics including both hard pavement and soft grass modeling.
- Primer-only starts.
- Persistent airplane even when the computer is off.
- Four naturally animated passengers that can sit in any seat.
- 3D Lights 'M' (built directly into the model).
- Pure3D Instrumentation.
- In cockpit pilot's map.
- Authentic fuel delivery includes priming and proper mixture behavior. Mixture can be tuned by the book using the EGT or by ear. It's your choice.
- A2A specialized materials with authentic metals, plastics, and rubber.
- Oil pressure system is affected by oil viscosity (oil thickness). Oil viscosity is affected by oil temperature. Now when you start the engine, you need to be careful to give the engine time to warm.
- Eight commercial aviation sponsors have supported the project including Phillips 66 Aviation, Champion Aerospace, and Knots2u speed modifications.
- And much more ...

QUICK-START GUIDE

CHANCES ARE, IF YOU ARE READING this manual, you have properly installed the A2A Accu-Sim Cherokee 180 Trainer. However, in the interest of customer support, here is a brief description of the setup process, system requirements, and a quick start guide to get you up quickly and efficiently in your new aircraft.

SYSTEM REQUIREMENTS

The A2A Simulations Accu-Sim Cherokee 180 Trainer requires the following to run:

- Requires licensed copy of **Microsoft Flight Simulator X**
- **Service Pack 2** (**SP2**) required

NOTE: while the A2A Accu-Sim Cherokee 180 Trainer may work with SP1 or earlier, many of the features may not work correctly, if at all. We cannot attest to the accuracy of the flight model or aircraft systems under such conditions, as it was built using the SP2 SDK. Only Service Pack 2 is required. The Acceleration expansion pack is fully supported but is NOT REQUIRED.

OPERATING SYSTEM:

- Windows XP SP2
- Windows Vista
- Windows 7
- Windows 8 & 8.1

PROCESSOR:

- 2.0 GHz single core processor (3.0GHz and/or multiple core processor or better recommended)

HARD DRIVE:

- 250MB of hard drive space or better

VIDEO CARD:

- DirectX 9 compliant video card with at least 128 MB video ram (512 MB or more recommended)

OTHER:

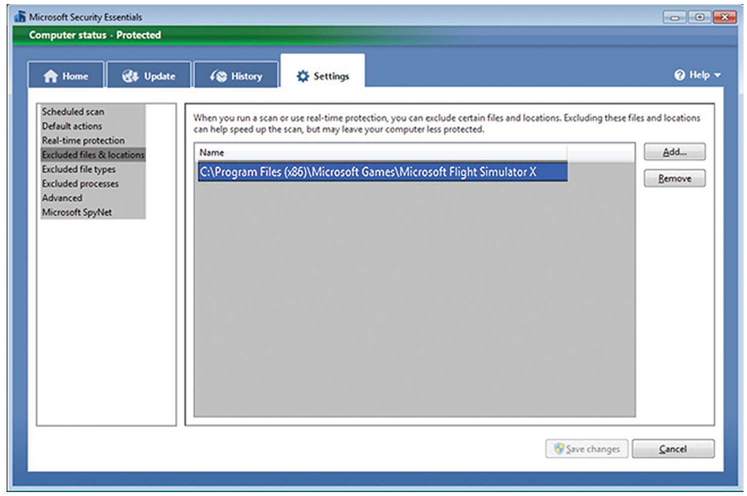
- DirectX 9 hardware compatibility and audio card with speakers and/or headphones

INSTALLATION

Included in your downloaded zipped (.zip) file, which you should have been given a link to download after purchase, is an executable (.exe) file which, when accessed, contains the automatic installer for the software.

To install, double click on the executable and follow the steps provided in the installer software. Once complete, you will be prompted that installation is finished.

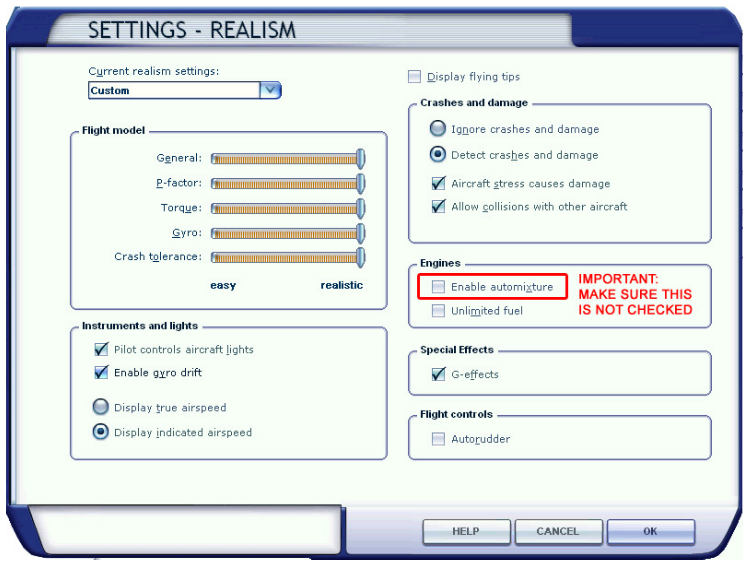
IMPORTANT: If you have Microsoft Security Essentials installed, be sure to make an exception for Microsoft Flight Simulator X as shown on the right.



REALISM SETTINGS

The A2A Simulations Accu-Sim Cherokee 180 Trainer was built to a very high degree of realism and accuracy. Because of this, it was developed using the highest realism settings available in Microsoft Flight Simulator X.

The following settings are recommended to provide the most accurate depiction of the flight model. Without these settings, certain features may not work correctly and the flight model will not perform accurately. The figure below depicts the recommended realism settings for the A2A Accu-Sim Cherokee 180 Trainer.



Flight Model

To achieve the highest degree of realism, move all sliders to the right. The model was developed in this manner, thus we cannot attest to the accuracy of the model if these sliders are not set as shown above. The only exception would be "Crash tolerance."

Instruments And Lights

Enable "Pilot controls aircraft lights" as the name implies for proper control of lighting. Check "Enable gyro drift" to provide realistic inaccuracies which occur in gyro compasses over time.

"Display indicated airspeed" should be checked to provide a more realistic simulation of the airspeed instruments.

Engines

Ensure "Enable auto mixture" is NOT checked.

Flight Controls

It is recommended you have "Auto-rudder" turned off if you have a means of controlling the rudder input, either via side swivel/twist on your specific joystick or rudder pedals.

Engine STRESS DAMAGES ENGINE

(Acceleration Only). It is recommended you have this **UNCHECKED.**

QUICK FLYING TIPS

- ✪ To Change Views Press A or SHIFT + A.
- ✪ Keep the engine at or above 800 RPM. Failure to do so may cause spark plug fouling. If your plugs do foul (the engine will sound rough), try running the engine at a higher RPM. You have a good chance of blowing them clear within a few seconds by doing so. If that doesn't work, you may have to shut down and visit the maintenance hangar.
- ✪ On landing, once the airplane settles slowly pull back on the yoke for additional elevator braking while you use your wheel brakes. Once the airplane has slowed down you can raise your flaps.
- ✪ Be careful with high-speed power-on dives (not recommended in this type of aircraft), as you can lose control of your aircraft if you exceed the max allowable speed.
- ✪ For landings, take the time to line up and plan your approach. Keep your eye on the speed at all times.
- ✪ Using a Simulation Rate higher than 4× may cause odd system behavior.
- ✪ A quick way to warm your engine is to re-load your aircraft while running.
- ✪ Lean your engine during ground operations to avoid spark plug fouling.

ACCU-SIM AND THE CHEROKEE 180

ACCU-SIM IS A2A SIMULATIONS' GROWING FLIGHT SIMULATION engine, which is now connectable to other host simulations. In this case, we have attached our Accu-Sim Cherokee 180 to Microsoft Flight Simulator X to provide the maximum amount of realism and immersion possible.

WHAT IS THE PHILOSOPHY BEHIND ACCU-SIM?

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 life. This is Accu-Sim, where no two flights are ever the same.

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 Accu-Sim aircraft is quite complete with full system modeling and flying an aircraft such as this 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 may not run smoothly. 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

We have gone to great lengths to bring the internal physics of the airframe, engine, and systems to life. 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 an actual 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 window that is cracked opened.

BE PREPARED – STAY OUT OF TROUBLE

The key to successfully operating almost any aircraft is to stay ahead of the curve and on top of things. Aircraft are not like automobiles, in the sense that weight plays a key role in the creation of every component. So, almost every system on your aircraft is created to be just strong enough to give you, the pilot, enough margin of error to operate safely, but these margins are smaller than those you find in an automobile. So, piloting an aircraft requires both precision and respect of the machine you are managing.

It is important that you always keep an eye on your oil pressure and engine temperature gauges. On cold engine starts, the oil is thick and until it reaches a proper operating temperature, this thick oil results in much higher than normal oil pressure. In extreme cold, once the engine is started, watch that oil pressure gauge and idle the engine as low as possible, keeping the oil pressure under 120psi.

PERSISTENT AIRCRAFT

Every time you load up your Accu-Sim Cherokee 180, you will be flying the continuation of the last aircraft which includes fuel, oil along with all of your system conditions. So be aware, no longer will your aircraft load with full fuel every time, it will load with the same amount of fuel you left off when you quit your last flight. You will learn the easy or the hard way to make, at the very least, some basic checks on your systems before jumping in and taking off, just like a real aircraft owner.

Additionally, in each flight things will sometimes be different. The gauges and systems will never be exactly the same. There are just too many moving parts, variables, changes, etc., that continuously alter the condition of the airplane, its engine and its systems.

NOTE: Signs of a damaged engine may be lower RPM (due to increased friction), or possibly hotter engine temperatures.

SOUNDS GENERATED BY PHYSICS

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 Cherokee 180 and includes engine sputter / spits, bumps and jolts, body creaks, engine detonation, runway thumps, and flaps, dynamic touchdowns, authentic simulation of air including buffeting, shaking, broken flaps, 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. Know that when you hear something, it is being driven by actual system physics and not being triggered when a certain condition is met. There is a big difference, and to the simulation pilot, you can just feel it.

GAUGE PHYSICS

Each gauge 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, 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 requires these to behave authentically.

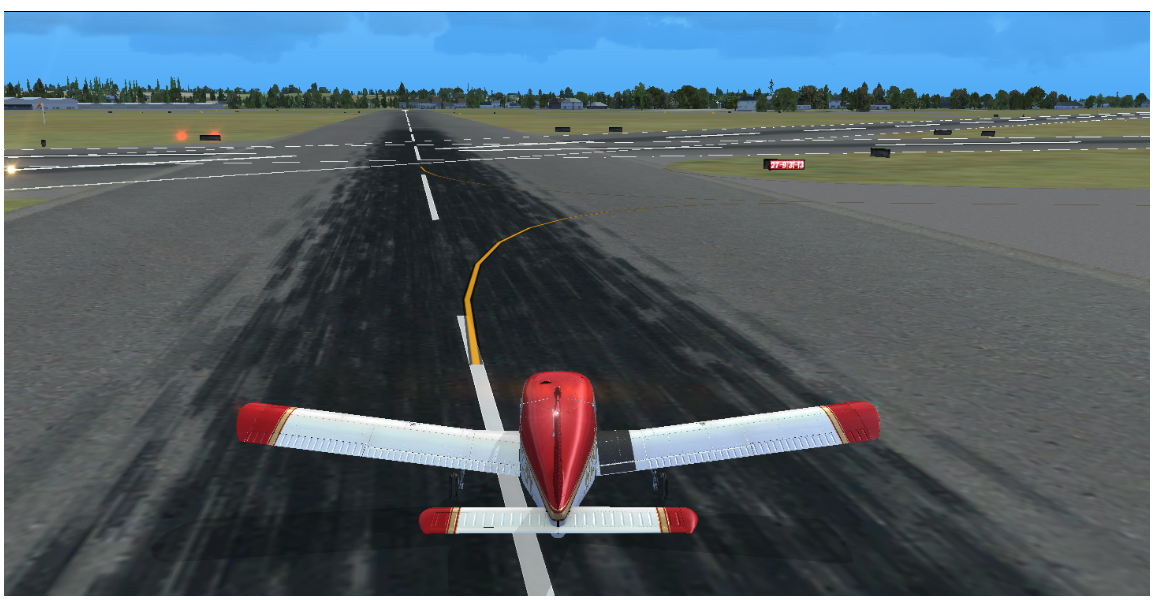
LANDINGS

Bumps, squeaks, rattles, and stress all happens in an aircraft, just when it is taxiing around the ground. Now take that huge piece of lightweight metal and slam it on the pavement. It's a lot to ask of your landing gear. Aircraft engineer's don't design the landing gear any more rugged than they have too. So treat it with kid gloves on your final approach. Kiss the pavement. Anything more is just asking too much from your aircraft.

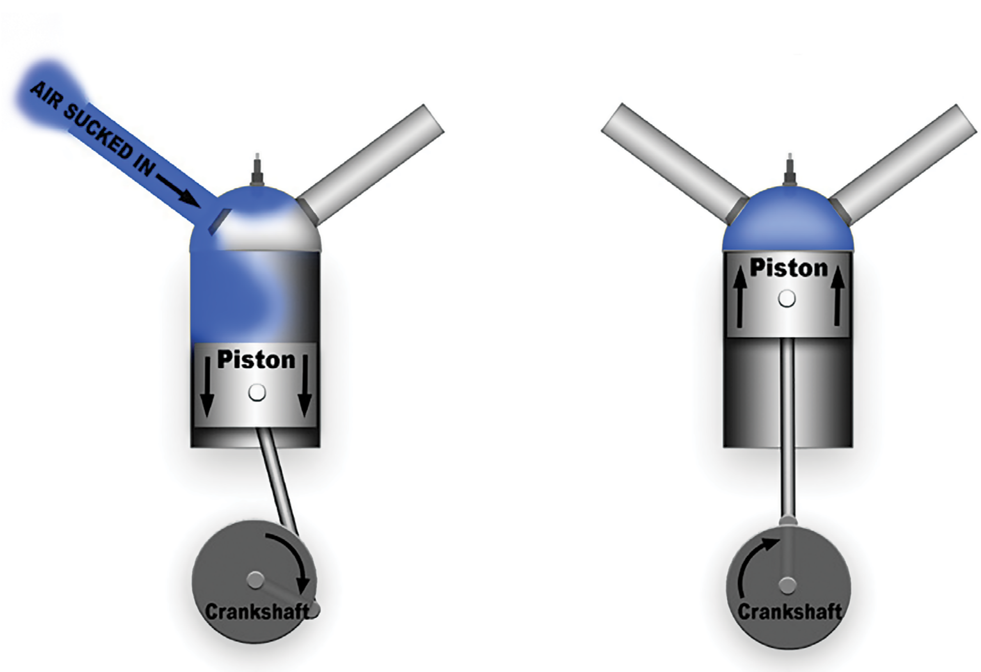
Accu-Sim watches your landings, and the moment your wheels hit the pavement, you will hear the appropriate sounds (thanks to the new sound engine capabilities). Slam it on the ground and you may hear metal crunching, or just kiss the pavement perfectly and hear just a nice chirp or scrub of the wheels.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

YOUR TURN TO FLY SO ENJOY

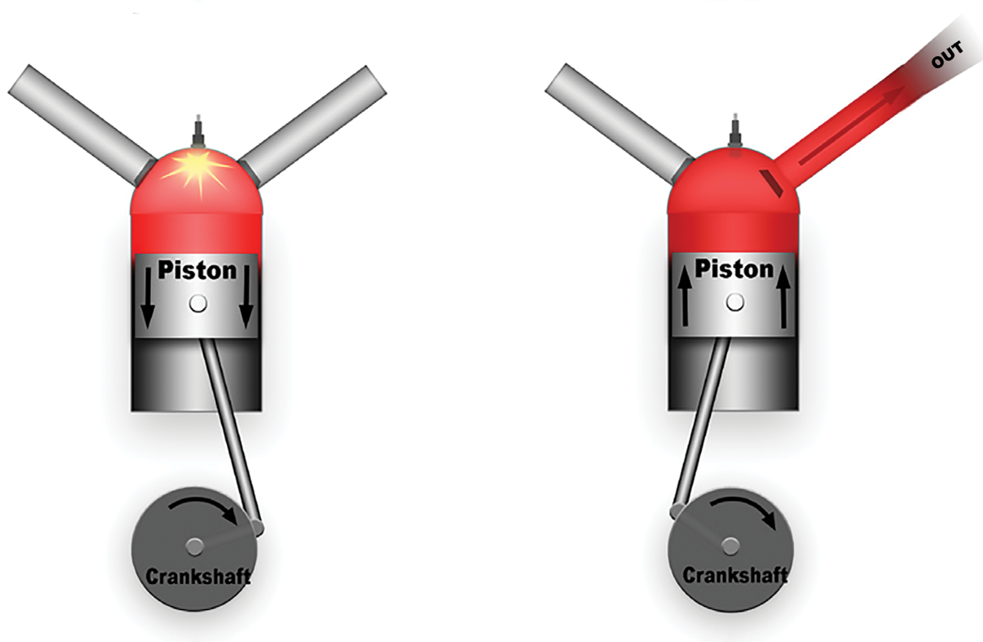
Accu-Sim is about maximizing the joy of flight. We at A2A Simulations are passionate about aviation, and are proud to be the makers of both the A2A Simulations Accu-Sim Cherokee 180. Please feel free to email us, post on our forums, or let us know what you think. Sharing this passion with you is what makes us happy.



ACCU-SIM AND THE COMBUSTION ENGINE



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 it's way back up, the burned mixture is forced out the exhaust.

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.

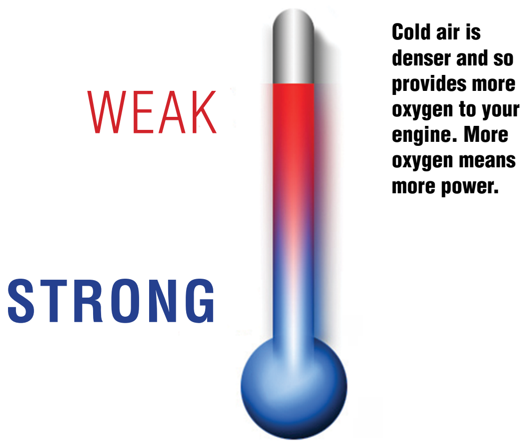
Look at these four images on the left and you will understand basically how an engine operates.

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 it's 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.



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:

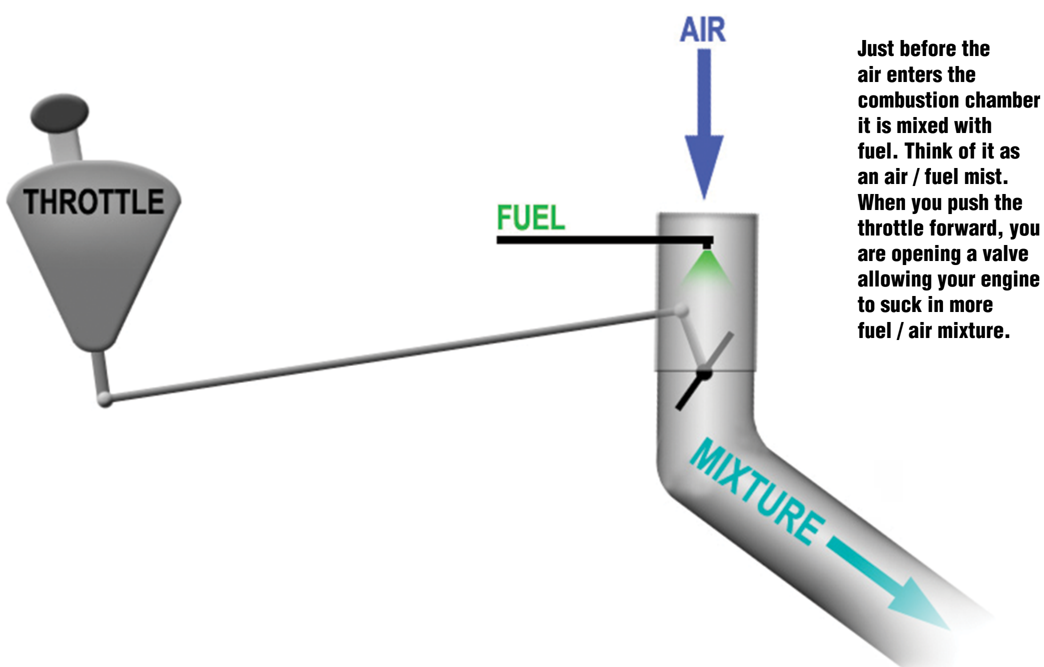
- For **HIGH POWER**, use a **RICHER** mixture.
- For **LOW POWER**, use a **LEANER** mixture.

THE MIXTURE LEVER

Most piston aircraft have a mixture lever in the cockpit that the pilot can operate. 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.



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 situation that requires it. For the most part, you will be 'throttling' your motor, meaning you will be be setting the limit.

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 29.92 in. Hg **BAROMETRIC PRESSURE**. To keep things simple, let's say 30 in. Hg 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?

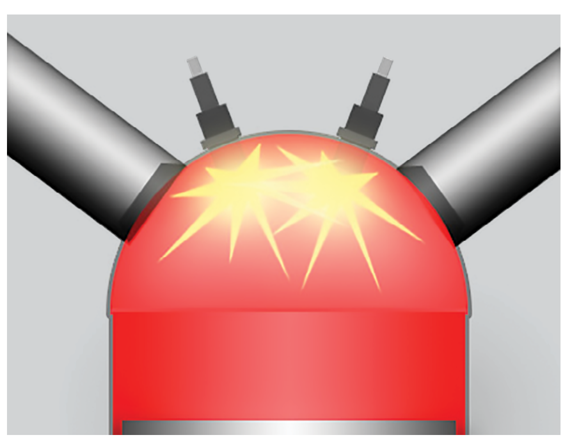
When your engine idles, it is being choked of air. It is given just enough air to sustain itself without stalling. If you could look down your carburetor throat when an engine is idling, those throttle plates would look like they were closed. However if you looked at it really closely, you would notice 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 near 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 near 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".

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.



The air and fuel are compress by the piston, then the ignition system adds the spark to create a controlled explosion.

ENGINE TEMPERATURE

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

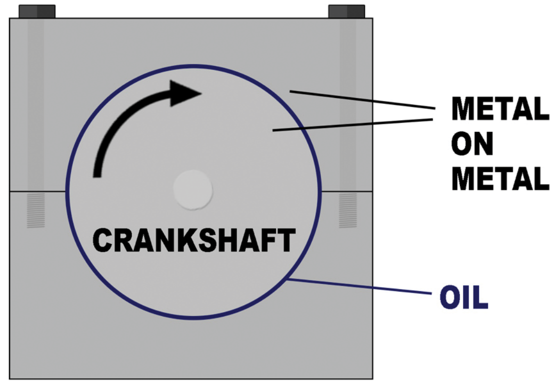
The hotter the metal, the weaker its strength.

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

LUBRICATION SYSTEM (OIL)

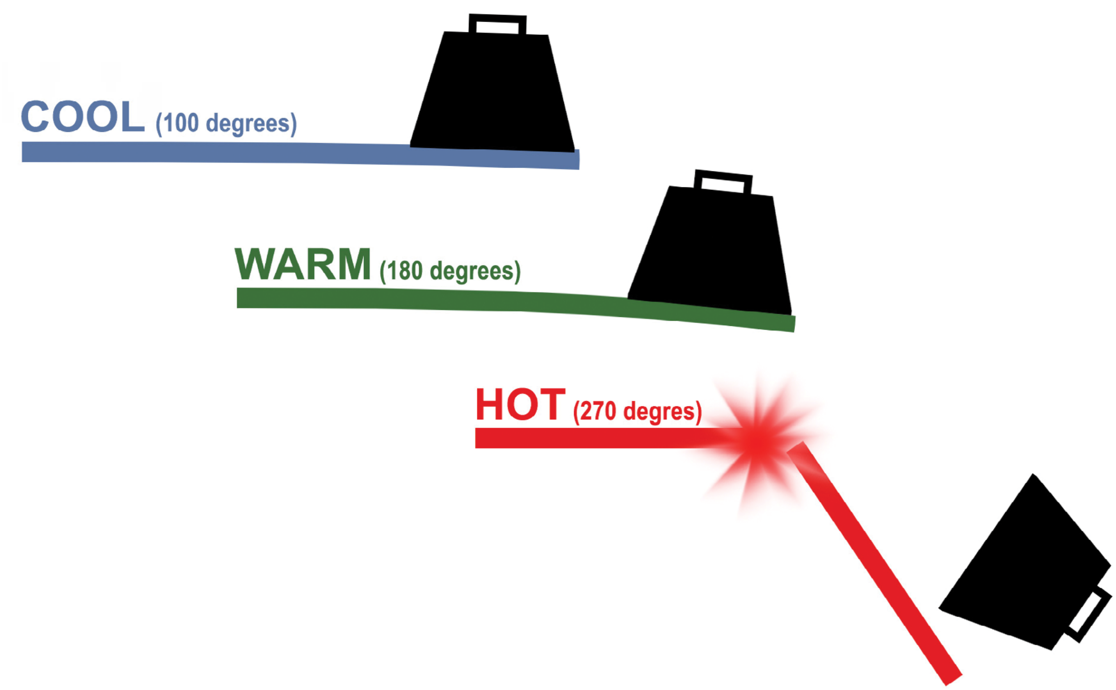
An internal combustion engine has precision machined metal parts that are designed to run against other metal surfaces. There needs to be a layer of oil between those surfaces at all times. If you were to run an engine and pull the oil plug and let all the oil drain out, after just minutes, the engine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

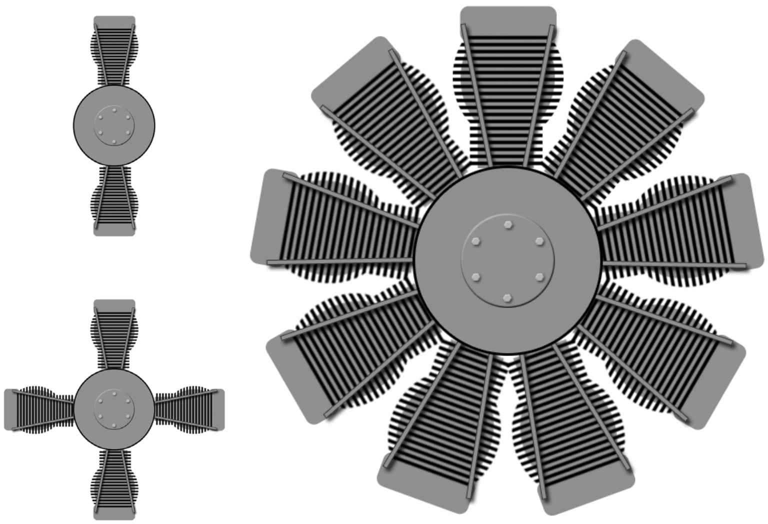
There is a minimum amount of oil pressure required for every engine to run safely. If the oil pressure falls below this minimum, then the engine parts are in danger of making contact with each other and incurring damage. A trained pilot quickly learns to look at his oil pressure gauge as soon as the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



Without the layer of oil between the parts, an engine will quickly overheat and seize.

Above 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.

Below 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 R4360

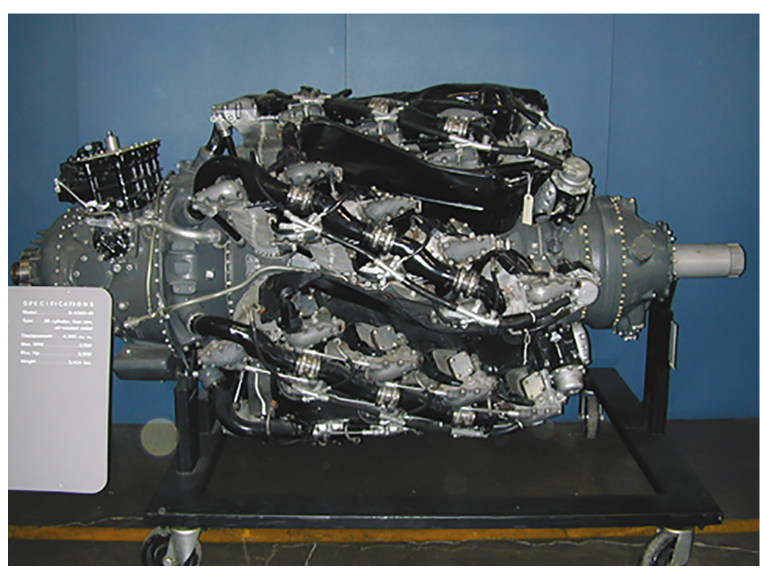
Pratt & Whitney took this even further, creating the R4360, with 28 Cylinders (this engine is featured in the A2A Boeing 377 Stratocruiser). The cylinders were run so deep, it became known as the "Corn Cob." This is the most powerful piston aircraft engine to reach production. There are a LOT of moving 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.



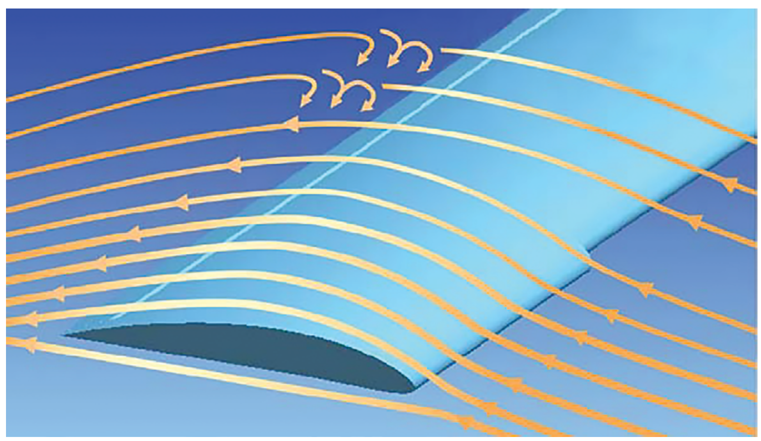
The "Corn Cob," the most powerful piston aircraft engine to reach production.

PROPELLERS

BEFORE YOU LEARN ABOUT HOW DIFFERENT PROPELLERS work, first you must understand the basics of the common airfoil, which is the reason why a wing creates lift, and in this case, why a propeller creates thrust.

It is interesting to note when discussing Bernoulli and Newton and how they relate to lift, that both theories on how lift is created were presented by each man not knowing their theory would eventually become an explanation for how lift is created.

They both were dealing with other issues of their day.



THE BERNOULLI THEORY

This has been the traditional theory of why an airfoil creates lift: Look at the image above which shows you how the shape of an airfoil splits the oncoming air. The air above is forced to travel further than the air at the bottom, essentially stretching the air and creating a lower pressure, or vacuum. The wing is basically sucked up, into this lower pressure. The faster the speed, the greater the lift.

THE NEWTON THEORY

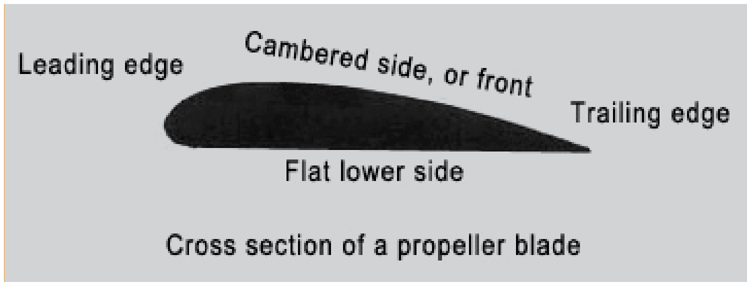
As the air travels across the airfoil's upper and lower surfaces, lift is created by BENDING the air down with great force at its trailing edge, and thus, the Newtonian force of opposite and equal reaction apply.

WHAT WE DO KNOW (AND WHAT THE PILOT NEEDS TO KNOW)

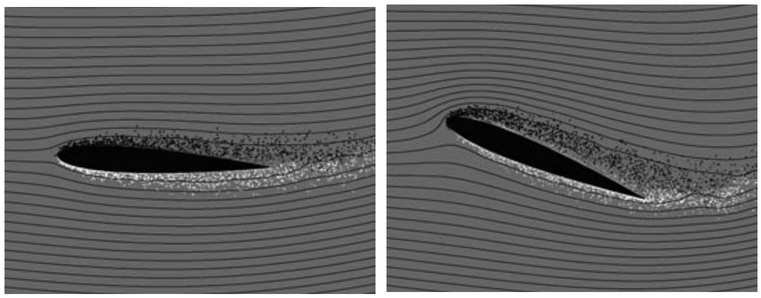
The airfoil is essentially an air diverter and the lift is the reaction to the diverted air. An airfoil's lift is dependent upon its shape, the speed at which it is traveling through the air, and its angle to the oncoming air (angle of attack)."

It is important that you note that we have deliberately not entered into the details and complete aerodynamics involved with either of the above explanations for lift as they go beyond the scope of this manual.

Unfortunately over time, the Bernoulli theory specifically has been misrepresented in many textbooks causing some confusion in the pilot and flight training community. Misrepresentations of Bernoulli such as the "equal transit theory" and other incorrect variations on Bernoulli have caused this confusion. Rather than get into a highly technical review of all this we at A2A simply advise those interested in the correct explanation of Bernoulli to research that area with competent authority.



Look at the cross section of a propeller blade. Essentially, the same process creates lift.



LEFT: Level Flight. A wing creating moderate lift. Air vortices (lines) stay close to the wing. RIGHT: Climb. Wing creating significant lift force. Air vortices still close to the wing.

For the purposes of this manual, A2A just wants you to be aware that both Bernoulli and Newton represent complete explanations for how lift is created.

The main thing we want to impress upon you here is that when considering lift and dealing with Bernoulli and Newton, it is important and indeed critical to understand that **BOTH** explanations are **COMPLETE EXPLANATIONS** for how lift is created. Bernoulli and Newton do **NOT** add to form a total lift force. **EACH** theory is simply a different way of **COMPLETELY** explaining the same thing.

BOTH Bernoulli and Newton are in fact in play and acting simultaneously on an airfoil each responsible completely and independently for the lift being created on that airfoil.

Hopefully we have sparked your interest in the direction of proper research.

WHAT IS A STALL?

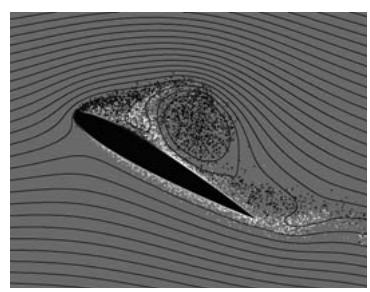
In order for a wing to produce efficient lift, the air must flow completely around the leading (front) edge of the wing, following the contours of the wing. At too large an angle of attack, the air cannot contour the wing. When this happens, the wing is in a "stall."

Typically, stalls in aircraft occur when an airplane loses too much airspeed to create a sufficient amount of lift. A typical stall exercise would be to put your aircraft into a climb, cut the throttle, and try and maintain the climb as long as possible. You will have to gradually pull back harder on the stick to maintain your climb pitch and as speed decreases, the angle of attack increases. At some point, the angle of attack will become so great, that the wing will stall (the nose will drop).

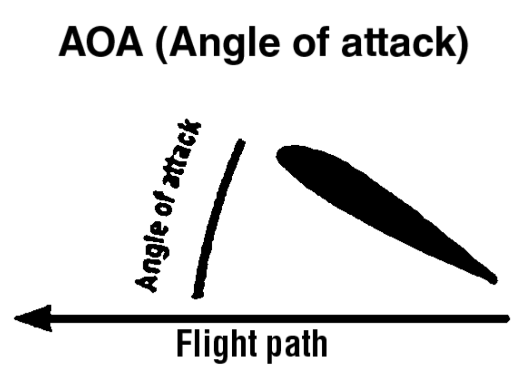
STALL

The angle of attack has become too large. The boundary layer vortices have separated from the top surface of the wing and the incoming flow no longer bends completely around the leading edge. The wing is stalled, not only creating little lift, but significant drag.

Can a propeller stall?
What do you think? More on this below.



Stall. A wing that is stalled will be unable to create significant lift.



LIFT VS ANGLE OF ATTACK

Every airfoil has an optimum angle at which it attacks the air (called angle of attack, or AoA), where lift is at it's peak. The lift typically starts when the wing is level, and increases until the wing reaches its optimum angle, lets say 15-25 degrees, then as it passes this point, the lift drops off. Some wings have a gentle drop, others can actually be so harsh, as your angle of attack increases past this critical point, the lift drops off like a cliff. Once you are past this point of lift and the angle is so high, the air is just being plowed around in circles, creating almost no lift but plenty of drag. This is what you experience when you stall an aircraft. The buffeting or shaking of the aircraft at this stall position is actually the turbulent air, created by your stalling wing, passing over your rear stabilizer, thus shaking the aircraft. This shaking can sometimes become so violent, you can pop rivets and damage your airframe. You quickly learn to back off your stick (or yoke) when you feel those shudders approaching.

Notice in the diagram on the next page, how the airfoil creates more lift as the angle of attack increases. Ideally, your wing (or propeller) will spend most of it's time moving along the left hand side of this curve, and avoid passing over the edge. A general aviation plane that comes to mind is the Piper Cherokee. An older version has what we call a "Hershy bar wing" because it is uniform from the root to the tip, just like an Hershy chocolate bar. Later, Piper introduced the tapered wing, which stalled more gradually, across the wing. The Hershy bar wing has an abrupt stall, whereas the tapered wing has a gentle stall.

A propeller is basically a wing except that instead of relying on incoming air for lift, it is spinning around to create lift, it is perpendicular to the ground, creating a backwards push of air, or thrust. Just remember, whether a propeller is a fixed pitch, variable pitch, or constant speed, it is always attacking a variable, incoming air, and lives within this lift curve.

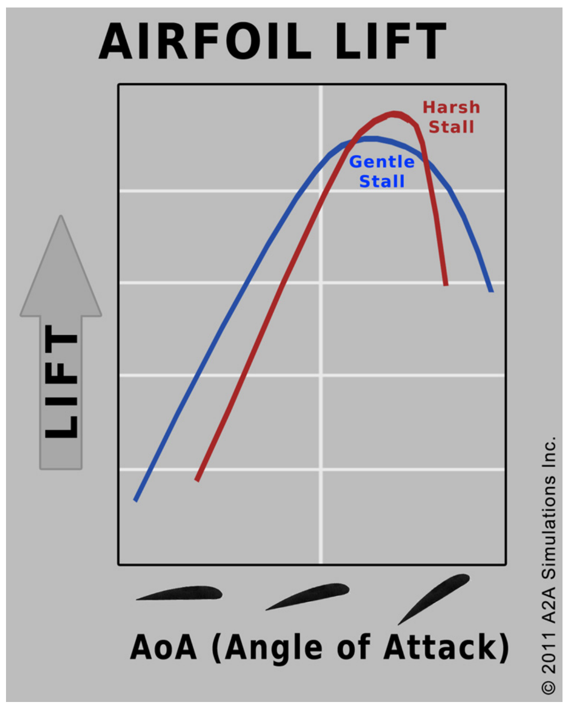
FROM STALL TO FULL POWER

With brakes on and idling, the angle at which the prop attacks the still air, especially closer to the propeller hub, is almost always too great for the prop to be creating much lift. The prop is mostly behaving like a brake as it slams it's side into the air. In reality, the prop is creating very little lift while the plane is not moving. This effect is known as prop stall, and is part of the Accu-Sim prop physics suite.

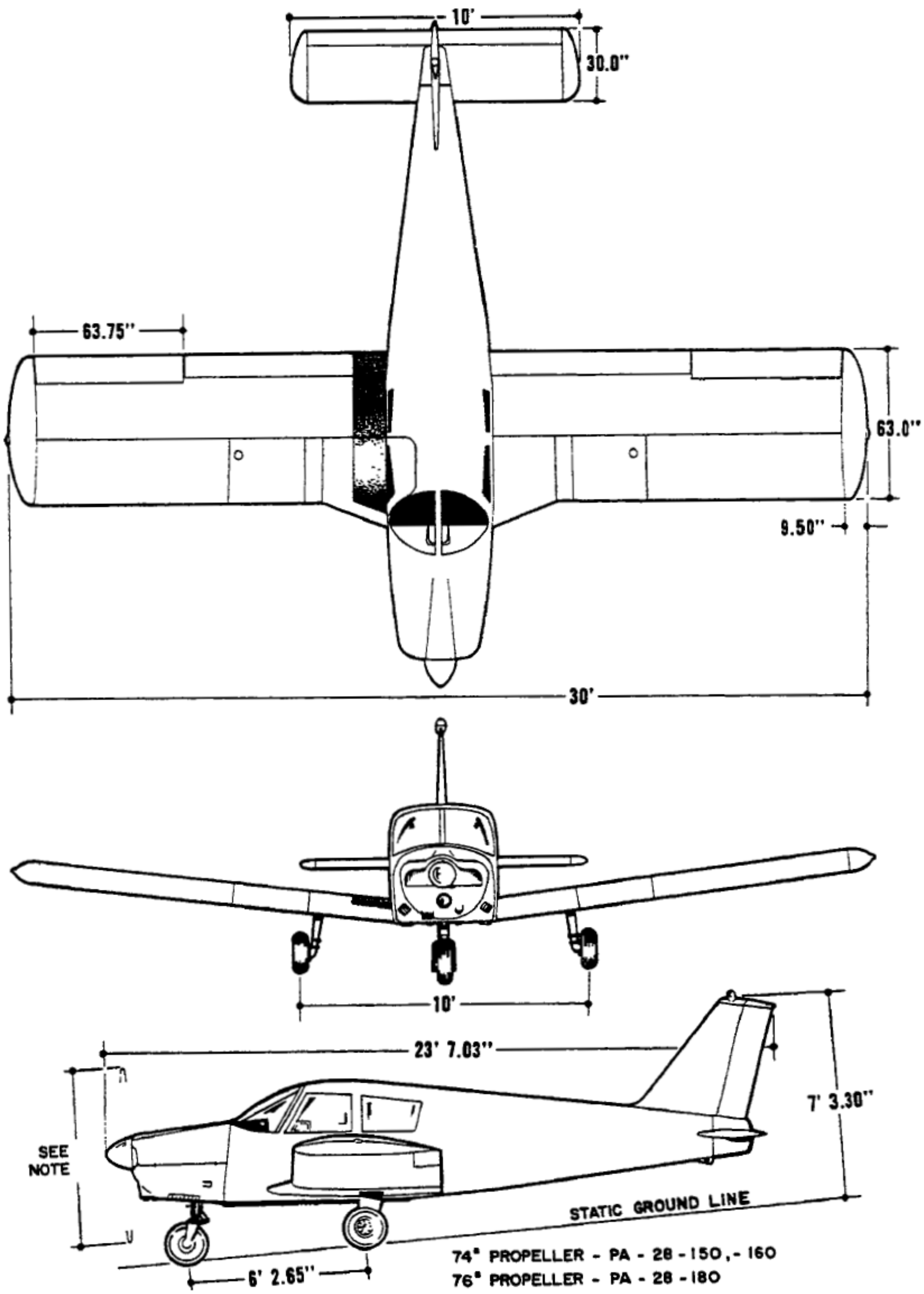
Once done with your power check, prepare for takeoff. Once you begin your takeoff run, you may notice the aircraft starts to pull harder after you start rolling forward. This is the propeller starting to get its proper "bite" into the air, as the propeller blades come out of their stalled, turbulent state and enter their comfortable high lift angles of attack it was designed for. There are also other good physics going on during all of these phases of flight, that we will just let you experience for the first time yourself.

PROP OVERSPEED

A fixed pitch prop spends almost all of it's life out of it's peak thrust angle. This is because, unless the aircraft is travelling at a specific speed and specific power it was designed for, it's either operating too slow or too fast. Lets say you are flying a P-40 and have the propeller in **MANUAL** mode, and you are cruising at a high RPM. Now you pitch down, what is going to happen? The faster air will push your prop faster, and possibly beyond it's 3,000 RPM recommended limit. If you pitch up your RPM will drop, losing engine power and propeller efficiency. You really don't have a whole lot of room here to play with, but you can push it (as many WWII pilots had to).



GENERAL



10'
30.0"
63.75"
63.0"
9.50"
30'
10'
23' 7.03"
7' 3.30"
SEE NOTE
STATIC GROUND LINE
6' 2.65"
74" PROPELLER - PA - 28 - 150, - 160
76" PROPELLER - PA - 28 - 180

ENGINES

Number of Engines: 1
Engine Manufacturer: Lycoming
Engine Model Number: O-360-A3A
Rated Horsepower: 180
Rated Speed (rpm): 2700
Bore (inches): 5.125
Stroke (inches): 4.375
Displacement (cubic inches): 361
Compression Ratio: 8.5:1
Engine Type: 4 Cylinder, Horizontally Opposed, Direct Drive, Air Cooled

PROPELLERS

Number of Propellers: 1
Propeller Manufacturer : Sensenich
Model: M76EMMS
Number of Blades: 2
Propeller Diameter (inches): 76
Propeller Type: Fixed Pitch

FUEL

Fuel Capacity (U.S. gal.): 50
Usable Fuel, Total: 48
Fuel Grade: Aviation
Minimum Octane: 100/130
Specified Octane: 100LL

OIL

Oil Capacity (U.S. Quarts): 8
Oil Specification: 15W-50 OR 20W-50
Oil Viscosity per Average Ambient Temp. for Starting

MAXIMUM WEIGHTS

	NORMAL	UTILITY
Maximum Takeoff Weight (lbs)	2400	1950
Maximum Landing Weight (lbs)	2400	1950
Maximum Weights in Baggage Compartment	200	0

STANDARD AIRPLANE WEIGHTS

Standard Empty Weight (lbs): 1270 (Accu-Sim is 1,350)
Weight of a standard airplane including
unusable fuel, full operating fluids and full oil

Maximum Useful Load (lbs): 1130
The difference between the Maximum Takeoff Weight
and the Standard Empty Weight

BAGGAGE SPACE

Compartment Volume (cubic feet): 17
Entry Width (inches): 22
Entry Height (inches): 20

SPECIFIC LOADINGS

Wing Loading (lbs per sq ft): 15.0
Power Loading (lbs per hp): 3.3

LIMITATIONS

THIS SECTION PROVIDES THE "FAA APPROVED" operating limitations, instrument markings, color coding and basic placards necessary for the operation of the airplane and its systems.

This airplane must be operated as a normal of utility category airplane in compliance with the operating limitations stated in the form of placards and markings and those given in this section and this complete handbook.

AIRSPEED LIMITATIONS

Never Exceed Speed (VNE): 171 IAS (mph)
Do not exceed this speed in any operation.

Maximum Structural Cruising Speed (VNO): 140 IAS (mph)
Do not exceed this speed except in smooth air and then only with caution

Design Maneuvering Speed (VA)
Do not make full or abrupt control movements above this speed
At 2400 LBS. G.W.: 129 IAS (mph)

Caution: Maneuvering speed decreases at lighter weight as the effects of aerodynamic forces become more pronounced. Linear interpolation may be used for intermediate gross weights. Maneuvering speed should not be exceeded while operating in rough air.

Maximum Flaps Extended Speed (VFE): 115 IAS (mph)
Do not exceed this speed with the flaps extended

AIRSPEED INDICATOR MARKINGS

Red Radial Line (Never Exceed): 170
Yellow Arc (Caution Range – Smooth Air Only): 140
Greed Arc (Normal Operating Range): 65 to 140
White Arc (Flap Down): 55 to 115

POWER PLANT LIMITATIONS

Number of Engines: 1
Engine Manufacturer : Lycoming
Engine Model No.: 0360-A3A

ENGINE OPERATING LIMITS

Maximum Horsepower: 180
Maximum Rotation Speed (RPM): 2700
Maximum Oil Temperature: 245°F

OIL PRESSURE

Minimum (red line): 25 PSI
Maximum (red line): 90 PSI

FUEL

Minimum Pressure (red line): .5 PSI
Maximum Pressure (red line): 8 PSI
Fuel Grade (AVGAS ONLY) (min octane): 100/130 - Green

PROPELLER

Number of Propellers: 1
Propeller Manufacturer : Sensenich
Propeller Model: 76EM8S5-60
Propeller Diameter: 76 inches
Propeller Tolerance
Static RPM at maximum: Not below 2275 RPM
Permissible throttle setting: Not above 2700 RPM

FLIGHT LOAD FACTORS

Positive Load Factor (max): 3.8G(Normal) 4.4G(Utility)
Negative Load Factor (max): No inverted maneuvers approved

TYPES OF OPERATION

The airplane is approved for the following operations when equipped in accordance with FAR 91 or FAR 135.

Day V.F.R.	Night V.F.R.
Day I.F.R.	Night I.F.R.
Non Icing	

FUEL LIMITATIONS

Total Capacity: 50 U.S. GAL
Unusable Fuel: 2 U.S. GAL
Usable Fuel: 48 U.S. GAL

The unusable fuel for this airplane has been determined as 1.0 gallon in each wing in critical flight attitudes.

The usable fuel in this airplane has been determined as 24.0 gallons in each wing.

NORMAL PROCEDURES

THIS SECTION CLEARLY DESCRIBES the recommended procedures for the conduct of normal operations for the Cherokee 180. All of the required (FAA regulations) procedures and those necessary for the safe operation of the airplane as determined by the operating and design features of the airplane are presented.

These procedures are provided to present a source of reference and review and to supply information on procedures which are not the same for all aircraft. Pilots should familiarize themselves with the procedures given in this section in order to become proficient in the normal operations of the airplane. The first portion of this section consists of a short form check list which supplies an action sequence for normal operations with little emphasis on the operation of the systems.

The remainder of the section is devoted to amplified normal procedures which provide detailed information and explanations of the procedures and how to perform them. This portion of the section is not intended for use as an in-flight reference due to the lengthy explanations. The short form check list should be used for this purpose.

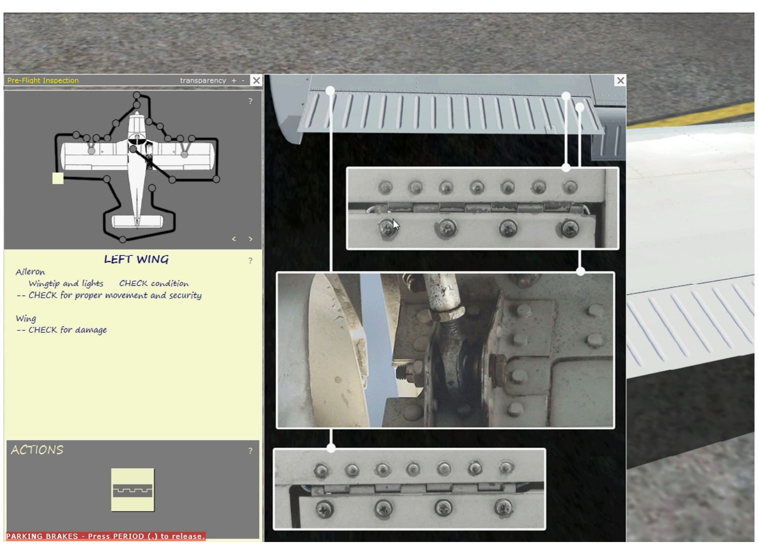
AIRSPEEDS FOR NORMAL OPERATION

The following airspeeds are those which are significant to the safe operation of the airplane. These figures are for standard airplanes flown at gross weight under standard conditions at sea level. Performance for a specific airplane may vary from published figures depending upon the equipment installed, the condition of the engine, airplane and equipment, atmospheric conditions and piloting technique.

Vx	Best Angle of Climb Speed	**76 mph**
Vy	Best Rate of Climb Speed	**85 mph**
Vbg	Best Glide Speed	**83 mph**
Vs	Stall Speed, normal configuration	**64 mph**
Vso	Stall Speed, landing configuration	**55 mph**
Vfo	Maximum Flap Extension Speed	**115 mph**
Va	Maneuvering Speed (at gross weight)	**129 mph**
Vno	Maximum Structural Cruising Speed	**140 mph**
Vne	Never Exceed Speed	**171 mph**
	Normal Climb Out	**100 mph**
	Short Field T/O, Flaps 25°	**74 mph**
	Normal Landing Approach, Flaps Up	**85 mph**
	Normal Landing Approach, Flaps 40°	**76 mph**
	Short Field Approach, Flaps 40°	**76 mph**
	Maximum Demonstrated Crosswind Velocity	**17 kts**

PREFLIGHT

When the aircraft is stopped with the engine off, press SHIFT-8 to bring up the interactive preflight inspection.



STARTING

After completion of preflight inspection:

1. Master switch ON
2. Check fuel quantity indicators
3. Apply and hold toe brakes or use parking brake.
4. Set the carburetor heat control in the full “COLD”position.
5. Select the desired tank with the fuel valve.
6. Move the mixture to the full “RICH” position.
7. Open the throttle 1/8 to 1/4 inch.
8. Turn the electric fuel pump “ON”.

In cold weather (below 40 degrees F.) prime the engine with one to three full strokes of the priming pump. If extremely cold, starting will be aided by pulling the propeller through by hand four to five revolutions (can use the engine starter as well) with the mag switch “OFF”.

After priming, turn the electric master switch on. Engage the starter and allow the engine to turn approximately one full revolution, then turn the ignition switch to the “Both” magneto position.

When the engine is firing evenly, adjust the throttle to 800 RPM. Check the oil pressure gauge for a pressure indication. If oil pressure is not indicated within thirty seconds, stop the engine and determine the trouble. If the engine fails to start at the first attempt, another attempt should be made without priming. If this fails, it is possible that the engine is over primed. Turn the magneto switch off, open the throttle slowly, and rotate the engine approximately ten revolutions with the starter. Re-prime the engine with one half the amount used in the initial attempt, turn the magneto switch to “Both”, and repeat the starting procedure.

WARM-UP

As soon as the engine starts, the oil pressure should be checked. If no pressure is indicated within thirty seconds, stop the engine and determine the trouble. In cold weather it will take a few seconds longer to get an oil pressure indication.

Warm-up the engine at 800 to 1200 RPM for at least two minutes.

GROUND CHECK

With the engine running at 2000 RPM, switch from both magnetos to only one and note the RPM loss; switch to the other magneto and again note the RPM loss. Drop off on either magneto should not exceed 125 RPM.

Check vacuum gauge. Indicator should read 5" Hg +/- l" Hg at 2000 RPM.

Check both the oil temperature and pressure. The temperature may be low for some time if the engine is being run for the first time of the day, but as long as the pressure is within limits the engine is ready for take-off. Carburetor heat should also be checked prior to take-off to be sure that the control is operating properly and to clear any ice which may have formed during taxiing. Avoid prolonged ground operation with carburetor heat ON as the air is unfiltered.

Take-off may be made as soon as ground check is completed, providing that the throttle may be opened fully without back firing or skipping, and without reduction in engine oil pressure.

TAKE-OFF

Just before take-off the following items should be checked:

1. Controls free
2. Flaps "UP"
3. Tab set
4. Mixture "RICH" (leaned for smooth operation at high elevations)
5. Carburetor heat "OFF"
6. Fuel on proper tank
7. Electric fuel pump "ON"
8. Engine gauges normal
9. Door latched
10. Altimeter and heading set
11. Safety belts/shoulder harness - fastened

The takeoff technique is conventional for the Cherokee. The tab should be set slightly aft of neutral, with the exact setting determined by the loading of the aircraft. Allow the airplane to accelerate to 50 to 60 miles per hour, then ease back on the wheel enough to let the airplane fly itself off the ground. Premature raising of the nose, or raising it to an excessive angle will result in a delayed take-off. After takeoff let the aircraft accelerate to the desired climb speed by lowering the nose slightly. To shorten take-off distance, flaps extended up to 25° may be used.

CLIMB

The best rate of climb at gross weight will be obtained at 85 miles per hour. The best angle of climb may be obtained at 74 miles per hour. At lighter than gross weight these speeds are reduced somewhat. For climbing enroute a speed of 100 miles per hour is recommended. This will produce better forward speed and increased visibility over the nose during the climb.

STALLS

The gross weight stalling speed of the Cherokee with power off and full flaps is 57 MPH. This speed is increased 9 miles per hour with the flaps up. Stall speeds at lower weights will be correspondingly less.

CRUISING

The cruising speed of the Cherokee is determined by many factors including power setting, altitude, temperature, loading, and equipment installed on the airplane. The normal cruising power is 55-75% of the rated horsepower of the engine. True airspeeds which maybe obtained at various altitudes and power settings can be determined from the charts in this handbook.

Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes, and reduces lead deposits when the alternate fuels are used. The mixture should be leaned when 75% power or less is being used. If any doubt exists as to the amount of power being used, the mixture should be in the FULL RICH position for all operations. Always enrich the mixture before increasing power settings.

The normal maximum cruising power is 75% of the rated horsepower of the engine. Airspeeds which may be obtained at various altitudes and power settings can be determined from the performance graphs provided.

Use of the mixture control in cruising flight reduces fuel consumption significantly, especially at higher altitudes. The mixture should be leaned during cruising operation above 5000 ft. altitude and at pilot's discretion at lower altitudes when 75% power or less is being used. If any doubt exists as to the amount of power being used, the mixture should be in the full "RICH" position for all operations under 5000 feet

To lean the mixture, disengage the lock and pull the mixture control until the engine becomes rough, indicating that the lean mixture limit has been reached in the leaner cylinders. Then enrich the mixture by pushing

the control towards the instrument panel until engine operation becomes smooth. If the airplane is equipped with the optional exhaust gas temperature (EGT) gauge, operate anywhere between peak EGT to 50° ROP (rich of peak).

The continuous use of carburetor heat during cruising flight decreases engine efficiency. Unless icing conditions in the carburetor are severe, do not cruise with the heat on. Apply full carburetor heat slowly and only for a few seconds at intervals determined by icing severity.

In order to keep the airplane in best lateral trim during cruising flight the fuel should be used alternately from each tank. It is recommended that one tank should be used for one hour after takeoff, then the other tank used for two hours, then return to the first tank, which will have approximately one and one half hour of fuel remaining if the tanks were full plus reserve at takeoff. The second tank will contain approximately one half hour of fuel.

APPROACH AND LANDING

Landing check list:

1. Fuel on proper tank
2. Mixture – rich
3. Elec. fuel pump on
4. Flaps - set
5. Fasten belts/harness

The airplane should be trimmed to an approach speed of about 85 miles per hour, with flaps up. The flaps can be lowered at speeds up to ll5 miles per hour, it desired, and the approach speed reduced 3 MPH for each additional notch of flaps. Carburetor heat should not be applied unless there is an indication of carburetor icing, since the use of carburetor heat causes a reduction in power which may be critical in case of a go around. Full throttle operation with heat on is likely to cause detonation.

The amount of flap used during landings and the speed of the aircraft at contact with the runway should be varied according to the landing surface, and existing conditions both wind wise and load wise. It is generally good practice to contact the ground at the minimum possible safe speed consistent with existing conditions.

Normally the best technique for short and slow landings is to use full flap and enough power to maintain the desired airspeed and approach flight path. Mixture should be full rich, fuel on the fullest tank, carburetor heat off, and electric fuel pump on. Reduce the speed during the flare-out and contact the ground close to the stalling speed (50 to 60 MPH). After ground contact hold the nose wheel off, as long as possible. As the airplane slows down, drop the nose and apply the brakes. If hard braking is required, there will be less chance of skidding

the tires if the flaps are retracted before applying the brakes, otherwise leave the flaps down for aerodynamic braking. Braking is most effective when back pressure is applied to the control wheel, putting most of the aircraft weight on the main wheels. In high wind conditions, particularly in strong cross winds, it may be desirable to approach the ground at higher than normal speeds, with partial or no flaps.

To stop the engine, after landing and when clear of the runway, pull the mixture control full out to idle cut-off. When using alternate fuels, the engine should be run up to 1200 R.P.M. for one minute prior to shutdown to clean out any unburned fuel. After the engine stops, turn the ignition and master switches off, and retract the flaps.

GROUND HANDLING AND MOORING

The Cherokee should be moved on the ground with the aid of the nose wheel tow bar provided with each plane and secured in the baggage compartment. Tie downs may be secured to rings provided under each wing, and to the tall skid. The aileron and stabilator controls should be secured by looping the safety belt through the control wheel, and pulling it tight. The rudder is held in position by its connections to the nose wheel steering, and normally does not have to be secured. The flaps are locked when in the full up position, and should be left retracted.

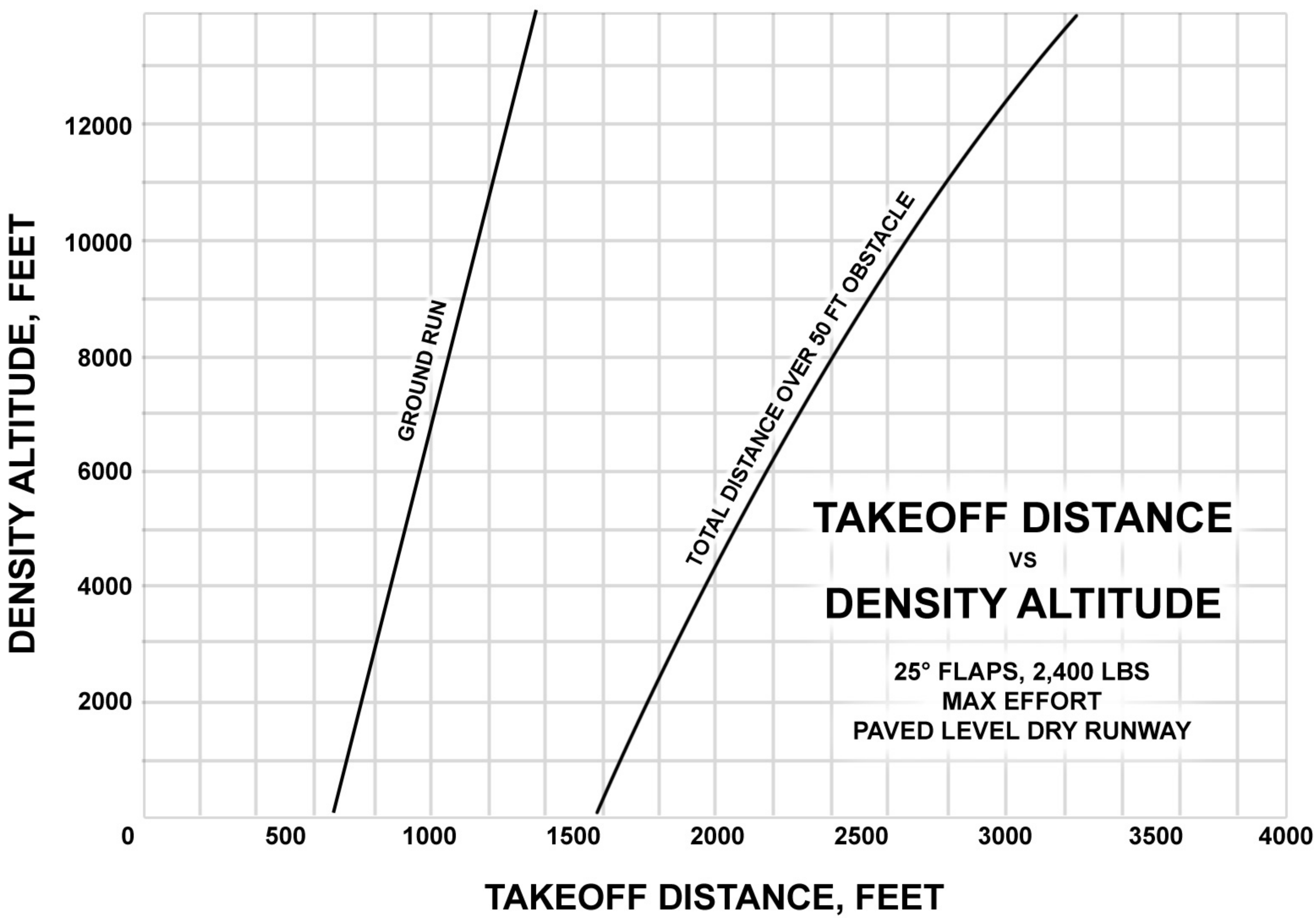
WEIGHT AND BALANCE –

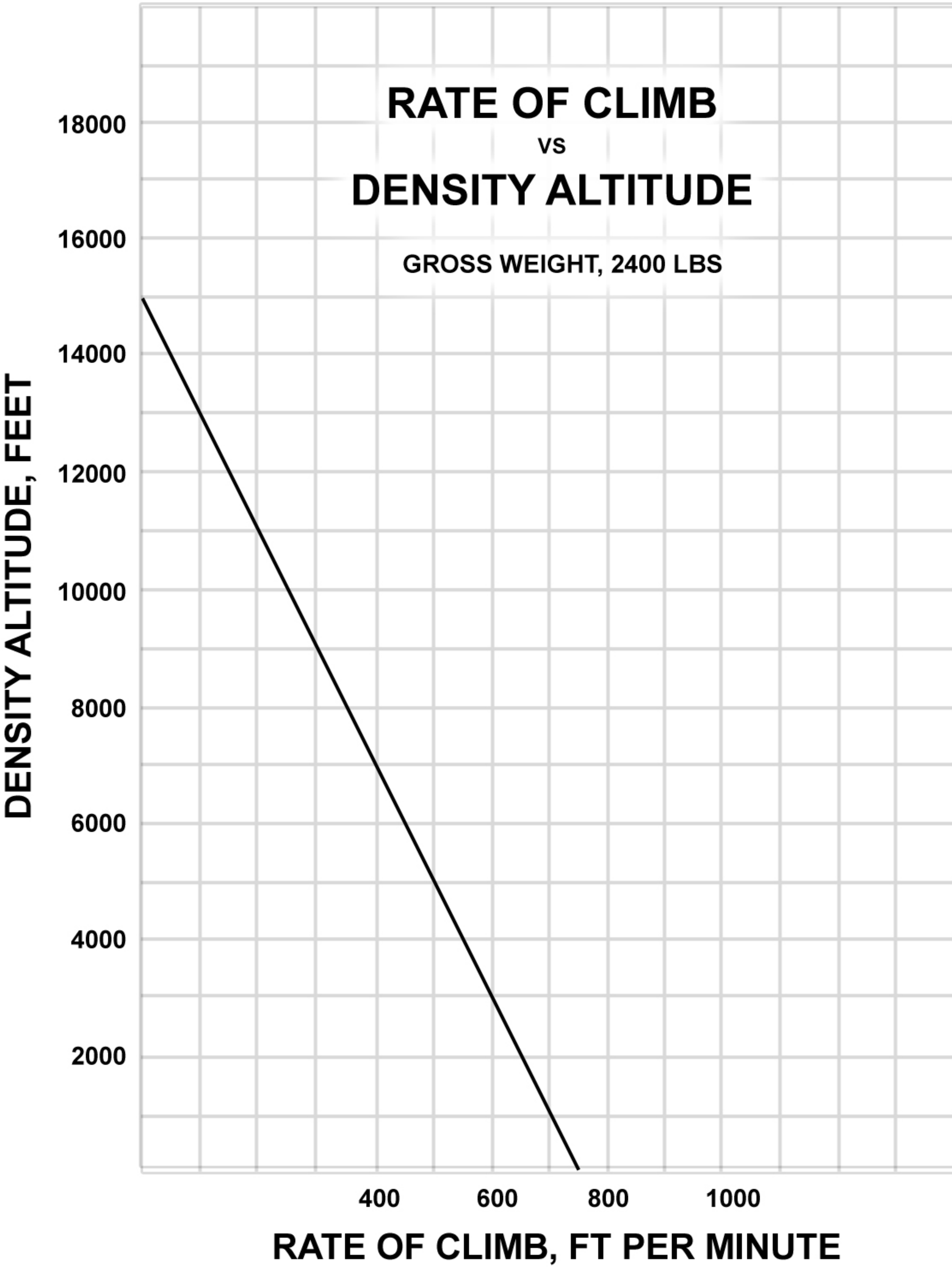
It is the responsibility of the owner and pilot to determine that the airplane remains within the allowable weight vs center of gravity envelope while in flight. For weight and balance data see the Airplane Flight Manual and Weight and Balance Form supplied with each airplane.

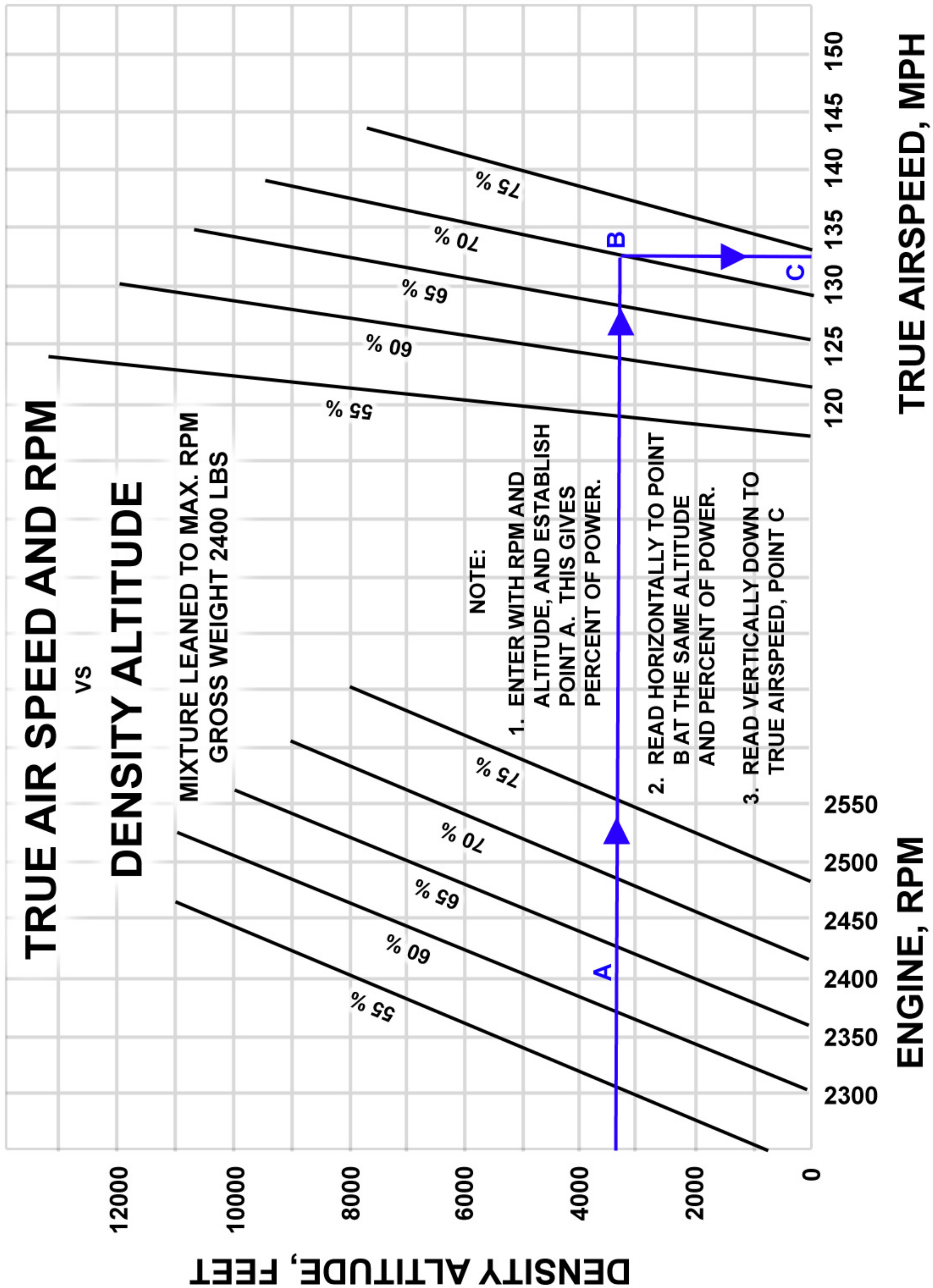
PERFORMANCE

THE PERFORMANCE INFORMATION PRESENTED in this section is based on measured Flight Test Data corrected to ICAO standard day conditions and analytically expanded for the various parameters of weights, altitude, temperature, etc. The performance charts are unfactored and do not make any allowance for varying degree of pilot proficiency or mechanical deterioration of the aircraft. The performance however can be duplicated by following the stated procedures in a properly maintained airplane.

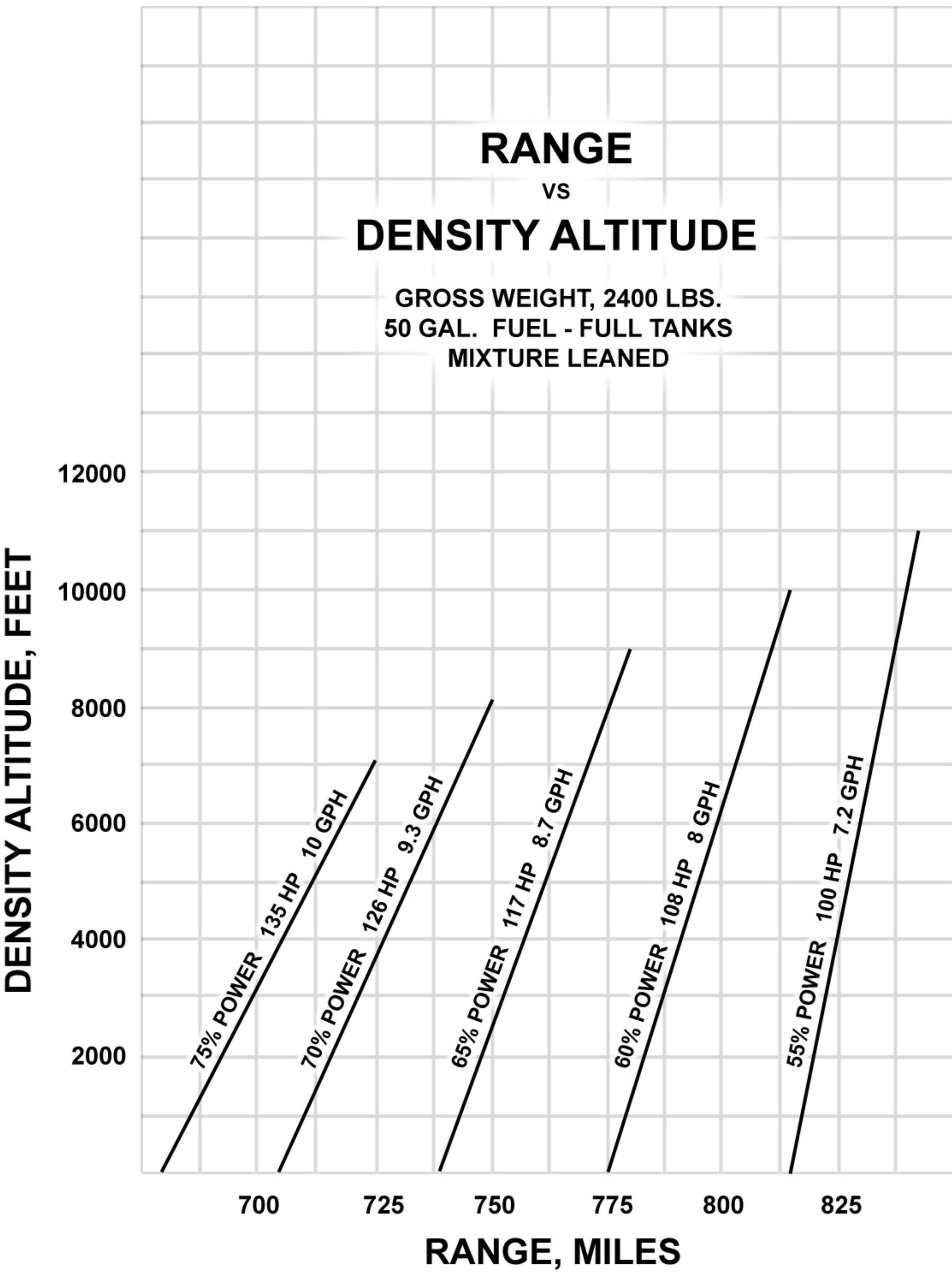
Effects of conditions not considered on the charts must be evaluated by the pilot, such as the effect of soft or grass runway surface on takeoff and landing performance, or the effect of winds aloft on cruise and range performance. Endurance can be greatly affected by improper leaning procedures, and in-flight fuel flow and quantity checks are recommended.

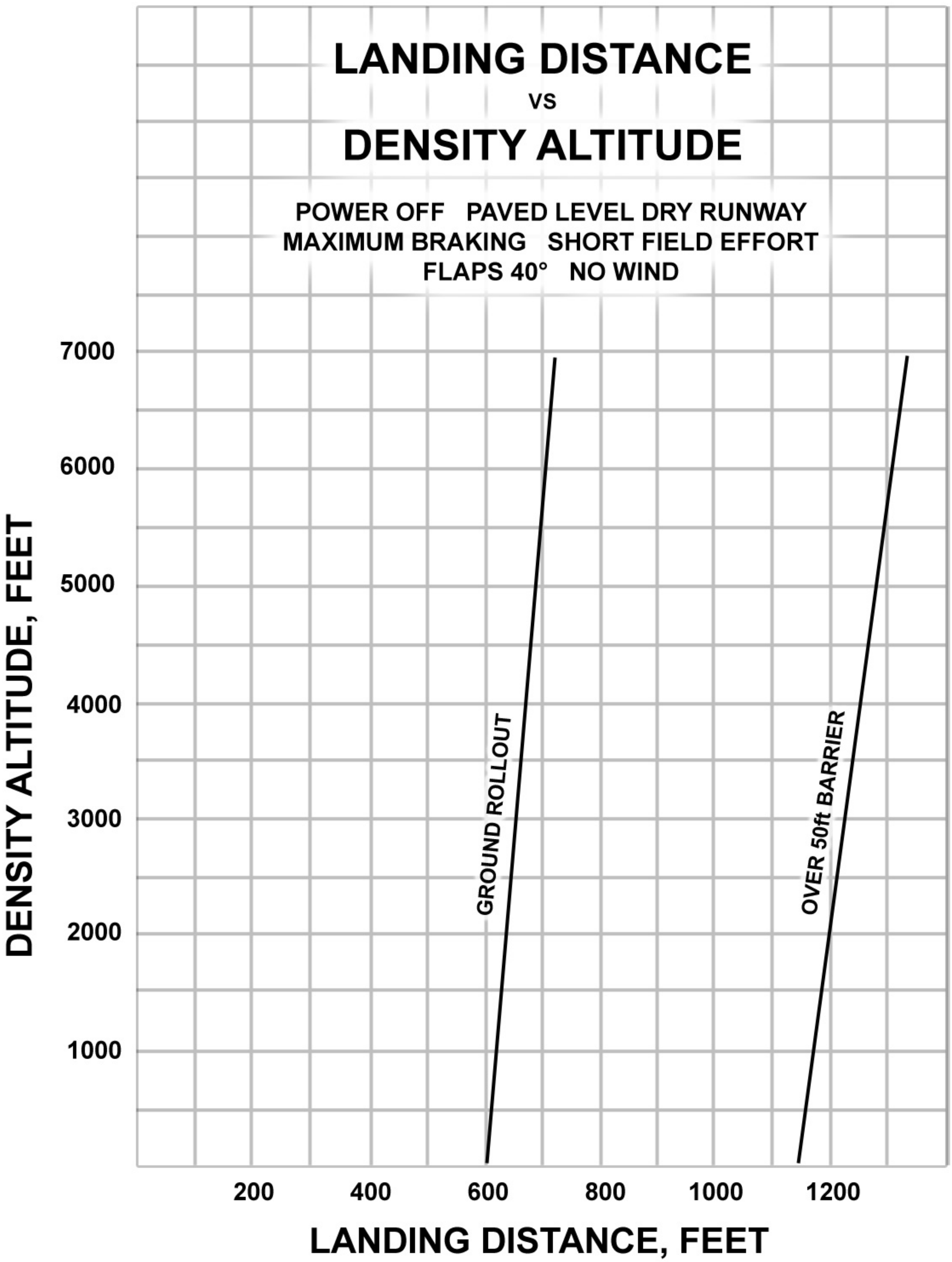

TAKEOFF DISTANCE
VS
DENSITY ALTITUDE
25° FLAPS, 2,400 LBS
MAX EFFORT
PAVED LEVEL DRY RUNWAY
GROUND RUN
TOTAL DISTANCE OVER 50 FT OBSTACLE
DENSITY ALTITUDE, FEET
12000
10000
8000
6000
4000
2000
0
500
1000
1500
2000
2500
3000
3500
4000
TAKEOFF DISTANCE, FEET


RATE OF CLIMB
VS
DENSITY ALTITUDE
GROSS WEIGHT, 2400 LBS
18000
16000
14000
12000
10000
8000
6000
4000
2000
DENSITY ALTITUDE, FEET
400
600
800
1000
RATE OF CLIMB, FT PER MINUTE



TRUE AIR SPEED AND RPM
VS
DENSITY ALTITUDE
MIXTURE LEANED TO MAX. RPM
GROSS WEIGHT 2400 LBS
NOTE:
1. ENTER WITH RPM AND ALTITUDE, AND ESTABLISH POINT A. THIS GIVES PERCENT OF POWER.
2. READ HORIZONTALLY TO POINT B AT THE SAME ALTITUDE AND PERCENT OF POWER.
3. READ VERTICALLY DOWN TO TRUE AIRSPEED, POINT C
55 %
60 %
65 %
70 %
75 %
A
B
C
ENGINE, RPM
2300
2350
2400
2450
2500
2550
TRUE AIRSPEED, MPH
120
125
130
135
140
145
150
DENSITY ALTITUDE, FEET
0
2000
4000
6000
8000
10000
12000

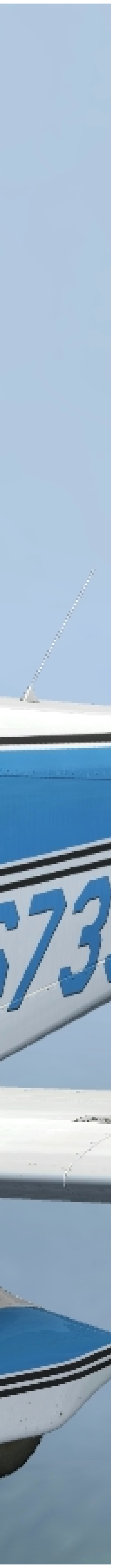

RANGE
VS
DENSITY ALTITUDE
GROSS WEIGHT, 2400 LBS.
50 GAL. FUEL - FULL TANKS
MIXTURE LEANED
DENSITY ALTITUDE, FEET
12000
10000
8000
6000
4000
2000
75% POWER 135 HP 10 GPH
70% POWER 126 HP 9.3 GPH
65% POWER 117 HP 8.7 GPH
60% POWER 108 HP 8 GPH
55% POWER 100 HP 7.2 GPH
700
725
750
775
800
825
RANGE, MILES


LANDING DISTANCE
VS
DENSITY ALTITUDE
POWER OFF PAVED LEVEL DRY RUNWAY
MAXIMUM BRAKING SHORT FIELD EFFORT
FLAPS 40° NO WIND
DENSITY ALTITUDE, FEET
7000
6000
5000
4000
3000
2000
1000
GROUND ROLLOUT
OVER 50ft BARRIER
200
400
600
800
1000
1200
LANDING DISTANCE, FEET

Power Setting Table-Lycoming Model 0-360 Series, 180 HP Engine

Press. Alt	Std Alt Temp °F	108 HP 60% Power RPM	117 HP 65% Power RPM	126 HP 70% Power RPM	135 HP 75% Power RPM	Press. Alt
SL	59	2290	2370	2440	2500	SL
1,000	55	2310	2390	2460	2520	1,000
2,000	52	2330	2410	2480	2540	2,000
3,000	48	2350	2430	2500	2560	3,000
4,000	45	2370	2450	2520	2580	4,000
5,000	41	2390	2470	2540	2600	5,000
6,000	38	2410	2490	2560	2620	6,000
7,000	34	2430	2510	2580	2640	7,000
8,000	31	2450	2530	2600	-	8,000
9,000	27	2470	2550	2620	-	9,000
10,000	23	2490	2570	-	-	10,000
11,000	19	2510	2590	-	-	11,000
12,000	16	2530	-	-	-	12,000

WEIGHT AND BALANCE



In order to achieve the performance and flying characteristics which are designed into the airplane, it must be flown with the weight and center of gravity (C.G.) positioned within the approved operating range (envelope). Although the airplane offers flexibility of loading, it cannot be flown with the maximum number of adult passengers, full fuel tanks, and maximum baggage. With the flexibility comes responsibility. The pilot must ensure that the airplane is loaded within the loading envelope before he makes a takeoff.

Misloading carries consequences for any aircraft. An overloaded airplane will not take off, climb, or cruise as well as a properly loaded one. The heavier the airplane is loaded, the less climb performance it will have.

Center of gravity is a determining factor in flight characteristics. If the C.G. is too far forward in any airplane, it may be difficult to rotate for takeoff or landing. If the C.G. is too far aft, the airplane may rotate prematurely on takeoff or tend to pitch up during climb. Longitudinal stability will be reduced. This can lead to inadvertent stalls and even spins, and spin recovery becomes more difficult as the center of gravity moves aft of the approved limit.

WEIGHT AND BALANCE LOADING FORM

(example using two 170 lbs passengers, full fuel, and 50lbs of baggage)

	Weight (lbs.) Arm Aft	Datum (in.)	Moment (in-lbs.)
Basic Empty Weight	1355	86.08	116,638
Front Seats	340	85.5	29,070
Rear Seats*	0	118.1	0
Baggage*	50	142.8	7,140
Fuel (max 48gal)	288	95.0	27,360
Total	2,033		180,208

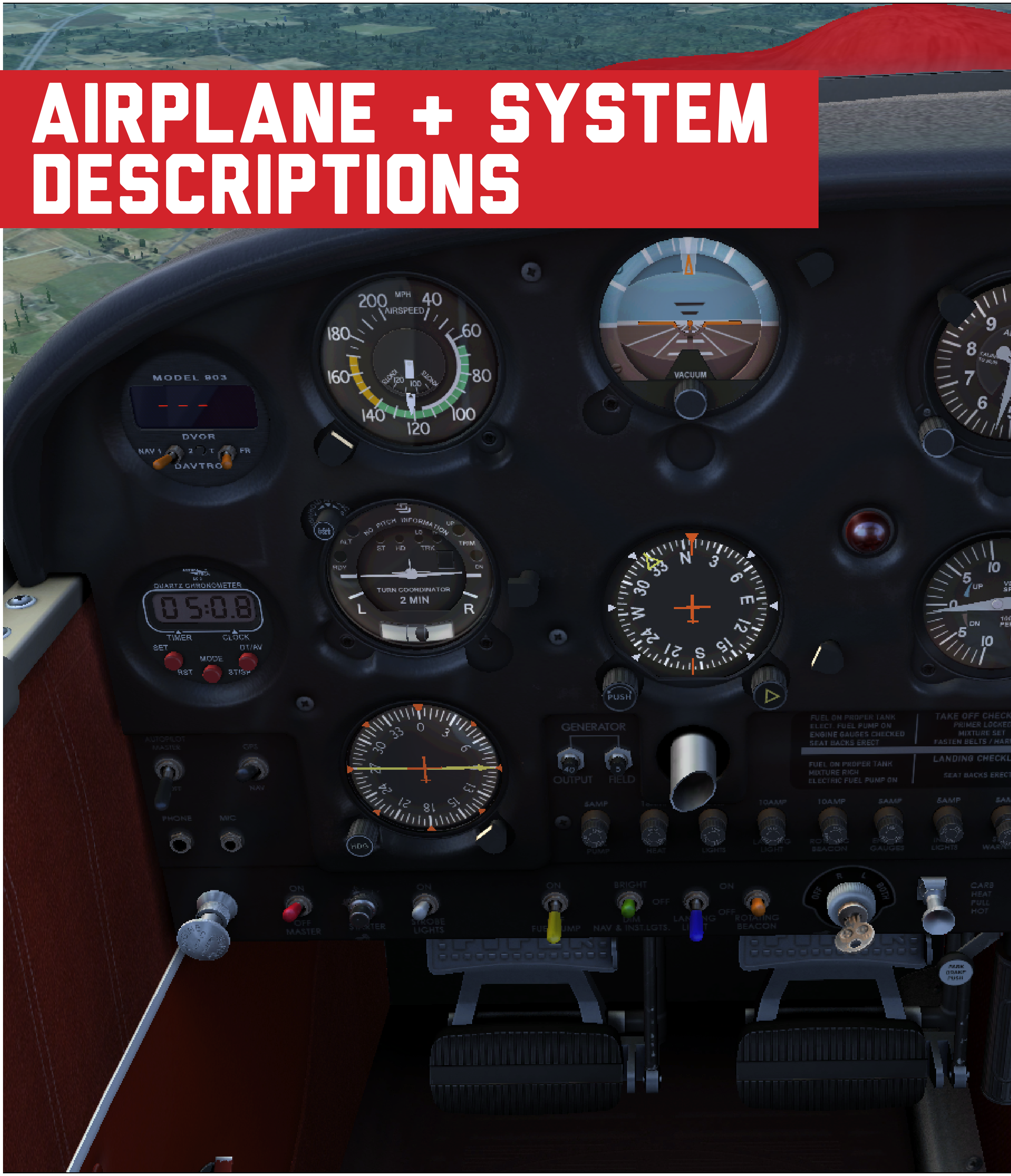
NOTE: Empty weight includes two gallons of unusable fuel, so the max fuel capacity for weight and balance calculations is 50 – 2 = 48 gallons

How to calculate the center of gravity:
Total Moment ÷ Total Weight = C.G. (center of gravity)
180,208 ÷ 2,033 = 88.64
C.G. = 88.64

Normal Category Limits: 84.0 - 95.8
Utility Category Limits: 84.0 – 86.5*

*Utility Category Operation – No baggage or rear passengers allowed. Max 1,950 lbs.

AIRPLANE + SYSTEM DESCRIPTIONS



THE PA-28-180 CHEROKEE IS A single-engine, low-wing monoplane of all metal construction. It has fourplace seating, two hundred pound baggage capacity, and a 180 horsepower engine.

ENGINE AND PROPELLER

The Cherokee is powered by a Lycoming O-360-A3A, 180 H.P. engine with a starter, 35 ampere 12 volt alternator, voltage regulator, shielded ignition, vacuum pump drive, fuel pump and a dry, automotive type carburetor air filter.

The exhaust system is of the cross-over type to reduce back pressure and improve performance. It is made entirely from stainless steel and is equipped with dual mufflers. A heater shroud around the mufflers is provided to supply heat for both the cabin and carburetor de-icing.

The Sensenich fixed-pitch 76EM8S5-60 propeller is made from a one-piece alloy forging.

STRUCTURES

All structures are of aluminum alloy construction and are designed to ultimate load factors well-in excess of normal requirements. All exterior surfaces are primed with etching primer and painted with acrylic enamel.

The wings are attached to each side of the fuselage by inserting the butt ends of the respective main spars into a spar box carry through which is an integral part of the fuselage structure, providing in effect a continuous main spar with splices at each side of the fuselage. There are also fore and aft attachments at the rear spar and at an auxiliary front spar.

The wing airfoil section is a laminar flow type, NACA 652-415 with the maximum thickness about 40% aft of the leading edge. This permits the main spar carry through structure to be located under the rear seat providing unobstructed cabin floor space ahead of the rear seat.

LANDING GEAR

The three landing gears use a Cleveland 600 x 6 wheel, the main wheels being provided with Cleveland single disc hydraulic brake assemblies, No. 30-55. All wheels use 600 x 6 four ply tires with tubes.

The nose gear is steerable through a 30 degree arc by use of the rudder pedals. A spring device is incorporated in the rudder pedal torque tube assembly to aid in rudder centering and to provide rudder trim. The nose gear steering mechanism also incorporates a hydraulic shimmy dampener. The oleo struts are of the air-oil type, with normal extension being 3.25 inches for the nose gear and 1.50 inches for the main gear under normal static load (empty weight of airplane plus full fuel and oil).

The standard brake system for the Cherokee consists of a hand lever and master cylinder which is located below and behind the left center of the instrument sub-panel. The brake fluid reservoir is installed on the top left front face of the firewall. The parking brake is incorporated in the master cylinder and is actuated by pulling back on the brake lever, depressing the knob attached to the handle and releasing the brake lever. To release the parking brake, pull back on the lever to disengage the catch mechanism and allow the handle to swing forward.

Optional toe brakes are available to supplement the standard hand lever and parking brake system.

CONTROL SYSTEMS

Dual controls are provided as standard equipment, with a cable system used between the controls and the surfaces. The horizontal tail is of the all movable slab type, with an anti-servo tab which also acts as a longitudinal trim tab, actuated by a control on the cabin ceiling. The stabilator provides extra stability and irreconcilability with less size, drag, and weight than conventional tail surfaces. The ailerons are provided with a differential action which tends to eliminate adverse yaw in turning maneuvers, and also reduces the amount of coordination required in normal turns. The flaps are manually

operated, balanced for light operating forces and spring loaded to return to the up position. A past-center lock incorporated in the actuating linkage holds the flap when it is in the up position so that it may be used as a step on the right side. The flap will not support a step load except when in the full up position, so it must be completely retracted when used as a step. [Editor's note: Even though its designed to be stepped on, many Cherokee owners prefer passengers avoid stepping on the flap]. The flaps have three extended positions, 10, 25 and 40 degrees.

FUEL SYSTEM

Fuel is stored in two twenty-five gallon tanks which are secured to the leading edge structure of each wing by screws and nut plates. This allows easy removal for service or inspection. The standard quantity of fuel is 50 gallons. To obtain 36 gallons of fuel, fill the tanks only to the bottom of the filler neck indicator (tabs), which extends some distance into the tanks.

This system allows the fuel quantity to be varied conveniently according to the payload. An auxiliary electric fuel pump is provided for use in case of failure of the engine driven pump. The electric pump should be on for all take-offs and landings. The fuel strainer, which is equipped with a quick drain, is located on the front lower left corner of the firewall. This strainer should be drained regularly to check for water or sediment accumulation. To drain the lines from the tanks, the tank selector valve must be switched to each tank in turn, with the electric pump on, and the gascolator drain valve opened. Each tank has an individual quick drain located at the bottom, inboard, rear corner. Fuel quantity and pressure are indicated on gauges located in the engine gauge cluster on the right side of the instrument panel.

ELECTRICAL SYSTEM

The electrical system includes a 12 volt alternator, battery, voltage regulator and master switch relay. The battery, regulator and relay are mounted in the battery compartment immediately aft of the baggage compartment. Access for service or inspection is conveniently obtained through a removable panel at lower right corner of the compartment.

Electrical switches and fuses are located on the lower left center of the instrument panel, and the left side of the instrument sub-panel. Standard electrical accessories include: Starter, Electric Fuel pump, Fuel Gauge, Stall Warning Indicator, Cigarette Lighter and Ammeter. Navigation Lights, Anti-Collision Light, Landing Light, Instrument Lighting and the Cabin Dome Light are offered as optional accessories. Circuit provisions are made to handle optional communications and navigational equipment.

Installed on the Cherokees is the F.T.P. (full time power) electrical system. Derived from the system are many advantages both in operation and maintenance. The main advantage is, of course, full electrical power output regardless of engine R.P.M. This is a great improvement for radio and electrical equipment operation. Also because of the availability of generator output at all times, the battery will be charging for a greater percentage of use, which will greatly improve cold-morning starting.

Unlike previous generator systems, the ammeter does not indicate battery discharge; rather it displays

in amperes the load placed on the alternator. With all electrical equipment off (except the master switch) the ammeter will be indicating the amount of charging current demanded by the battery. As each item of electrical equipment is turned on, the current will increase to a total appearing on the ammeter. This total includes the battery. The maximum continuous load for night flight, with radios on, is about 30 amperes. This 30 ampere value, plus approximately two amperes for a fully charged battery, will appear continuously under these flight conditions. The amount of current shown on the ammeter will tell immediately whether the alternator system is operating normally, as the amount of current shown should equal the total amount of amperes being drawn by the equipment which is operating. If no output is indicated on the ammeter during flight, reduce the electrical load by turning off all unnecessary electrical equipment. Check both 5 ampere field breaker and 60 ampere output breaker and reset if open. lf neither circuit breaker is open, turn off the master switch for 30 seconds to reset the overvoltage relay. If ammeter continues to indicate no output, maintain minimum electrical load and terminate flight as soon as practical.

HEATING AND VENTILATING SYSTEM

Heat for the cabin interior and the defroster system is provided by a heater muff attached to the exhaust system. The amount of heat desired can be regulated with the controls located on the lower right side of the instrument panel. Fresh air inlets are located in the leading edge of the wing at the intersection of the tapered and straight sections. A large adjustable outlet is located on the side of the cabin near the floor at each seat location.

CABIN FEATURES

The instrument panel of the Cherokee is designed to accommodate the customary advanced flight instruments and all the normally required power plant instruments. The Artificial Horizon, Directional Gyro and some Turn and Bank instruments are vacuum operated through use of a vacuum pump installed on the engine. Later C Model Cherokees are equipped with electric turn and bank instruments. A natural separation of the flight group and the power group is provided by placing the communications and radio navigational equipment in the center of the panel.

CENTER STACK AVIONICS SUITE

We have spent much time developing extra modes and functions that you won't find in any FSX airplane, like independent DME receiver, pilot- programmable COMM channels and NAV OBS mode. For example, you should pay attention to the autopilot. Even though it may look familiar, you need to learn how to operate it properly or you may find you plane going in completely wrong direction.

The avionics suite in your Accu-Sim Piper Cherokee 180 is so complete, the best source for your information is straight from the manufacturer. Below are links to the latest manuals online:

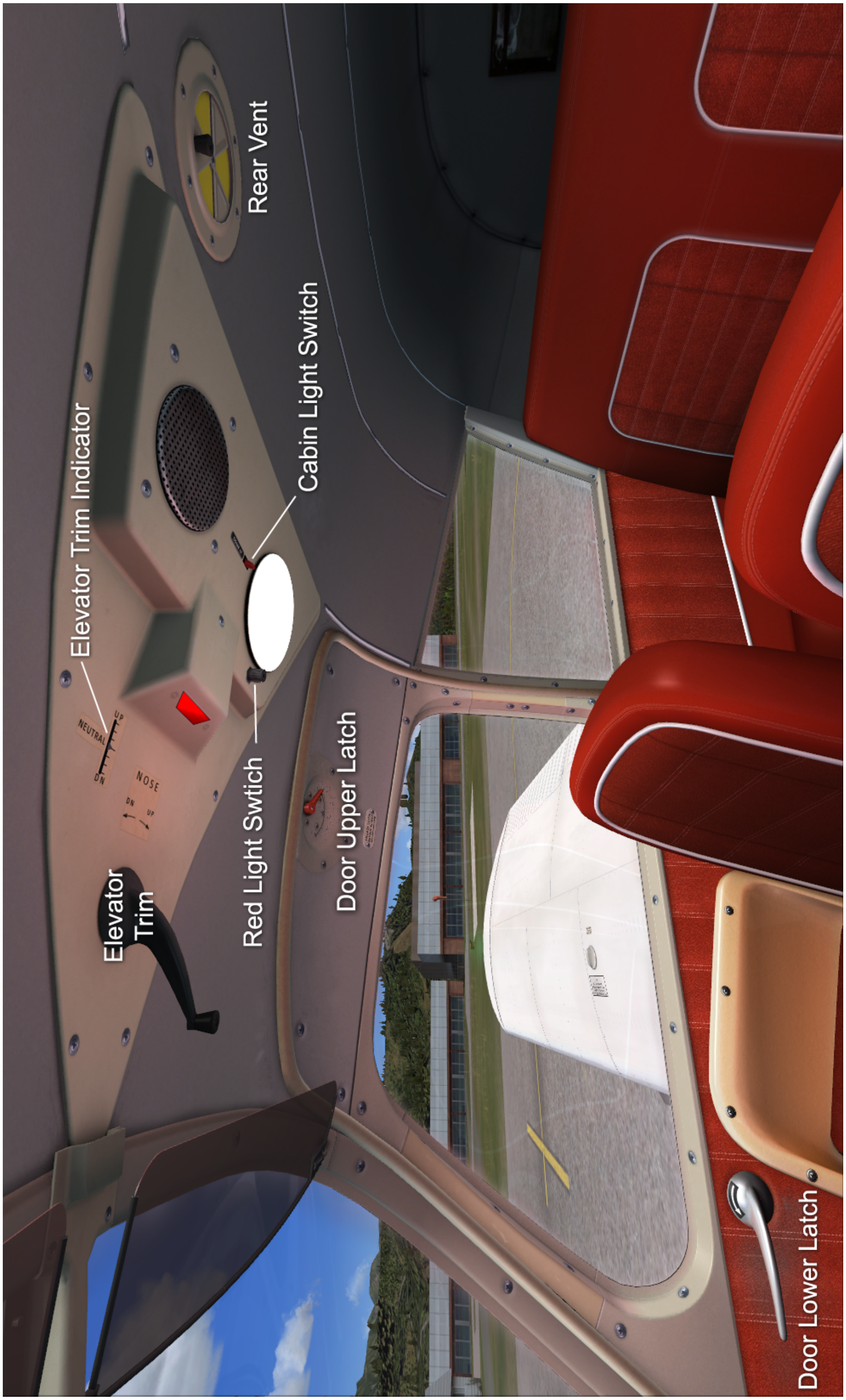
DVOR
http://www.davtron.com/cmsAdmin/uploads/m903_brochure.pdf

Clock
http://www.adstcoil.com/admin/userfiles/file/manuals/lc-2/ads_lc2_oper_instruction.pdf

Autopilot:
http://sharepoint.s-tec.com/Documentation/Shared%20Documents/Pilot%20Operating%20Handbooks%20(POH)/System%20Twenty_Thirty_%20Thirty%20ALT.pdf

ADF, DME:
https://dealer.bendixking.com/servlet/com.honeywell.aes.utility.PDFDownLoadServlet?FileName=/TechPubs/repository/006-18110-0000_5.pdf


Magnetic Compass
Avionics & Radios
RPM
EGT
Vacuum
Fuel L / R
Ammeter
Oil Temp
Fuel Pressure
Oil Pressure
Manual
Main Vent
Defroster
Cockpit Heat
Floor Vent
Mixture
Radio Backlight
Avionics Master
Pitot Heat
Rudder Trim
Flaps
VOR 1
VOR 2
Throttle
Altitude
Climb
Alternator Breakers
FUSES
Parking Brake
Carb Heat
Ignition
Stall Warning
Beacon
Landing Light
Nav Lights
Attitude
Heading
Fuel Pump
Digital VOR
Strobes
Starter
Master Battery
Primer
Fuel Selector
Floor Vent
Airspeed
Turn & Bank
Chronometer
Headphones
Digital VOR
AutoPilot Master
Map


Rear Vent
Cabin Light Switch
Elevator Trim Indicator
NEUTRAL
UP
DN
NOSE
DN
UP
Elevator Trim
Red Light Swtich
Door Upper Latch
Door Lower Latch

EMERGENCY PROCEDURES

THIS SECTION CONTAINS PROCEDURES THAT ARE recommended if an emergency condition should occur during ground operation, takeoff, or in flight. These procedures are suggested as the best course of action for coping with the particular condition described, but are not a substitute for sound judgment and common sense. Since emergencies rarely happen in modern aircraft, their occurrence is usually unexpected, and the best corrective action may not always be obvious. Pilots should familiarize themselves with the procedures given in this section and be prepared to take appropriate action should an emergency arise.

Most basic emergency procedures, such as power off landings, are a normal part of pilot training. Although these emergencies are discussed here, this information is not intended to replace such training, but only to provide a source of reference and review, and to provide information on procedures that are not the same for all aircraft. It is suggested that the pilot review standard emergency procedures periodically to remain proficient in them.

ENGINE POWER LOSS DURING TAKEOFF

1. If sufficient runaway remains for a normal landing, land straight ahead.
2. If insufficient runaway remains:
   - **a.** Maintain safe airspeed
   - **b.** Make shallow turns to avoid obstructions
   - **c.** Flaps as situation requires
3. If sufficient altitude to attempt a restart:
   - **a.** Maintain safe airspeed
   - **b.** Fuel selector — tank containing fuel
   - **c.** Electric fuel pump — check ON
   - **d.** Mixture — check RICH
   - **e.** Carburetor heat — ON
   - **f.** Primer — locked
4. If still no power, plan power off landing

ENGINE POWER LOSS IN FLIGHT

1. Fuel selector — tank containing fuel
2. Electric fuel pump — ON
3. Mixture — check RICH
4. Carburetor heat — ON
5. Engine gauges — check for indication of cause of pwr loss
6. Primer — check locked
7. If no fuel pressure is indicated, check tank selector position is on a tank containing fuel.
8. When power is restored:
    a. Carburetor heat — OFF
    b. Electric fuel pump — OFF
9. If power is not restored, prepare power off landing.
10. Trim for 76 KIAS

POWER OFF LANDING

1. Locate suitable field.
2. Establish spiral pattern
3. 1000 ft. above field at downwind position for normal landing approach.
4. When field can easily be reached, slow to 66 KIAS for shortest landing.
5. Touchdowns should normally be made at lowest possible airspeed with full flaps.
6. When committed to landing:
    a. Ignition — OFF
    b. Master switch — OFF
    c. Fuel selector — OFF
    d. Mixture — idle cut-off
    e. Seat belt and harness — tight

FIRE IN FLIGHT

1. Source of fire — check
2. Electrical fire (smoke in cabin):
    a. Master switch — OFF
    b. Vents — open
    c. Cabin heat — OFF
    d. Land as soon as practicable.
3. Engine fire:
    a. Fuel selector — OFF
    b. Throttle — Closed
    c. Mixture — idle cut-off
    d. Electric fuel pump — check OFF
    e. Heater and defroster — OFF
    f. Proceed with power off landing procedure.

HIGH OIL TEMPERATURE

Land at nearest airport and investigate the problem.

Prepare for a power off landing.

LOSS OF OIL PRESSURE

Land as soon as possible and investigate cause.

Prepare for power off landing.

LOSS OF FUEL PRESSURE

1. Electric fuel pump — ON
2. Fuel selector — check on full tank
3. Land as soon as possible as. Low fuel pressure may indicate a fuel leak.

ALTERNATOR FAILURE

1. Verify failure
2. Reduce electrical load as much as possible.
3. Alternator circuit breakers – check
4. Alt switch — OFF 1 second then on
5. If no output:
   a. Alt switch — OFF
   b. Reduce electrical load and land as practical.

SPIN RECOVERY

1. Throttle — idle
2. Ailerons — neutral
3. Rudder — full opposite to direction of rotation
4. Control wheel — full forward
5. Rudder — neutral when rotation stops
6. Control wheel — smoothly regain level flight altitude

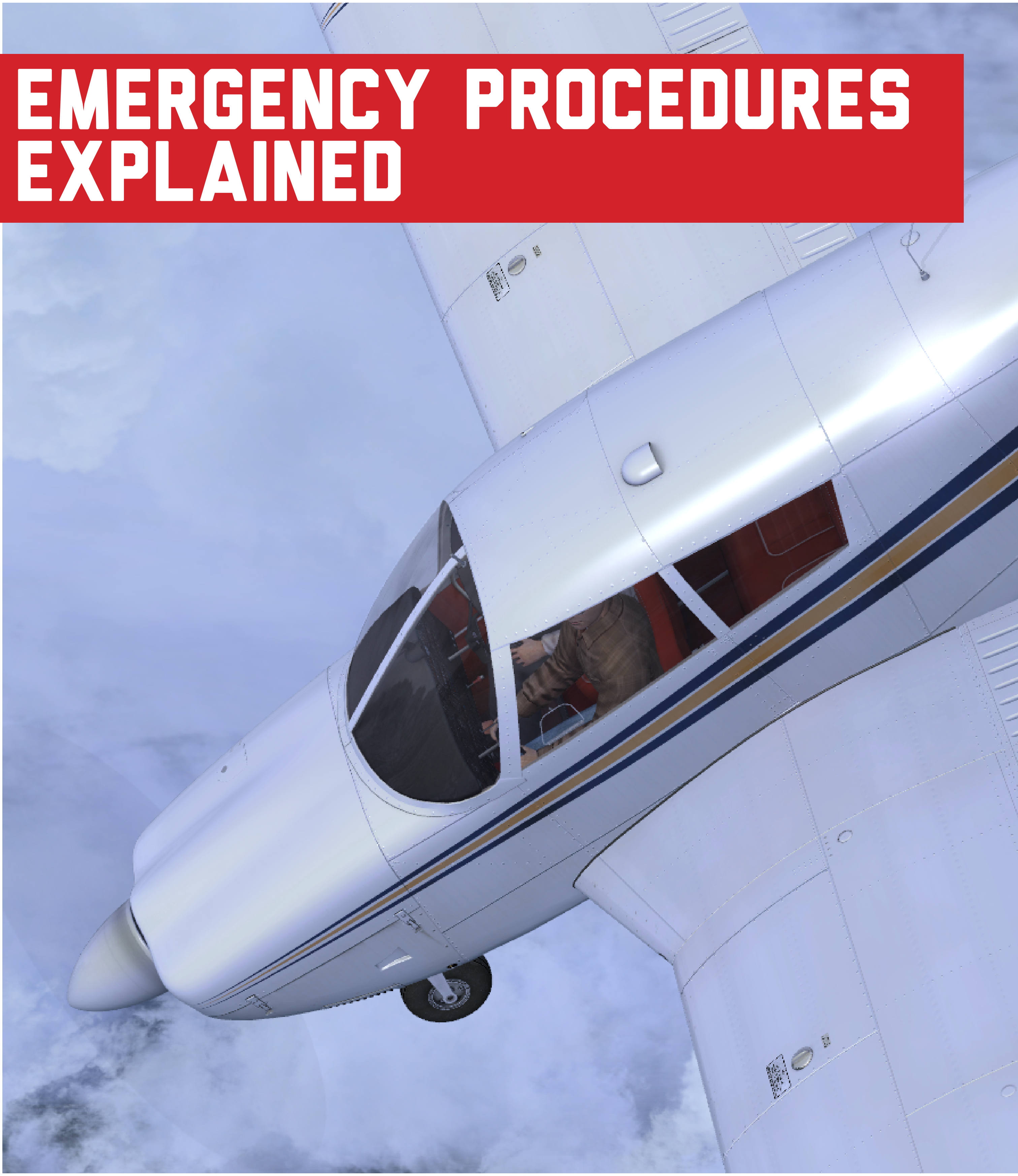
CARBURETOR ICING

1. Carburetor Heat — ON
2. Mixture — max. smoothness

ENGINE ROUGHNESS

1. Carburetor heat — ON
2. If roughness continues after one min:
3. Carburetor heat — OFF
4. Mixture — max smoothness
5. Electric fuel pump — ON
6. Fuel selector — switch tanks
7. Engine gauges — check
8. Magneto switch — ”L”&“R” then BOTH
9. If operation is satisfactory on either one, continue on that magneto at reduced power and full “RICH” mixture to first airport. Prepare for power off landing

EMERGENCY PROCEDURES EXPLAINED



THE FOLLOWING PARAGRAPHS ARE PRESENTED to supply additional information for the purpose of providing the pilot with a more complete understanding of the recommended course of action and probable cause of an emergency situation.

ENGINE POWER LOSS DURING TAKEOFF

The proper action to be taken if loss of power occurs during takeoff will depend on the circumstances of the particular situation.

If sufficient runway remains to complete a normal landing, land straight ahead.

If insufficient runway remains, maintain a safe airspeed and make only a shallow turn if necessary to

avoid obstructions. Use of flaps depends on the circumstances. Normally, flaps should be fully extended for touchdown.

If sufficient altitude has been gained to attempt a restart, maintain a safe airspeed and switch the fuel selector to another tank containing fuel. Check the electric fuel pump to ensure that it is "ON" and that the mixture is "RICH." The carburetor heat should be "ON" and the primer checked to ensure that it is locked.

If engine failure was caused by fuel exhaustion, power will not be regained after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds.

If power is not regained, proceed with the Power Off Landing procedure.

ENGINE POWER LOSS IN FLIGHT

Complete engine power loss is usually caused by fuel flow interruption and power will be restored shortly after fuel flow is restored. If power loss occurs at a low altitude, the first step is to prepare for an emergency landing. An airspeed of at least 76 KIAS should be maintained.

If altitude permits, switch the fuel selector to another tank containing fuel and turn the electric fuel pump "ON." Move the mixture control to "RICH" and the carburetor heat to "ON." Check the engine gauges for an indication of the cause of power loss. Check the engine gauges for an indication of the cause of the power loss. Check to ensure the primer is locked. If no fuel pressure is indicated, check the tank selector position to be sure it is on a tank containing fuel.

When power is restored move the carburetor heat to the "OFF" position and turn "OFF" the electric fuel pump. If the preceding steps do not restore power, prepare for an emergency landing.

If time permits, turn the ignition switch to "L" then to "R" then back to "BOTH." Move the throttle and

mixture control levers to different settings. This may restore power if the problem is too rich or too lean a mixture or if there is a partial fuel system restriction. Try other fuel tanks. Water in the fuel could take some time to be used up, and allowing the engine to windmill may restore power. If power is due to water, fuel pressure indications will be normal.

If engine failure was caused by fuel exhaustion power will not be restored after switching fuel tanks until the empty fuel lines are filled. This may require up to ten seconds. If power is not regained, proceed with the Power Off Landing procedure (refer to the emergency check list and paragraph 3.13).

POWER OFF LANDING

If loss of power occurs at altitude, trim the aircraft for best gliding angle 76 KIAS (if equipped, Air Cond. Off) and look for a suitable field. If measures taken to restore power are not effective, and if time permits, check your charts for airports in the immediate vicinity: it may be possible to land at one if you have sufficient altitude.

Real word tip: If possible, notify the FAA by radio of your difficulty and intentions. If another pilot or passenger is aboard, let him help.

When you have located a suitable field, establish a spiral pattern around this field. Try to be at 1,000 feet above the field at the downwind position, to make a normal landing approach. When the field can easily be reached, slow to 66 KIAS with flaps down for the shortest landing. Excess altitude may be lost by widening your pattern, using flaps or slipping, or a combination of these.

Touchdown should normally be made at the lowest possible airspeed. When committed to a landing, close the throttle control and shut "OFF" the master and ignition switches. Flaps may be used as desired. Turn the fuel selector valve to "OFF" and move the mixture to idle cut-off. The seat belts and shoulder harness (if installed) should be tightened. Touchdown should be normally made at the lowest possible airspeed.

FIRE IN FLIGHT

The presence of fire is noted through smoke, smell, and heat in the cabin. It is essential that the source of the fire be promptly identified through instrument readings, character of the smoke, or other indications since the action to be taken differs somewhat in each case. Check for the source of the fire first.

If an electrical fire is indicated (smoke in the cabin), the master switch should be turned "OFF." The cabin vents should be opened and the cabin heat turned "OFF." A landing should be made as soon as possible.

If an engine fire is present, switch the fuel selector to "OFF" and close the throttle. The mixture should be at idle cut-off. Turn the electric fuel pump "OFF." In all cases, the heater and defroster should be "OFF." If radio communication is not required, select master switch "OFF." Proceed with power off landing procedure.

NOTE: The possibility of an engine fire in flight is extremely remote. The procedure given is general and pilot judgment should be the determining factor for action in such an emergency.

LOSS OF OIL PRESSURE

Loss of oil pressure may be either partial or complete. A partial loss of oil pressure usually indicates a malfunction in the oil pressure regulating system, and a landing should be made as soon as possible to investigate the cause and prevent engine damage.

A complete loss of oil pressure indication may signify oil exhaustion or may be the result of a faulty gauge. In either case, proceed toward the nearest airport, and be prepared for a forced landing. If the problem is not a pressure gauge malfunction, the engine may stop suddenly. Maintain altitude until such time as a dead stick landing can be accomplished. Don't change power settings unnecessarily, as this may hasten complete power loss.

Depending on the circumstances, it may be advisable to make an off airport landing while power is still available, particularly if other indications of actual oil pressure loss, such as sudden increases in temperatures, or oil smoke, are apparent, and an airport is not close.

If engine stoppage occurs, proceed with Power Off Landing.

LOSS OF FUEL PRESSURE

If loss of fuel pressure occurs, turn "ON" the electric fuel pump and check that the fuel selector is on a full tank. If the problem is not an empty tank, land as soon as practical and have the engine-driven fuel pump and fuel system checked.

HIGH OIL TEMPERATURE

An abnormally high oil temperature indication may be caused by a low oil level, an obstruction in the oil cooler, damaged or improper baffle seals, a defective gauge, or other causes. Land as soon as practical at an appropriate airport and have the cause investigated.

A steady, rapid rise in oil temperature is a sign of trouble. Land at the nearest airport and let a mechanic investigate the problem. Watch the oil pressure gauge for an accompanying loss of pressure.

ALTERNATOR FAILURE

Loss of alternator output is detected through zero reading on the ammeter. Before executing the following procedure, ensure that the reading is zero and not merely low by actuating an electrically powered device, such as the landing light. If no increase in the ammeter reading is noted, alternator failure can be assumed. The electrical load should be reduced as much has possible. Check the alternator circuit breakers for a popped circuit.

The next step is to attempt to reset the overvoltage relay. This is accomplished by moving the "ALT" switch to "OFF" for one second and then to "ON." If the trouble was caused by a momentary overvoltage condition (16.5 volts and up) this procedure should return the ammeter to a normal reading. If the ammeter continues to indicate (0) output, or if the alternator will not remain reset, turn off the "ALT" switch, maintain minimum electrical load and land as soon as practical. All electrical load is being supplied by the battery.

SPIN RECOVERY

Intentional spins are prohibited in this airplane. If a spin is inadvertently entered, immediately move the throttle to idle and the ailerons to neutral.

Full rudder should then be applied opposite to the direction of rotation followed by control wheel full forward. When the rotation stops, neutralize the rudder and ease back on the control wheel as required to smoothly regain a level flight attitude.

CARBURETOR ICING

Under certain moist atmospheric conditions at temperatures of -5 to 20 degrees C, it is possible for ice to form in the induction system, even in summer weather. This is due to the high air velocity through the carburetor venturi and the absorption of heat from this air by vaporization of the fuel.

To avoid this, carburetor preheat is provided to replace the heat lost by vaporization. Carburetor heat should be full on when carburetor ice is encountered. Adjust mixture for maximum smoothness.

ENGINE ROUGHNESS

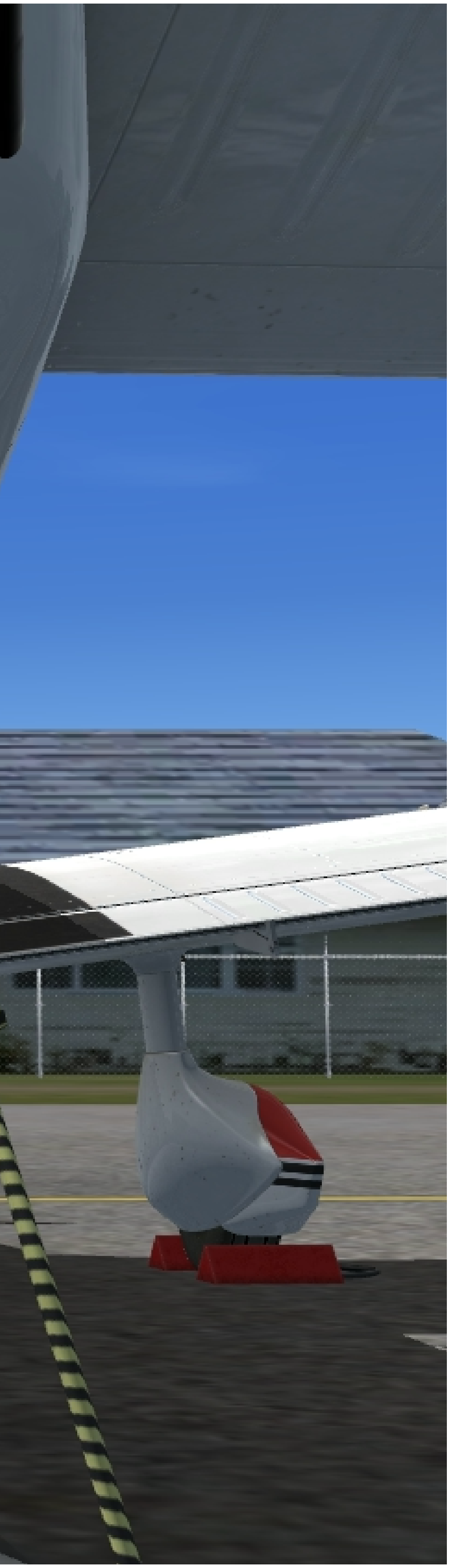
Engine roughness is usually due to carburetor icing which is indicated by a drop in RPM, and may be accompanied by a slight loss of airspeed or altitude. If too much ice is allowed to accumulate, restoration of full power may not be possible; therefore, prompt action is required.

Turn carburetor heat on. RPM will decrease slightly and roughness will increase. Wait for a decrease in engine roughness or an increase in RPM, indicating ice removal. If no change in approximately one minute, return the carburetor heat to "OFF."

If the engine is still rough, adjust the mixture for maximum smoothness. The engine will run rough if too rich or too lean. The electric fuel pump should be switched to "ON" and the fuel selector switched to the other tank to see if fuel contamination is the problem. Check the engine gauges for abnormal readings. If any gauge readings are abnormal, proceed accordingly. Move the magneto switch to "L" then to "R," then back the "BOTH." If operation is satisfactory on either magneto, proceed on that magneto at reduced power, with mixture full "RICH," to a landing at the first available airport. If roughness persists, prepare for a precautionary landing at pilot's discretion.

NOTE: Partial carburetor heat may be worse than no heat at all, since it may melt part of the ice, which will refreeze in the intake system. When using carburetor heat, therefore, always use full heat, and when ice is removed return the control to the full cold position.

AIRPLANE HANDLING, SERVICE + MAINTENANCE



THIS SECTION CONTAINS FACTORY RECOMMENDED procedures for proper ground handling and routine care and servicing of your airplane. It also identifies certain inspection and maintenance requirements which must be followed if your airplane is to retain that new plane performance and dependability. It is wise to follow a planned schedule of lubrication and preventive maintenance based on climatic and flying conditions encountered in your locality.

FUEL CONTAMINATION

Fuel contamination is usually the result of foreign material present in the fuel system, and may consist of water, rust, sand, dirt, microbes or bacterial growth. In addition, additives that are not compatible with fuel or fuel system components can cause the fuel to become contaminated. Before each flight and after each refueling, use a clear sampler cup and drain at least a cupful of fuel from each fuel tank drain location and from the fuel strainer quick drain valve to determine if contaminants are present, and to ensure the airplane has been fueled with the proper grade of fuel. If contamination is detected, drain all fuel drain points including the fuel reservoir and fuel selector quick drain valves and then gently rock the wings and lower the tail to the ground to move any additional contaminants to the sampling points. Take repeated samples from all fuel drain points until all contamination has been removed. If, after repeated sampling, evidence of contamination still exists, the airplane should not be flown. Tanks should be drained and system purged by qualified maintenance personnel. All evidence of contamination must be removed before further flight. If the airplane has been serviced with the improper fuel grade, defuel completely and refuel with the correct grade. Do not fly the airplane with contaminated or unapproved fuel. In addition, Owners/Operators who are not acquainted with a particular fixed base operator should be assured that the fuel supply has been checked for contamination and is properly filtered before allowing the airplane to be serviced. Fuel tanks should be kept full between flights, provided weight and balance considerations will permit, to reduce the possibility of water condensing on the walls of partially filled tanks. To further reduce the possibility of contaminated fuel, routine maintenance of the fuel system should be performed in accordance with the airplane Maintenance Manual. Only the proper fuel, as recommended in this handbook, should be used, and fuel additives should not be used unless approved by Cessna and the Federal Aviation Administration.

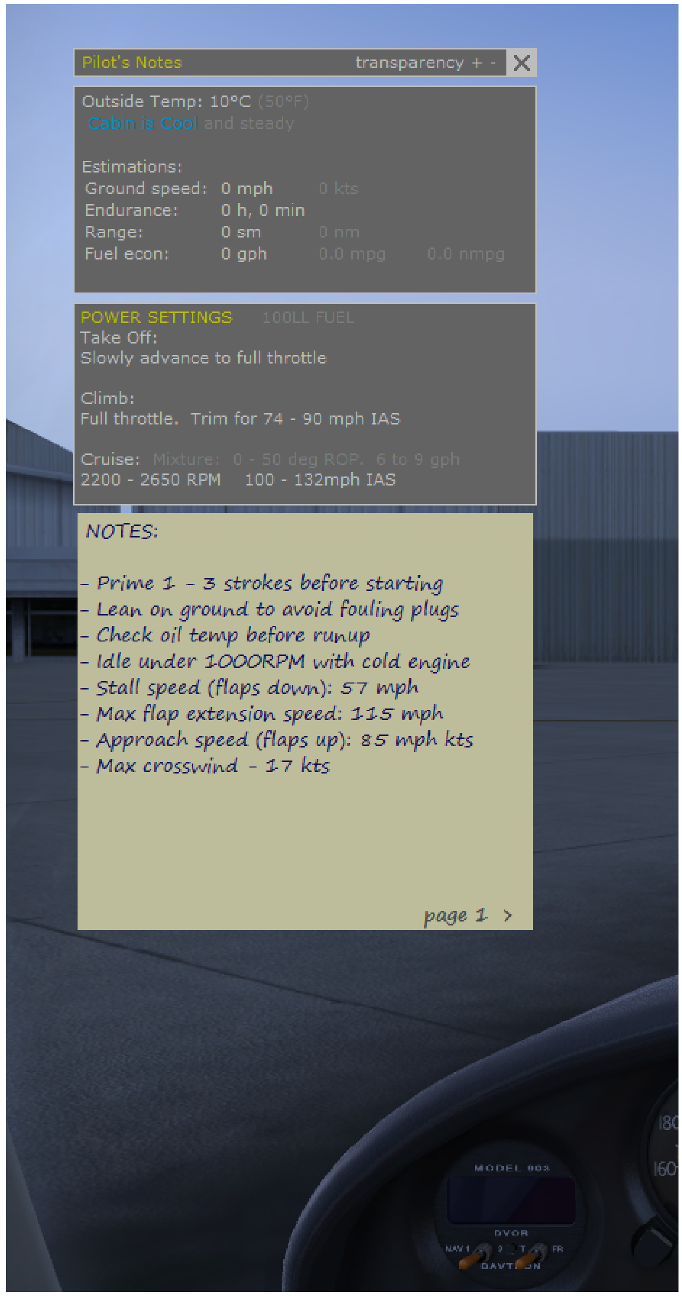
2D PANELS

The 2D panels are there to provide the extra functionality needed when there is so much additional information available to you, the pilot.

Each 2D panel is accessed by the key-press combination in parentheses after the 2D panel title.

Pilot's Notes (Shift 2)

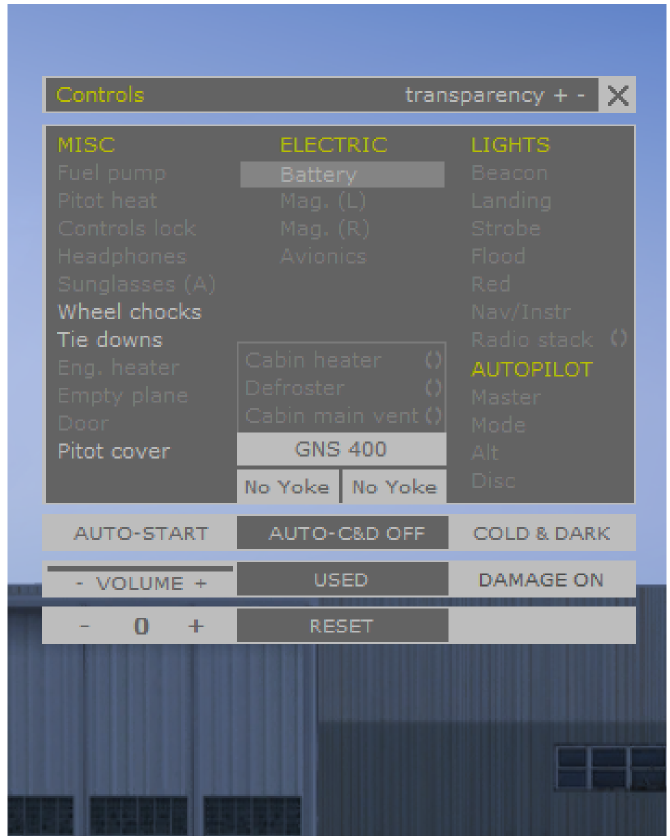
- Outside Temp: is the ambient temperature outside the aircraft.
- Watch Engine Temps: this warning will display if your engine temperature is nearing danger limits. Corrective action should be carried out immediately if this warning appears.
- Cabin Temperature: displays how comfortable the temperature of the cabin feels.
- Ground Speed: this is your speed in relation to the ground in miles/hour and knots.
- Endurance: this figure tells you approximately how long you could remain in powered flight before running out of fuel. This figure will update throughout your flight, and as such you should take into account that during a climb phase, the endurance will be less than once the aircraft is settled in a cruise configuration.
- Range: given in statute (sm) and nautical miles (nm), this figure will give you an approximation of your maximum range under current fuel consumption and airspeed conditions. Again, this figure will change depending on your flight phase.
- Fuel Economy: is the current fuel burn rate given in gallons/hour (gph), miles/gallon (mpg) and nautical miles/gallon (nmpg).
- Power Settings: this represents your clipboard, showing you important information for the correct settings for take off, climb and cruise configurations.
- Notes: these are a set of pages (accessed by the small arrow to the right of the page number) that include information such as actions to be carried out when first entering the cabin, to landing checks.

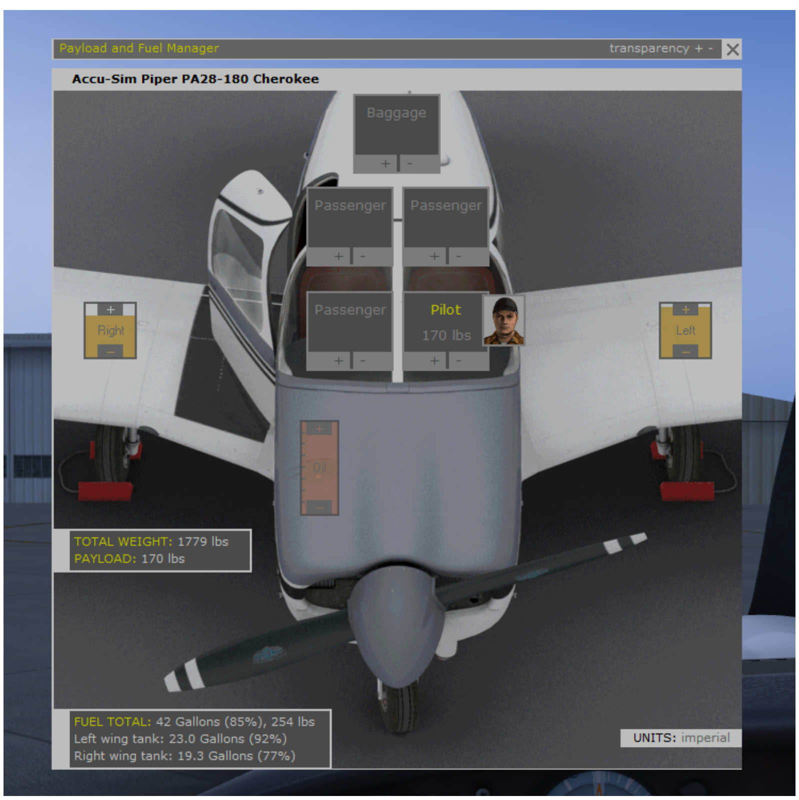


Controls (Shift 3)
Initially designed to provide a means to perform various in cockpit actions whilst viewing the aircraft from an external viewpoint, this control panel now provides quick access to a number of different commands.

From this panel, you can:

- Remove the pilot figure from the external view (only available whilst the engine is not running). Note the visual change in the aircraft balance when you remove the pilot.
- Control electrical systems such as the generator or magnetos.
- Toggle aircraft lighting, both internal and external.
- Change the GPS system installed in your aircraft, from a bracket mounted handheld unit, to panel mounted units, or no GPS installed at all.
- Set whether you want the aircraft to already be in a Cold and Dark state when you first enter it.
- Have your aircraft switch to a "Used" state, where some aircraft components will immediately show signs of wear. Check your maintenance hangar before you go flying, so that you're aware of the systems and components that you'll need to keep an eye on.
- Turn Accusim damage on and off.





Payload and Fuel Manager (Shift 4)
The payload and fuel manager not only gives you an overview of your current payload, fuel and oil quantities, it is also an interactive loading screen, where you can:

- Add and remove passengers and baggage.
- Increase or decrease pilot, passenger and baggage weights.
- Add or remove oil in the reservoir, and change the oil viscosity depending on seasonal changes.
- Add or remove fuel from the wing tanks.
- Change between viewing weights and measures in imperial or metric format.
- View, at a glance, total aircraft weight, payload weight, and total fuel quantities.

Pilot's Map (Shift 5)

The pilot's map gives full and easy access to information that may be found on real maps, and allows this information to be accessed from the cockpit, as opposed to using the default map via the drop-down menus.

The accompanying panel to the map allows you to select what information you want to have displayed on the map, from a compass rose to low altitude airways.

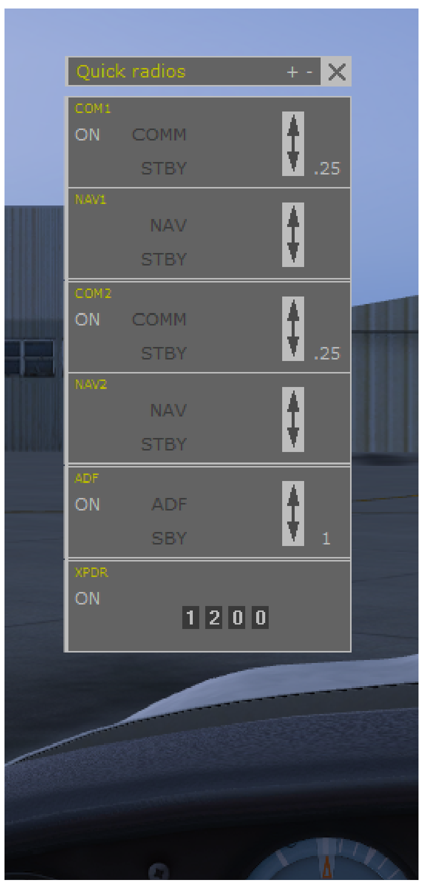
Also note that some of the button selections have an increasing amount of information presented with each subsequent button press.

For example, the **APT** (Airport) button will show the following information:

- **APT 1:** Airport ID.
- **APT 2:** Airport name.
- **APT 3:** Airport elevation.
- **APT 4:** Airport radio frequencies.

Quick RAdios (Shift 6)

This small popup panel provides input for your virtual cockpit radios but in a simplified and easy to use manner. This popup features all the amenities of the actual radios but in a singular unit which allows you to control your communication, navigation, ADF and transponder radios from a single source.



Maintenance Hangar (Shift 7)

The maintenance hangar is where you can review the current state of your aircraft and its major systems. It is one of the core elements to visualizing Accusim at work.

With the invaluable assistance of your local aircraft maintenance engineer/technician, a.k.a "grease monkey", you will be able to see a full and in-depth report stating the following:

- A summary of your airframe, engine and propeller installed.
- Total airframe hours, and engine hours since the last major overhaul.
- General condition of the engine.
- Important notes provided by the ground crew.

From the maintenance hangar, you can also carry out a complete overhaul, by clicking the **COMPLETE OVERHAUL** button in the bottom right corner. This will overhaul the engine and replace any parts that are showing signs of wear or damage, with new or reconditioned parts.

In order to fix any issues the mechanic has flagged up, we need to inspect the engine in greater detail. By left clicking the "CHECK ENGINE" text on the engine cover, it will open the following window.

COLOUR CODES:

- **GREEN: OK**
- **YELLOW: WATCH**
- **RED: MUST FIX OR REPLACE**

Heavy wear or a component failure will be shown in red, and these components must be replaced.

We can choose to continue flying with the worn components, but extra care should be used and a close eye kept on those systems/components.

Any component with a yellow highlight is worn, but not unserviceable, so do not have to be replaced.

Compression Test

At the lower right hand corner is a **"COMPRESSION TEST"** button, which will tell your mechanic to run a high pressure differential compression test on the engine cylinders.

This is done by compressed air being applied through a regulator gauge to the tester in the cylinder. The gauge would show the total pressure being applied to the cylinder.

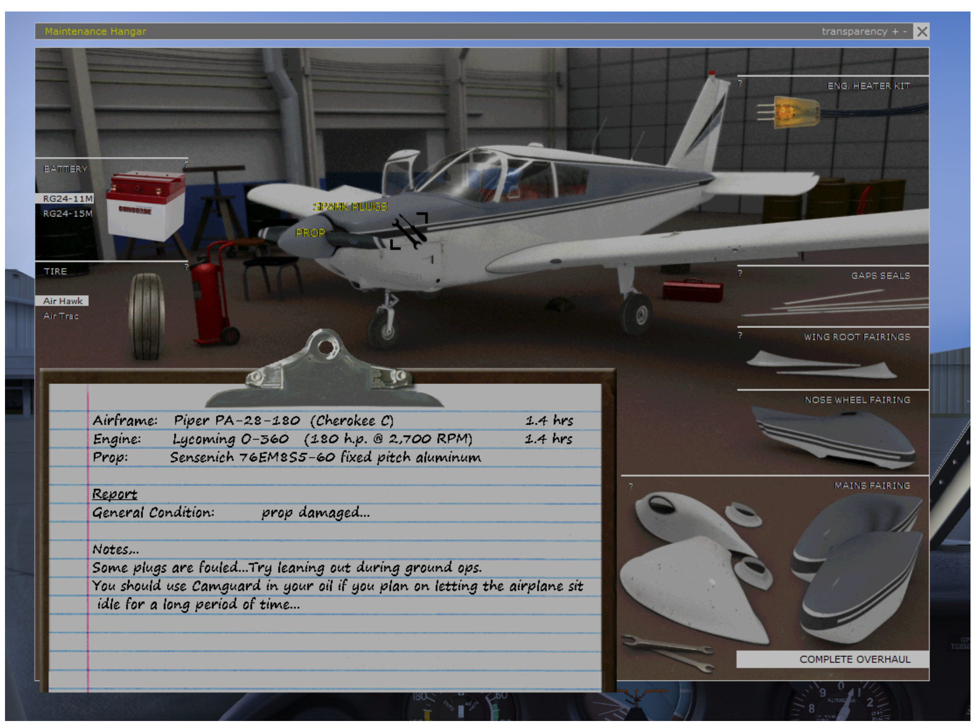
The compressed air would then pass through a calibrated restrictor and to the cylinder pressure gauge. This gauge would show the actual air pressure within the cylinder.

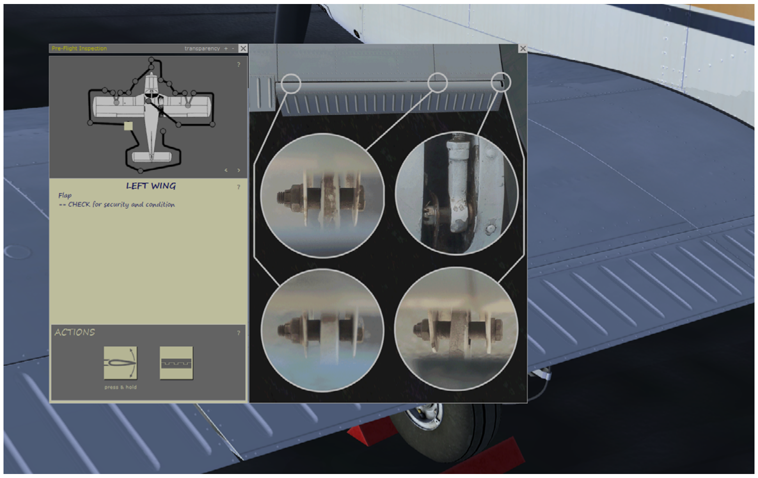
Any difference in pressure between the two gauges would indicate a leak of air past the engine components, whether that is the valves, piston rings, or even a crack in the cylinder wall itself.

The readings that your mechanic presents to you in the "Compression Test Results" in the notes section, will be annotated with the actual amount of pressure read in the cylinder over the actual pressure that was applied to the cylinder through the regulator.

Low compression on a cylinder isn't necessarily a terrible thing, because as the engine picks up in speed, the worn cylinder becomes productive. It is mostly noticed at lower R.P.M.'s where the cylinder may have trouble firing, and also a marked increase in oil consumption may also occur (sometimes with an accompanying blue smoke out of that cylinder during flight).

However, note that this is a reading of the general condition of the cylinders, and lower condition does bring additional risks of failure, or even engine fires.





Pre-Flight Inspection (Shift 8)

The Pre-Flight Inspection is another advancement in bringing real life standard operating procedures into FSX.

The inspection system is done in such a way as to emulate making your walkaround inspection prior to flight.

There are 19 separate check sheets which are accessed by clicking the arrows in the bottom right corner of the aircraft top-down view window.

As you select the next check sheet, you will automatically be moved to the relevant view around the aircraft.

It's not just a case of clicking the next check sheet over and over again however, as there are actions to be carried out and visual checks to be made in order to complete the pre-flight correctly. If you miss something, maybe the landing light lens cover on the leading edge is smashed, expect to be notified by your mechanic in the Maintenance Hangar, as his sharp eye will pick up anything you miss.

The checklist itself shows an overview of the aircraft, with your walkaround route in black, and dots to highlight the areas where subsequent checks will be carried out.

The check list starts with actions to be carried out in the cockpit, prior to your walkaround.

Ensure that the checklist is carried out correctly, as checks and actions missed here, will prevent you from carrying out the proper checks during your walkaround.

The first of the external checks covers the tail area. The checklist now has an additional bottom section in which specific actions can be carried out, or additional views can be accessed as a reference to what to look out for.

By left clicking on an action button, it will either perform an action, i.e. remove the tail tie down, or it will bring up a reference picture. In the example below, we're looking at the elevator hinges.

As part of the walkaround, checking the fuel tank sump quick drain valves is an extremely important check. If water enters the engine, expect a brief interlude of coughing and spluttering, quickly followed by the sound of silence.

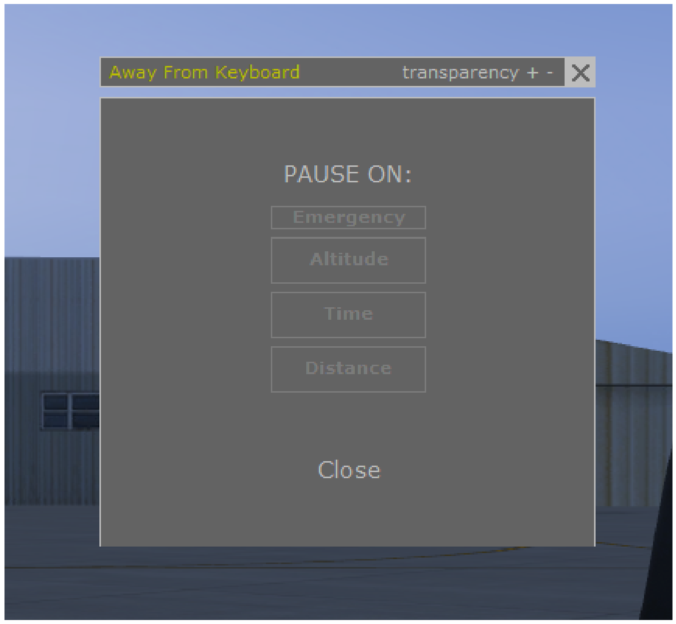
The oil dipstick is not only essential in gauging the total oil quantity, but also the condition of the oil. As you put hours on your engine, expect the oil to become darker due to suspended particulates that are too fine to be trapped by the filter. The oil also goes through chemical changes, which over time means that the oil isn't as capable of protecting your engine as it was when new.

Pause Control (shift 9)

The pause controls are made available for those times when you need to be away from the simulation.

By left clicking the various boxes, you will turn that pause command on, and for the Altitude, Time and Distance boxes, a plus and minus arrow allow you to change the values for when the pause command will be issued.

If more than one box is switched on, the first trigger to be reached will pause the simulation.



CREDITS

MICROSOFT:
Creators of Microsoft Flight Simulator X

EXTERNAL AIRCRAFT ARTIST:
Michal Puto (lead), Marcelo da Silva

INTERNAL AIRCRAFT ARTIST:
Robert Rogalski

PROGRAMMING:
Scott Gentile, Robert Rogalski, Michal Krawczyk, Krzysztof Sobczak

PUBLIC RELATIONS, WEB DESIGN:
Lewis Bloomfield

LEAD CONSULTANT:
Dudley Henriques

DIRECTOR OF QUALITY CONTROL:
Oskar Wagner

VISUAL EFFECTS AND AUDIO:
Scott Gentile

MANUAL:
Mitchell Glicksman, Scott Gentile

MANUAL EDITING AND PROOFREADING:
The beta team

MANUAL GRAPHIC DESIGN:
Mark Kee

SPONSORS:
Phillips66 Aviation, Knots2U, Champion Aerospace,
ASL Camguard, Concorde Battery, and Lord Corporation.

QUALITY CONTROL BETA TEAM:
The world's most effective and knowledgeable flight simulation beta team, including Cody Bergland, Forest "FAC257" Crooke, Glenn Cummings (GlennC), Ryan "Hog Driver" Gann, Mitchell Glicksman, Captain Jakey, Erwin Schultze (dutch506), Guenter Steiner, Paul "Gypsy Baron" Strogen, Gunter "Snorre" Schneider, Matt "mattgn" Newton, Lewis Bloomfield & Oskar "lonewulf47" Wagner.

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